DiVAI 2014

10th International Scientific Conference on Distance Learning in Applied Informatics

Conference Proceedings

May 5 - 7, 2014

Štúrovo, Slovakia

Wolters Kluwer

Constantine the Philosopher University in Nitra
Faculty of Natural Sciences
Department of Computer Science

and

University of Hradec Králové
Faculty of Science
Department of Informatics

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Preface

Dear readers!

Publishing is a reflection of the quality of a university teacher. During his/her teaching career, he/she can potentially encounter many issues which must be tackled in order to improve the quality of the teaching process, and to put the results into practice. In the current era of modern technology, characterised by information and communication, it is important that the department or institute providing university education establishes itself by publishing nationally as well as at the international level.

We, at the Department of Computer Science at the Faculty of Natural Sciences at Constantine the Philosophy University in Nitra, decided 12 years ago to organise a conference focusing on the use of ICT applications in the teaching of computer science. In the early years of the conference we were very careful about the number and quality of articles presented and the participants invited. The participants came mostly from Slovak and Czech computer science departments, which were not highly regarded by other departments for their use of modern information technology to support the teaching at their faculties. In the first few years of the conference (called DIVAI - Distance Learning in Applied Informatics), the powerful community of computer science experts has successfully proved that supporting teaching by using Internet tools has its merits and deserves a permanent place mainly in long-distance learning. Departments of computer science in Slovakia and Czech Republic started to use these tools and created suitable educational environments for the use of their applications. For our department, such a tool was the learning management system Moodle, which is still in use, not only at our department, but also in the majority of European countries.

Later, conference participation was extended to experts from other countries, such as the Czech Republic, Poland, Slovenia, Lithuania, Latvia and Hungary. This year, the 10th conference, we will welcome participants from Serbia, Ukraine, Tunisia, Brazil, Austria and other countries. The conference has one aim in common with the university system - to utilise Internet services and tools focusing on eliminating barriers to continued cooperation in this area.

After finishing the 9th conference and based on the reviews and feedback of the conference participants, we sent the conference proceedings to Thomson Reuters' Web of Science database for indexing. After some time, we were honoured by receiving a positive evaluation following indexing in the WoS database. At this year's conference, we will publish (in printed form) accepted and reviewed high quality contributions. We have asked the Prague headquarters of Wolters Kluwer, the renowned publishing house, to publish the proceedings. We believe that after the rigorous review and selection of the best contributions, you will receive a professional and high quality published document on the use of modern IT tools during the university teaching process.

In conclusion, I hope that all readers of the conference proceedings document regard the document highly and I also hope to it is useful and informative to all those who are interested in these issues at all levels of education in their specialised fields.

I want to express my deep gratitude and thanks to all members of the programme committee, as well as to the members of the organising committee for their willingness and helpfulness during the preparatory stage of the conference. I would also like to thank them in advance for their help during the running of the DIVAI 2014 conference and during the publication editing for the final version which will be submitted to the Thomson Reuters WoS database for indexing. We believe that the publication will be positively regarded not only by the readers, but also by the evaluators at Thomson Reuters.

Milan Turčáni

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Keynote Lectures

Integrating Personalized Learning with Industrial Cooperation

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Abstract

The paper compares approaches used at the best institutions worldwide based on open online courses (MOOC) with massive impact (thousands, tens of thousands of participants in a course and millions all together), and approaches applied in our context, which in principle can not benefit from a globally known institution name neither bet on secondary effects, such as attracting me hundreds of potential quality candidates for postgraduate studies at them in large. The model used at Masaryk University, Faculty of Informatics is based more on individualization of learning passages for students from a much narrower region (Czech Republic, Slovakia and surroundings) but can benefit from long-term, close, and rich collaboration with companies of various character and focus. Technology alone played there a less important role - automation of management of the entire passage is difficult and not so essential. Anyway, it is important to grasp the process, tracking outcomes, quality and integration in the context of those programs rather than creation of new study programs for students massively coming from outside. What is common for both approaches is a focus on the individual needs of learners and sustainability that are addressed by both approaches but much different ways.

Keywords

Collaborative learning. Computer and Information Science Education. Business.

INTRODUCTION

Personalized learning is gaining on popularity in primary and secondary education in the US schools in the last couple of years (McClaskey, 2014). With some delay, we will encounter this trend in the following years at our universities. The aim of this paper is to identify flexible and sustainable ways to provide personalized university education in ICT or similar disciplines. Primarily, it will provide definitions of the concepts of *individualized*, *differentiated* and *personalized* learning. Secondly, we characterize MOOCs (Massive Online Open Courses), their business models, sustainability, and potential to be personalized. We claim that MOOCs are not a sustainable way to establish personalized studies at typical Central-European public university institutions. Alternatively, we propose a model for personalized studies engaging industrial cooperation.

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FROM CLASSICAL THROUGH INDIVIDUALIZED TO PERSONALIZED LEARNING

Though we are targeting different groups in different context – universities, it is equally important to see what is currently changing in the primary and secondary education. Thus, we can discover what the children will gradually *know*, *expect* and be *used to do* when they come to a tertiary educational facility – university. Therefore, we will be ready to make further steps to satisfy their natural expectations.

Individualized learning means the teacher still directs the teaching-learning process but reflects individual needs by instructing the individuals differently (Bray & McClaskey, 2013) while *personalized* learning requires the learners to drive their learning themselves. As a "lighter version" of individualized approach, Bray and McClaskey use the term *differentiated teaching/learning* when the teacher differently instructs groups instead of individuals. The main distinguishing features of the three approaches can be categorized as follows:

Table 1. *From Frontal Teaching To Individualized Learning*
(Bray and McClaskey, 2013) extended by Tomáš Pitner

dimension	frontal	individualized	differentiated	personalized
responsibility	teacher	teacher considering individual needs	teacher considering different (group) needs	learner helped by teacher
goals (target competencies, content, form)	teacher -based on curriculum	teacher identifies global + individual goals	teacher identifies different goals for different groups	set and maintain by learner
instruments (ways, tools)	teacher selects on "one size fits all" basis	selected by teacher to fit the learner individual needs	selected by teacher to fit the group needs	learner acquires skills to set up the plan, select the tools
interpersonal (collaboration, teamwork abilities)	either none or directed groupwork	more individual	groupwork	networking to peers, teachers, others
assessment (benchmarking, testing, grading)	assessing learning a classical way, assess what has been learned	assessing learning a classical way with some exceptions	of learning and for learning, partially used to improve learning	learning by assessing and assessing to improve learning

Most conflicts between classical (frontal), individualized, differentiated and finally personalized arise from the clash of responsibilities – since the curriculum and traditions require the teacher to be responsible for the overall process and its results, and learners are expected to accept this subordination even though the their personal future is in game.

Personalized learning recently faces two main challenges: Primarily, it needs to be massive enough to achieve efficiency. Secondly, it must shift from traditional concept of *personalization* (actually called *individualization* in Table 1) of predefined matter by selecting the content and form appropriate for the given learning profile of the respective student to really *personalized learning* directed by the learner not the teacher. Educational

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institutions succeeding in combining these (partially contradictious) requirements will go the right way.

MOOC AS INSTRUMENTS FOR PERSONALIZED LEARNING?

Not earlier than in the last 2-3 years, *online open courses* offered already for a longer time by major universities turned to be really massive and finally became a revival of the old idea of gradual replacement of traditional college education by online courses. It took at least a decade to provide (broadband) Internet availability to masses and to have massively scalable enterprise technology to be used for operating e-learning systems being able to serve hundreds of thousands of online users. The *MIT OpenCourseWare* can be seen as a precursor of todays MOOC in a smaller scale than we encounter today.

What is MOOC

MOOC courses are characterized to be *Massive*, i.e. serving masses of students at a time; with current available technology up to hundreds of thousands per course can be achieved – e.g. Udacity's CS101, with an enrollment of over 300,000 students is supposed to be the largest MOOC opened so far (Ripley, 2012).

MOOC can be divided into two conceptually different groups (Siemens, 2012). One concentrates on *connectivistic* approach, relying on group collaboration, peer –review and community, whereas the second resembles more a kind of *broadcasting* and is thus closer to a frontal in-class education, which might be supported by technology. The latter employs automated feedback through objective, online assessments instead of communication with humans. The distinction is not primarily determined by technology, there can be different approaches used by courses promoted on the same platform.

Traditional vs. New Features

Riplye report about the founders of Udacity, professors Thrun and Norvig recognizing that MOOC must provide the students with a completely different experience than mostly broadcasting: "*So they started planning lessons that would put the student at the center of everything. They created a series of problems for students to solve so that they had to learn by doing, not by listening." quoted in (Ripley, 2012)*

However, Bousquet (2012) claims that big MOOC operators like Udacity will probably stick with the traditional model of (though enhanced) broadcasting and online testing being driven by cost-cutting efforts, instead of letting excellent professors sustainably maintain online community around MOOC. The business model will finally determine the sustainability of MOOC and their profiling.

Business Models

The major MOOC platforms like Udacity, Coursera and Edx have attracted robust financing from either venture investors (in dozens of millions USD), major universities like MIT, Stanford, Harvard, Princeton joining or even initiating the movement, and gaining technological support from dominant online players like Google. Udacity, Coursera and Edx are now seen as *Ivy League for the masses* (Ripley, 2012). There are many expectations related to MOOC in general. Among others, students or their parents hope MOOC can

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lower the tuition costs that have bloated up causing nearly $1 trilion of students loans accumulated over years – which holds not only for the Ivy League level schools but for the system as a whole.

Situation in Europe

In continental Europe, and particularly in new EU Member States (NMS) the situation is completely different. The burden caused by loans mostly does not specifically relate to university studies, and in most countries in NMS category, the tuition is not paid at public schools at all, being limited to private institutions. Therefore, there is one argument less for raising the popularity of MOOCs. Moreover, achieving a formal university degree is still supposed to be at least equally important as the knowledge and skills gained during the studies. So, MOOCs in Europe cannot compete with other (traditional) modes of study with lower costs.

Limitations

To summarize, MOOCs in general are challenging traditional colleges by providing potentially cheaper tuition (Kim, 2012) but, particularly in Europe, they: a) only rarely provide a university degree which is still demanded by majority of students, b) it is unclear whether the free-for-student business model is sustainable in a longer run, highly likely not without sacrificing quality; c) the personalized or differentiated, student-centred approach is not seen by default. Finally, it is d) difficult to personalize the mostly learning content and activities mostly predefined by the tutor/course author.

The inability to personalize a mass course is not only caused by cost savings and thus reductions in the number of tutors that would assist individual participants on their learning paths. A more serious obstacle which is in principle impossible to remove completely is the absence of a *lively (eco)system* around each MOOC course/activity. Though MOOC can feature hundreds of thousands participants even in a single course run, it is difficult to provide a fully-fledged, campus-based study environment with end-to-end guidance that is expected to really achieve personalized learning experience.

Considering the drawbacks of MOOC approach and the inability to take advantages of MOOC in our (i.e. a Central-European public university) context, we further claim we can find study models better reflecting the needs of our students while keeping the system cost-effective and sustainable. Primarily, let us look at the conceptual background we for designing and implementing personalized learning.

FOUNDATIONS OF PERSONALIZED LEARNING

We build our view on originally psychological *Person-centered Approach* introduced by Carl Rogers (1961) and applied not solely in psychotherapy but also widely in teaching (Rogers, 1983) an subsequently in *Person-centered Technology-enhanced Learning* by Motschnig (2005).

Later on, Derntl (2005), and Derntl et al (2007) published a series of works related to design and deployment of *learning patterns for person-centered technology-enhanced learning*, followed recently by design of patterns suitable for *secondary education of ICT* proposed by Standl-Gruber (2014).

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Now we propose a *set of patterns for personalized learning* that is enabled by close academic-industrial collaboration as implemented at Masaryk University, Faculty of Informatics in the last decade.

PATTERNS OF PERSONALIZED LEARNING

Traditionally we *adapted* (*personalized*) the *content*, the level of *detail* (*depth* or *difficulty*), and the *form* to individual needs (e.g. learning style). However, having the distinction between individual, differentiated, and personalized, the traditional adaptive learning was rather *individualization* than *personalization* as the content emerged from the teacher. Now we target *personalization* combining individual student-centered study goals. The following patterns of personalized learning enable effective and efficient personalized learning on a relatively large scale.

Study fields (programs). Nowadays, we observe a decreasing ratio of obligatory courses in favor of optional ones within our study IT-targeted program. The trend started almost one and half decade ago, around the end of 90s with the European "Bologna system" boosting it by forcing the university education to be more transparent by clear separation of study stages and transferable credits EU-wide. FI MU was one of the first Czech academic institutions reflecting this in their study programs. Later in 2000s, the *Service Science, Management and Engineering* (SSME) program was launched as the first one not solely founded on the traditional combination of theoretical informatics and/or information technology. This change offered the students a completely new degree of freedom of choosing their own path to learn computer science.

Wide spectrum of courses. During its evolution, FI MU has collected an ensemble of several hundreds of unique courses (around 400) given each year, which is likely the maximum reached at Central-European IT-teaching colleges so far. Together with the freedom of choice, this rich spectrum of courses makes the fundaments of learning personalization at FI MU.

Interims. With the advent of new business-oriented study programs, namely the SSME at FI MU, a great portion of the student/learner time spent moves from in-class learning to interims in companies, being set up based on individual preferences in combination with business requirements and the influence of the study program profile defined by the university. This helps the student to understand the necessity of mutual understanding between individual vision and needs of the reality.

Contests. College learning should not be seen as limited to credit courses only. On the contrary, the school should encourage students to see themselves as *learners* who are responsible for their achievements. If we succeed in it, then less formal or informal learning experiences are equally important as completing credit courses. Various contest, focused e.g. on open-source software development or solving a given (authentic or synthetic) software development task, are an organic way to improve not only software development-related skills, but also communication competencies, and other personal qualities, such as reliability, patience, and endurance when confronted with real life of "social coding" representing the current mainstream paradigm for open-source development. Another format of competitions is targeted at solving concrete problems emerging from the needs of industrial partners.

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Lab Interims are another way to confront the theoretical knowledge gained during the SSME and previous studies. While *Interims* engage the students in collaborating companies where they usually act as assistants to managers, help to communicate with the clients, or improve processes among others, the *Lab interims* mean participation in a research lab usually on a local research institution. Such interims broaden the supply of individual learning option by enriching it with research dimension. Research itself is a combination of individual and team effort and allows satisfying individual needs by selecting the right research lab for hosting the interim.

Bachelor and Master Theses. Writing and defending the theses represent the final steps to attain the university education. The university legislation allows the students to either select the topic of the thesis from the list provided by the faculty or propose their own one. This provides a great level of freedom given the faculty has enough supervisors willing to supervise topic brought by the students while still being able to help the students. It requires much broader grasp than the traditional model based on the topics proposed by the professors and selected (perhaps modified) by the students.

Coaching pushes the individualized learning to its maximum. It is completely individual and self-paced. The coach does not direct the coached person but helps him/her to find his/her own ways by discovering the inner potential. FI MU enriched its portfolio by coaching in 2013, starting the first round of coaching by identifying the initial set of potential coaches from academia and industry and then training them.

In-term Projects represent a lightweight enrichment of individualized elements in university education. The course featuring in-term project is an efficient way to combine *frontal education* (easy, cheap) and *individual learning* achieved during working on individual or team projects with a reasonable level of freedom, so usually the project is not composed by a fixed set of task but instead, its topic, technology is selected or created by the student(s) who participate in it.

Courses by Industrial Partners. FI MU established its Association of Industrial Partners (AIP, www.fi.muni.cz/for_partners) in 2007 after a decade of mostly informal cooperation with companies. AIP focuses on long-term cooperation measured primarily by intensity of collaboration in co-supervising graduation (bachelor- and master-) theses with certain lower bounds for each category of the partnership. However, apart of theses supervision and research cooperation, teaching activities are a vital component of a working cooperation. Both parties can benefit: the company keeps in touch with the students, their potential employees; students are in contact with real-life experts. There is usually one precondition, though not a *conditio sine qua non*: it works the best if the lecturers/tutors coming from the company have authentic experience from the university where the course takes place.

Research with Industrial Partners is undoubtedly one of the ultimate goals of academic-industrial cooperation as seen from the FI MU perspective. However, it also brings another level of individualization of study passages for talented and motivated students wanting to skip the baseline of study requirements and do more. Participation in a research team involving an industrial partner brings several advantages. Primarily, the research problems authentically emerge from practice. Secondly, the participation means direct contact and collaboration with potential future employer with the chance to continue working on a similar problem further.

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Participation in projects is a similar way to involve gifted students in university activities. In some aspects, this kind of individual participation can offer even wider options than pure engagement in research. Students – project collaborators can act not only as research assistants but also as junior managers or in administrative positions. It allows them to broaden their competencies behind the standard curriculum, to establish closer contacts to local academics as well as project partners, frequently also coming from abroad.

Courses with "open" content. The syllabi of obligatory courses at FI MU are under supervision, as they affect the profile of graduates. However, the flexibility is bigger for optional courses – the content can change from one year to another, it can even be partially adopted *en passant* during the semester if an interesting topic emerges. The flexibility makes it an instrument for further individualization of studies. It is a typical case that a student working on a master- or PhD- thesis in a lab presents his/her either intermediate or final results in the lab seminar while the audience can intercept, comment, and be inspired for their own work.

Courses fostering entrepreneurship are a new (and in many sense unique) way to encourage students to run their own businesses. Since the demand for highly qualified IT stuff in Brno and CZ in general rises during the last years, it is not easy to think about taking the risk and establishing an own business instead of accepting a well-paid job e.g. in an international company. Despite this fact, FI MU together with partners like the South Moravian Innovation Centre run a course focusing on helping the students – potential young entrepreneurs with the first steps towards their own business and avoid usual mistakes and frustrations.

User groups such as Java-, Google-, or Microsoft-, but also TeX- or Linux- User Groups represent extra-curricular activities mostly driven by students themselves. The faculty can help with the rooms and ensures certain support of management and promotion. Local user group members or companies' representatives bring the content in. The attendance extremely varies depending on topic – famous names or hot topic, such as mobile development, attract dozens, even hundreds students for such event. The "brand name" of the particular user group helps to catch the primary attention of students but it does not work automatically – good content is always the key.

ROLE OF INDUSTRIAL COOPERATION

From the above patterns that have been designed, introduced and tested throughout the last years, we can identify a significant role of the industrial partners. We summarize the influence of the academic-industrial collaboration on personalization of learning in Table 3. The table indicates for each activity whether it contributes to either frontal (traditional), individualized, differentiated, or personalized learning.

Table 2. Influence of academic-industrial collaboration on personalization of learning (current state at FI MU, 2014)

academic-industrial activity	frontal	individualized	differentiated	personalized
Co-design of curriculum;	General changes in curriculum	Enabling individualized	Enforcing presence of	Setting partially personalized goals of

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Extending spectrum of courses	reflecting the needs of the industry; courses based on lecturing	activities, eg. interim projects	team-project learning patterns	eg. interims; most of industrial courses voluntary - students select
Contests	Same tasks for all	Participants can select concrete tasks individually (out of available)	Different groups participate in different contests	contests voluntary, students choose which one and/or select tasks
Lab interims	N/A	Interim goals very individual but emerge from needs of the lab and company	N/A	lab interims voluntary, students choose and negotiate the content
Theses	Common (formal) academic requirements	Problems defined by student or supervisor (academic or industrial)	N/A	Student selects topic, time, and can tune the content (but limited with industrial involvement)
Coaching	N/A	N/A	N/A	Fully personalized but not for everybody due to low number of coaches
In-term projects	Usually the same framework for all	Individual selection of topic	Group selection of topic, teamwork	space for personalized goals
Participation in research	rarely frontal (for all)	Depending on researcher's ability to assign tasks to student's individual needs	Goes more easily for groups	Methods or even goals might be partially personalized
Courses fostering entrepreneurship	Some frontal content but for small number of students	Maybe some teacher-defined individual content	Ideal when "one group per one business idea"	Always predominantly personal preferences – student wants and defines

INSTITUTION'S ROLES REDEFINED BY PERSONALIZATION

We argue that the above identified and implemented learning patterns contributed to redefining and redesigning the legacy university education and the teacher's role in ICT-related fields in order to:

Responsibility. We try to educate students to *think and act independently*. We encourage them to think before they act because they must feel they have the *responsibility themselves*, neither their teacher, nor their coach, nor their team lead. It is

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not true that students coming to the tertiary education consciously accept the above roles, at least now yet. They might even not be aware of them. It is our duty to make them familiar with this *way of thinking*.

Incompleteness. Personalized learning or even personalized education of our students are just parts of their personal and professional development and there are many more factors than just the school and certainly more than just *our* school. So we should *not overestimate* our impact on their personal and professional preferences and achievements.

Teacher is not just coach. From the above statements, it looks like the teacher in a personalized learning setting is a coach. This is, however, not completely true. The teacher always plays a mixed role – the teacher should have many qualities typically attributed to coaches but we find differences here. Namely, the teacher is expected to act as a mediator between the expectations of the society (government, stakeholders at schools, or scientific world), and the learner. In this sense, the position of the teacher exposes some (although limited) similarities with coaches hired and paid by a company to help e.g. managers to improve their skills *in the interest* of the company who pays for it. Such *external interests* should, however, play a significantly weaker role at the university.

CONCLUSION

Primarily, the paper showed trends in educational towards personalization. Then, the potential of massive open online courses in providing personalized learning has been discussed. Thirdly, our personalization effort based on Person-Centered Approach and industrial cooperation was introduced together with a set of concrete learning patterns. Finally, we summarized how personalization changes the role of institutions. Using personal learning environments or other IT tools for facilitation of personalized learning with industrial cooperation remains an interesting topic for further research and development.

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Usage of Social Networking Websites: Lithuanian, Slovenian and Russian University Students' Position

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Abstract

It is obvious, that information communication technologies (ICT) are developing very intensively. Over the latter decade, fast growth of social networks as of a special ICT device (SNW) is observed, the increase of their diversity both from a functional and consumer point of view. One can claim that SNW permeate into all human activity spheres. Social networking websites "move" into educational area as well. Nowadays a lot of various social networking websites (or technologies devoted to creation of social networks online and their effective usage) are used not only for entertainment, leisure or communication, but also for teaching/learning purposes. Therefore, it is very important to understand the main motives of using social networking websites, to analyse their probable advantages and disadvantages. This research relates to the usage of social networking websites. The purpose of the research is to ascertain how university students from three different countries (Lithuania, Slovenia, and Russia) use social networking websites; how they value them; what opinion they have about various social networking websites; what they know about them. A questionnaire, Social Networks, with 16 questions was used in the research. The original questionnaire was translated into the national languages by the local researchers involved in the study. This research was carried out in 2013-2014, recognizing that it is especially important to understand the essential motives of using social networking websites, to analyze their probable advantages and disadvantages, to make some comparisons among students from the different countries. Students pointed out different SN website advantages and disadvantages, expressed their general view and position.

Key words

Evaluation. Education system. ICT. Social Networking Websites. University students.

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INTRODUCTION

The growth of the usage of social networking websites is determined by various reasons however, ICT rapid spread is one of the most determining factors, firstly. New technologies provide various possibilities. Speaking about social networking websites, it is worth to emphasize their diversifiable possibilities. The functionality of social networking websites (SNW) is increasing, diversifying and this in its own way opens different possibilities for the consumers, also serves as a factor encouraging the usage of social networking sites.

SNW advantages and disadvantages are analysed in various aspects, more and more different level research studies are carried out. First of all, it remains unclear, how SNW usage changes personality features and identity. The carried out experimental research (Gentile, Twenge, Freeman, Campbell, 2012) showed, that the time spent in social networking websites influences more positive self-evaluation of the youth, though this also depends on a concrete internet cafe. Earlier carried out research studies revealed that social networking websites are a very popular student communication device, a powerful instrument of socialisation. On the other hand, the mentioned research revealed, that time shortage and a very great SNW variety are hindering factors for the consumers to involve into social network cafes (Luo, 2010). In T. Childers (2011) opinion, online social network tools and other provided possibilities can and have to be successfully used in academic work, e.g., communicating with colleagues and the learning people. This is rather effective, seeking to make students interested in writing activity and digital story telling. As an example the author gives http://education.skype.com as a perfect possibility joining the classes and allotting the teaching time. J. Kord and L. Wolf-Wendel (2009) analyzed SN and academic integration questions in the population of the first course university students. It was stated, that students spent 2.5 hours per day for SNW, mostly communicated with peers, friends and family. A minimal interaction with teachers and other university community members was observed. It shows once again, that the usage of SNW for academic purposes still remains problematic.

The research of SNW usage in five countries (Lithuania, Romania, Ukraine, Czech Republic, Turkey) university student population showed that SNW are the most popular among Turkish respondents and the least popular among Czech ones. SN evaluations of other country respondents (LT, RO, UA) are close to average. For example, Lithuanian and Romanian respondents are convinced that SNW is a good means of spending leisure time. Turkish and Ukrainian respondents doubt in this, and Czech ones – do not agree with this statement. The statement, that *SNW provide national and international knowledge was evaluated at the highest by Turkish respondents*, Romanian, Czech and Lithuanian respondents do not doubt in this, and Ukrainian representatives doubt or do not agree. Romanian representatives state that SN is a reliable computer device, though respondents from other countries doubt in this or do not agree (Lamanauskas, Šlekienė, Ragulienė, Iordache, Pribeanu, Bilek, Cavas, Mazurok, 2013). The carried out Lithuanian university students' questionnaire qualitative analysis showed that students like SNW, because in them one can communicate with acquaintances, with friends and relatives living abroad, get acquainted with various people not only from Lithuania, but also from all over the world, find proper, useful information, share it with the other participants of the portal, entertain oneself i.e., play games, listen to music, see photos and so on. SNW is a joyful

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entertainment. Also, the respondents notice, that overindulgence in SNW not only increases addiction, but also distracts from real, true communication; communication skills in real life decrease, people alienate (Lamanauskas, Šlekienė, Ragulienė, 2012b). The research carried out in Romania also showed that the majority of students consider that SN websites partly improve communication abilities, while 32% consider that SNW usage has no influence on their communication abilities (Iordache, Lamanauskas, 2013). Turkish university teachers' (prospective teachers') rates of educational use and adoption levels of social networks, is quite high (Unal, Koroglu, 2013).

It is obvious, that social networking website developers should devote significant attention to develop safety standards as well as user-friendly navigation tools, as these measures can enhance trust as well as increase the number of users. Academic community should search for effective ways of using SNW in direct educational activity seeking for a higher study quality.

Thus, **research object** is the usage of social networking websites. **Research purpose** is to ascertain how 3 country (Lithuania, Slovenia, Russia) university students use social networking websites, how they value them, what opinion they have about various social networking websites, what they know about them. The main research questions are:

- What social networking websites do students know and use most frequently?
- What social networking website functions do students use and why?
- Do students like social networking websites and why?
- What do students know about how social networking websites use published personal and other type of information?
- What is students' attitude to possibilities provided by social networking websites?

METHODOLOGY OF RESEARCH

General Research Characteristics, Respondents

In the research organised by three countries – Lithuania, Slovenia and Russia in 2012-2013, participated 1343 respondents. University study 1st- 4thcourse students participated in the questionnaire. Out of them – 918/44.6% from Lithuania, 211/15.7% from Russia and 214/15.9% Slovenian students (table 1). More girls (942/70.1%) than boys (401/29.9%) participated: Lithuania - male 340/37.0%, female 578/63.0%; Russia male 35/16.6%, female 176/83.4%; Slovenia – male 26/12.1%, female 188/87.9% (table 1).

Table 1. Information about the respondents (N/%).

According to country		Lithuania (LT)	Russia (RUS)	Slovenia (SLO)	Total
		918/68.4	211/15.7	214/15.9	1343/100
According to sex	Male	340/37.0	35/16.6	26/12.1	401/29.9
	Female	578/63.0	176/83.4	188/87.9	942/70.1

This is a part of a complex research which has been carried out since 2012 (Lamanauskas, Šlekienė, Ragulienė, 2012a). The chosen countries represent separate regions, at the same time they are different in social, economic, technological respect.

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Three countries'- Lithuania, Slovenia and Russia University students' position from the point of view of SNW is presented in this work. Russia represents Eastern Europe region, Lithuania represents Central Europe, and Slovenia represents the Balkan region.

Instrument

The authors' prepared questionnaire was used in the research. 16 questions form the questionnaire *Social networks.* 3 questions in the questionnaire are allotted to establish the characteristics of the respondents, 5 open type questions. The 6th question was assigned to evaluate the frequency of social networking website usage. 23 main networking websites are presented in the list. The 8th question was allotted to evaluate the functions of social networking websites (e.g., communication, advertisement, friend search, information exchange and so on). Also, 26 various type statements about social networking websites were presented and respondents were asked to evaluate them applying the interval Likert scale (from "Completely agree" to "Completely disagree").

Statistical Data Analysis

In order to analyze research data, measures of descriptive statistics are applied (absolute and relative frequencies, popularity or usage indexes ($0 \leq PI/UI \leq 1$), and standard deviations. The closer is PI/UI value to 1, the more important, more significant is the statement to the respondent, or respondent better approves of it. The SSPS statistics batch is used as an instrument for data processing.

RESEARCH RESULTS

The analysis of the question in the questionnaire *How often do you use the internet*? showed that even 1181/87.9% of students use the internet a few times a day (table 2), 109/8.1% - once a day, 31/2.3% - 3-5 times per week, and less frequently – less than 2% of the respondents. The analysis in terms of countries shows that distribution is equal to average. The research showed that the absolute majority of the respondents use the internet and have the possibility to connect to it even a few times a day. Thus, for today's youth the internet is a necessity.

Table 2. The frequency of using the internet (N/%). N = 1343

Usage frequency	LT	RUS	SLO	All countries
A few times a day	795/86.6	191/90.5	195/91.1	1181/87.9
Once a day	81/8.8	13/6.2	15/7.0	109/8.1
3-5 times per week	26/2.8	4/1.9	1/5	31/2.3
1-2 times per week	12/1.3	2/0.9	1/0.5	15/1.1
Every two weeks	3/0.3	1/0.5	2/0.9	6/0.4
Less	1/0.1	0/0.0	0/0.0	1/0.1
Total	918/100	211/100	214/100	1343/100

It was interesting to know how much time on average the students spend on the internet during one visit. It turned out that the respondents during one visit on the internet spend a very different amount of time, i.e., for the majority of them it changes

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from 10 min. to two hours (table 3): from 10 to 30 min. - 347/25.8%, from 30 min. to 1h. - 319/23.8%, from 1 to 2h. - 308/22.9% respondents. Not a big part of the respondents (163/12.1%) spend more than three hours on the internet. This is more noticeable among Russian students, because even one fourth of them (53/25.1%) stay on the internet more than 3hours, and the other fourth from 1 to 2 hours (53/25.1%). However, the Slovenian students spend a shorter time on the internet i.e., even 110/51.4% spend only from 10 to 30 min. during one visit on the internet and 50/23.4% up to 1 hour. The great majority of Lithuanian students allot from 10 min. to 2 hours for one visit on the internet: 202/22.0% – from 10 to 30 min., 237/25.8% – from 30 min. to 1 h.; 242/26.4% from 1 to 2 hours.

Table 3. Students about the time spent on the internet (N/%). N = 1343

Time	**LT**	**RUS**	**SLO**	**All countries**
Less than 10 min.	16/1.7	2/0.9	21/9.8	39/2.9
From10 to 30 min.	202/22.0	35/16.6	110/51.4	347/25.8
From 30 min. to 1h.	237/25.8	32/15.2	50/23.4	319/23.8
From 1 to 2h.	242/26.4	53/25.1	13/6.1	308/22.9
From 2 to 3 h.	118/12.9	36/17.1	11/5.1	165/12.3
More than 3 h.	101/11.0	53/25.1	9/4.2	163/12.1
Missing	2/0.2	0/0.0	0/0.0	2/0.1
Total	**918/100**	**211/100**	**214/100**	**1343/100**

Having found out, how often and how much time the students spend on the internet, it was purposeful to ask how often and how much time they allot to social networks.

Analysing the question *How often do you use social networking websites* it was revealed, that the biggest part of the respondents - 834/62.1% - (table 4) visit social networking sites online at least a few times a day and 304/22.6% - at least once a day. Even 173/82.0% of Russian and 161/75.2% of Slovenian respondents visit social networking sites a few times a day, Russian 24/11.4% and Slovenian 33/15.4% - once a day, and the rest – 3-5 times per week and less. The distribution of Lithuanian students' participation in social networking websites is very close to average. It has been noticed, that the distribution of using the internet and social networking websites is, in fact, very similar, therefore, we can claim that the majority of the respondents every time they connect to the internet, always visit social networks as well.

Table 4. The frequency of visiting social networking websites (N/%). N = 1343

Visiting frequency	**LT**	**RUS**	**SLO**	**All countries**
A few times a day	500/54.5	173/82.0	161/75.2	834/62.1
Once a day	247/26.9	24/11.4	33/15.4	304/22.6
3-5 times per week	34/3.7	8/3.8	9/4.2	51/3.8
1-2 times per week	53/5.8	0/0.0	0/0.0	53/3.9
Every two weeks	17/1.9	0/0.0	5/2.3	22/1.6
Less	59/6.4	1/0.5	6/2.8	66/4.9
Missing	8/0.9	5/2.3	0/0.0	13/0.97
Total	**918/100**	**211/100**	**214/100**	**1343/100**

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To the question *How much time on average do you spend on internet social networking websites during one visit?* 537/40.0% respondents answered, that between ten minutes and half an hour, 253/18.8% - less than ten minutes (table 5) and 227/16.9% – from 30 min. to 1h. 167/12.4% of respondents stay in social networking websites from 1 to 2hours and only 63/4.7% spend more than 3 hours. Even 33/15.6% of Russian respondents stay in social networking websites more than 3 hours. While only 2/0.9% of Slovenian ones. Comparing with the time spent on the internet in general, one can claim, that social networking websites occupy not a small part of the time spent on the internet.

Table 5. Students about the time being spent on the social networking websites (N/%). N = 1343

Average time being spent during one visit	**LT**	**RUS**	**SLO**	**All countries**
Less than 10 min.	191/20.8	7/3.3	55/25.7	253/18.8
From10 to 30 min.	377/41.1	56/26.5	104/48.6	537/40.0
From 30 min. to 1h.	151/16.4	41/19.4	35/16.4	227/16.9
From 1 to 2h.	113/12.3	44/20.9	10/4.7	167/12.4
From 2 to 3 h.	43/4.7	25/11.8	8/3.7	76/5.7
More than 3 h.	28/3.1	33/15.6	2/0.9	63/4.7
Missing	15/1.6	5/2.3	0	20/1.5
Total	**918/100**	**211/100**	**214/100**	**1343/100**

The students were asked how they like social networking websites. The answers showed (table 6), that social networking sites are favourite and popular among the youth (PI = 0.69, SD = 0.30). Lithuanian respondents gave a smaller evaluation of the popularity of social networks (PI = 0.66, SD = 0.30) than Slovenian (PI = 0.76, SD = 0.32) and Russian (PI = 0.76, SD = 0.29) students.

Table 6. Attitude to social networking websites.

Do you like social networking websites?	**No (N/%)**	**Partly (N/%)**	**Yes (N/%)**	**Total (N/%)**	**PI**	**SD**
LT	63/6.9	502/54.9	350/38.3	915/100.0	0.66	0.30
RUS	8/3.8	86/41.0	116/55.2	210/100.0	0.76	0.29
SLO	16/7.5	72/33.6	126/58.9	214/100.0	0.76	0.32
Total	87/6.5	660/49.3	592/44.2	1339/100.0	0.69	0.30

(PI – popularity index, $0 \leq PI \leq 1$; SD - standard deviation)

Unfurling the answers according to SNW evaluation (*No, Partly, Yes*), one can see (Figure 1), that the bigger part of Slovenian (126/58.9%) and Russian (116/55.2%) respondents really like (Yes) SNW, and only 350/38.3% of Lithuanians chose that evaluation. Mostly Lithuanian respondents (502/54.9%) gave evaluation *Partly* for SNW. This attitude is smaller of Slovenia (72/33.6%) and Russia (86/41.0%). Evaluation *No* is bigger of Slovenian (16/7.5%) and Lithuanian (63/6.9%) respondents, and the smallest of the Russian (8/3.8%).

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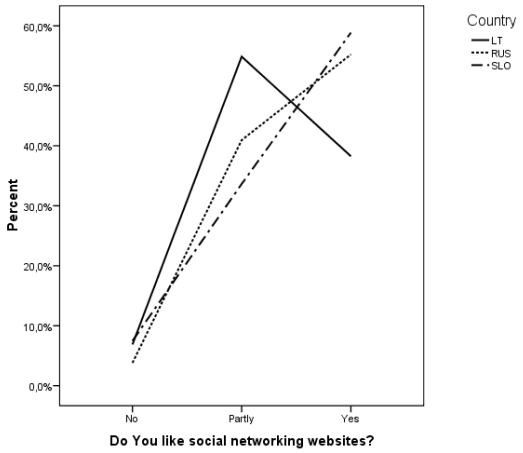


Figure 1: Evaluation of social networking websites

In the questionnaire 23 known social networking site names were presented for the research and it was interesting to find out, how often the respondents participate in them. Only 10 social networking websites were chosen for the analysis (table 7), because in the rest participate less than 1% of the respondents. All the other SNW mentioned in the questionnaire are visited very rarely, however, there isn't any which wouldn't be used at least by a few respondents. In these internet portals every consumer can create his profile, make friends, communicate in interest groups and so on.

The most popular SNW are 3, which are most frequently visited by the respondents, having participated in the research. Mostly visited internet networking websites are: *YouTube* (UI = 0.83, SD = 0.25), *Facebook* (UI = 0.77, SD = 0.39), and *Google+* (UI = 0.55, SD = 0.44). Though SN site *Facebook* is mostly used only by Slovenian (UI = 0.93, SD = 0.24) and Lithuanian (UI = 0.87, SD = 0.31) respondents, however, among Russian students it is not popular (UI = 0.18, SD = 0.28).

Table 7. Students about participation in social networking websites: usage frequency.

Social networking websites	**LT**			**RUS**			**SLO**			**Total**		
	UI	N	SD	UI	N	SD	UI	N	SD	UI	N	SD
Facebook	0.87	918	0.31	0.18	211	0.28	0.93	214	0.24	0.77	1343	0.39
Twitter	0.03	914	0.15	0.21	211	0.36	0.07	214	0.22	0.07	1339	0.21
My Space	0.02	913	0.11	0.02	211	0.11	0.03	214	0.14	0.02	1338	0.11
Windows Live Profile	0.03	913	0.15	0.01	211	0.07	0.04	214	0.16	0.03	1338	0.14
YouTube	0.87	918	0.21	0.60	211	0.35	0.91	214	0.16	0.83	1343	0.25
Flickr	0.03	914	0.14	0.01	211	0.06	0.02	214	0.13	0.02	1339	0.13
Reddit	0.02	914	0.12	0.01	211	0.07	0.00	214	0.00	0.01	1339	0.10
Dailymotion	0.03	914	0.13	0.00	211	0.00	0.01	214	0.08	0.02	1339	0.11
Vimeo	0.05	913	0.18	0.03	211	0.15	0.02	214	0.12	0.04	1338	0.17
Google+	0.58	914	0.45	0.50	211	0.43	0.49	214	0.43	0.55	1339	0.44
Others	0.23	407	0.40	0.88	211	0.31	0.00	214	0.00	0.33	832	0.46

(UI – usage index, , $0 \leq UI \leq 1$;SD - standard deviation)

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National social networking websites are worth mentioning as well. In the graph *Other* the respondents could enter still not mentioned SNW. Absolutely all Russian respondents entered national SNW *Vkontakte.* One can see*,* that SNW *Vkontakte* is the most popular SNW of all in that country (UI = 0.88, SD = 0.31). Lithuanian respondents pointed out such SNW as *Klase*, *One*. However, they were inscribed by less than a half Lithuanian respondents, having participated in the questionnaire (407/ 44%), besides, they are not visited frequently (UI = 0.23, SD = 0.40). Slovenian respondents did not point out any national SNW.

In terms of countries, 5 social networking websites were analysed in more detail: *Facebook*, *Twitter*, *YouTube*, *Google*, *Other* (Figure 2). From Figure 2 one can see, that Lithuanian and Slovenian respondents value *Facebook* (LT - PI = 0.87, SD = 0.31; SLO - PI = 0.93, SD = 0.24) and *YouTube* (LT - PI = 0.87, SD = 0.21; SLO - PI = 0.91, SD = 0.16) at the highest, however, for Russian respondents *Facebook* is not popular (PI = 0.18, SD = 0.28), *YouTube* (PI = 0.60, SD = 0.35) is more often visited. The most popular for Russian respondents is *Vkontakte*. *Google+* is similarly likable by all country respondents, having participated in the research: LT - PI = 0.58, SD = 0.45; SLO - PI = 0.49, SD = 0.43; RUS - PI = 0.50, SD = 0.43. Russian respondents like *Twitter* as well, but for Lithuania and Slovenia this SNW is very slightly popular: RUS - PI = 0.21, SD = 0.36; LT - PI = 0.03, SD = 0.15; SLO - PI = 0.07, SD = 0.22.

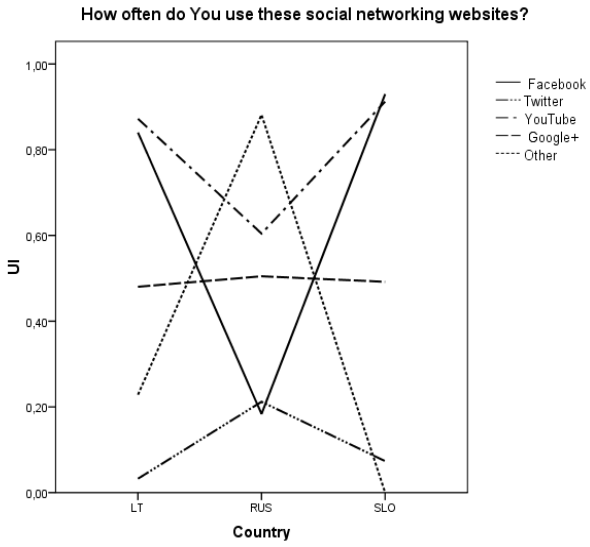


Figure 2: Evaluation of the use of social networking websites

The respondents were asked to evaluate social networking website functions according to their importance for them. 14 functions were presented and they had to be evaluated using five range scale from completely not important to very important. Popularity index was calculated (Table 8).

Table 8. Social networking website function importance.

Functions	**LT**			**RUS**			**SLO**			**Total**		
	PI	N	SD	PI	N	SD	PI	N	SD	PI	N	SD
Games (on-line)	0.22	914	0.30	0.17	210	0.27	0.23	212	0.26	0.21	1336	0.29

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Communication (including communication in interest groups)	0.76	916	0.29	0.81	209	0.28	0.82	212	0.23	0.78	1337	0.28
Exchanging photos, videos and so on	0.57	913	0.33	0.68	209	0.30	0.56	212	0.27	0.58	1334	0.32
Advertisement	0.24	914	0.31	0.26	210	0.34	0.42	212	0.30	0.27	1336	0.32
Learning and exchanging information	0.74	916	0.32	0.75	210	0.29	0.79	212	0.26	0.75	1338	0.30
Friend search	0.51	915	0.34	0.55	210	0.36	0.51	212	0.29	0.51	1337	0.34
Spending leisure time	0.53	916	0.31	0.53	210	0.33	0.50	212	0.28	0.53	1338	0.31
"Spying"	0.26	913	0.33	0.26	210	0.34	0.28	212	0.28	0.26	1335	0.32
Texting	0.61	917	0.33	0.63	210	0.35	0.63	212	0.28	0.62	1339	0.32
Link posting from internet	0.40	914	0.34	0.37	210	0.34	0.56	212	0.26	0.42	1336	0.33
Link posting using mobile phone	0.23	915	0.30	0.26	210	0.32	0.46	212	0.29	0.27	1337	0.31
Video conversations in groups	0.30	914	0.34	0.41	210	0.36	0.36	212	0.30	0.32	1336	0.34
Evaluation or "Read.Watch.Listen" technology	0.21	913	0.30	0.48	210	0.34	0.33	212	0.27	0.27	1335	0.32
Flirting	0.29	911	0.33	0.22	210	0.31	0.23	212	0.28	0.26	1333	0.32

PI – popularity index, $0 \leq PI \leq 1$;SD - standard deviation

The most important functions are communication (PI = 0.78, SD = 0.28) and learning and exchanging information (PI = 0.75, SD = 0.30). Quite popular are: texting (PI = 0.62, SD = 0.32), exchanging photos, videos and so on. (PI = 0.58, SD = 0.32), spending leisure time on the internet (PI = 0.53, SD = 0.31) and friend search (PI = 0.51, SD = 0.34). The least popular in social networking websites are games (on-line) (PI = 0.21, SD = 0.29), flirting and spying (PI = 0.26, SD = 0.32).

Communication functions are more important for Slovenian and Russian respondents (SLO - PI = 0.82, SD = 0.23; RUS - PI = 0.81, SD = 0.28), but this function is less important for Lithuanians (LT - PI = 0.76, SD = 0.29). Exchanging photos, videos and so on in SN sites is the most popular for Russian respondents: RUS - PI = 0.68, SD = 0.30; LT - PI = 0.57, SD = 0.33; SLO - PI = 0.56, SD = 0.27. For Slovenians *Link posting from internet* (SLO - PI = 0.56, SD = 0.26; LT - PI = 0.40, SD = 0.34; RUS - PI = 0.37, SD = 0.34) and *Link posting using mobile phone* (SLO - PI = 0.46, SD = 0.29; RUS - PI = 0.26, SD = 0.32; LT - PI = 0.23, SD = 0.30) are more popular. *Evaluation or "Read.Watch.Listen" technology* is more important for Russian respondents: RUS - PI = 0.48, SD = 0.34; SLO - PI = 0.33, SD = 0.27; LT - PI = 0.21, SD = 0.30.

The consumers' actions in social networking websites are public unless the consumer indicates privacy levels (show to everybody, to friends or only to himself). Therefore, the respondents were asked whether they know, how social networking websites use published personal and other type of information.

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The answers showed, that not a small part of all three country respondents completely don't know (290/21.7%), and more than half know only partly (741/55.4%) about the usage of their presented information (table 9). Thus, the ways should be sought how to present information in a more suitable way on that question.

Table 9. The level of knowledge about how SNW use published personal or other type of information.

Do You know how social networking websites use published personal or other type of information?	**Don't know** (N/%)	**Partly know** (N/%)	**Yes, I know** (N/%)	**Total** (N/%)	**PI**	**SD**
LT	199/21.8	498/54.5	216/23.7	913/100.0	0.51	0.34
RUS	39/18.5	123/58.3	49/23.2	211/100.0	0.52	0.32
SLO	52/24.4	120/56.3	41/19.2	213/100.0	0.47	0.33
Total	290/21.7	741/55.4	306/22.9	1337/100.0	0.51	0.33

(PI – popularity index, 0 ≤ PI ≤ 1; SD - standard deviation)

In the questionnaire, 4 statements were presented about people, who are using social networking sites and respondents were asked to evaluate the statements according to their importance (table 10). All the statements got a very high evaluation (0.76 – 0.61). The biggest positive view is, that these are people, *enjoying communication* (PI = 0.76, SD = 0.20); *Searching for novelties* (PI = 0.72, SD = 0.22), a little smaller - *Having communication difficulties in real life* (PI = 0.61, SD = 0.28).

Table 10. Students about people tending to use social networking websites.

Evaluate these statements about people, tending to use social networks	**LT**	**RUS**	**SLO**	**Total**
	PI/SD	PI/SD	PI/SD	PI/SD
1. Enjoying communication	0.78/0.19	0.71/0.22	0.74/0.19	0.76/0.20
2. Enjoying new technologies	0.71/0.21	0.64/0.22	0.74/0.18	0.71/0.21
3. Searching for novelties	0.71/0.22	0.82/0.20	0.66/0.21	0.72/0.22
4. Having communication difficulties in real life	0.63/0.27	0.48/0.30	0.64/0.26	0.61/0.28

(PI – popularity index, 0 ≤ PI ≤ 1; SD - standard deviation)

Analysing in respect of countries, one can see (Figure 3), that Russian respondents value *Searching for novelties* (PI = 0.82, SD = 0.20) at the highest, and *Having communication difficulties in real life* (PI = 0.48, SD = 0.30) - the lowest. Lithuanian and Slovenian respondents value this statement higher and rather similarly: SLO - PI = 0.64, SD = 0.26; LT - PI = 0.63, SD = 0.27. The respondents of three countries very similarly value the statement, that these are the people, *enjoying communication:* LT - PI = 0.78, SD = 0.19; SLO - PI = 0.74, SD = 0.19; RUS - PI = 0.71, SD = 0.22. The respondents of all three countries acknowledge the fact that people using SNW are *enjoying new technologies.* However, it is more significantly expressed among Slovenian (PI = 0.74, SD = 0.18) and Lithuanian (PI = 0.71, SD = 0.21) respondents, a little less - among the Russian. (PI = 0.64, SD = 0.22).

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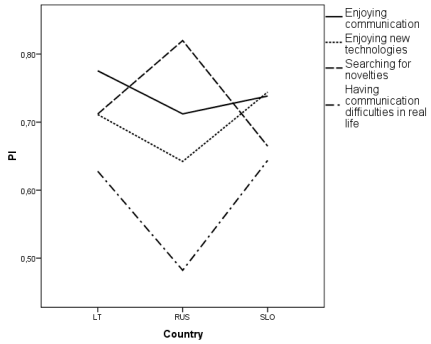


Figure 3: Knowledge about people tending to use social networking websites.

The respondents were asked, whether participation in social networking websites improves their information communication abilities. They could answer: *yes, it improves*; *partly improves*; *has no influence*. Respondents' opinion analysis showed (table 11), that the relationship between participation in social networking sites and information communication ability improvement is not highly expressed (PI = 0.40, SD = 0.31). More than half of all country respondents think, that using SNW only partly improves IC abilities: LT - 54.9%, SLO - 57.0%, RUS - 67.0%. And even 34.9% of Lithuanian, 29.0% of Slovenian and 15.8% of Russian respondents claim, that it completely does not have any influence.

Table 11. Students' opinion about SN and information communication abilities.

Does the usage of SN websites improve Your information communication abilities?	**Has no influence (N/%)**	**Partly improves (N/%)**	**Yes, improves (N/%)**	**Total (N/%)**	**PI**	**SD**
LT	320/34.9	503/54.9	93/10.2	916/100.0	0.38	0.31
RUS	33/15.8	140/67.0	36/17.2	209/100.0	0.51	0.29
SLO	62/29.0	122/57.0	30/14.0	214/100.0	0.43	0.32
Total	**415/31.0**	**765/57.1**	**159/11.9**	**1339/100.0**	**0.40**	**0.31**

(PI – popularity index, 0 ≤ PI ≤ 1; SD - standard deviation)

Social networking websites reveal the participants' activity, sociality, because the main information is this, what the consumer wrote, what his mood was, who he started dating, who he started going out with, what photos installed, how he comments, who he joined and so on. 26 statements about social networks were presented in the questionnaire and the respondents were asked to evaluate them in the 5 range scale from *completely agree* to *completely disagree*.

The respondents, having participated in the research value social networking sites in various aspects rather high and the majority of evaluations are similar and balance at about statement evaluation average (table 12). Almost all people, having participated in every country's survey, use social networking sites and accentuate that *SN websites is a* perfect means of communication and SN websites is good possibility to find out various news (PI = 0.76, SD = 0.19). Respondents very highly value the statement - SN *websites is a perfect means for self-advertisement* (PI = 0.73, SD = 0.22) and approve that *Information conveyed by SN websites can have negative influence on teenagers' behaviour and health* and that *SN websites make negative influence on pupils' marks and ability to concentrate* (PI = 0.73, SD = 0.21).

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Respondents emphasise that *Communication in virtual space will never substitute direct peoples' relations* (PI = 0.89, SD = 0.18). The biggest worry about communication in virtual environment was expressed by Russian respondents (PI = 0.93, SD = 0.14), and by Slovenian – a little slighter (PI = 0.84, SD = 0.22).

The students, having participated in the research, doubt that *SN websites save time, allow acting more effectively* (PI = 0.55, SD = 0.27) and that *SN websites can encourage the youth for suicide* (PI = 0.54, SD = 0.25), though Slovenian respondents agree with the latter statement more than doubt (PI = 0.63, SD = 0.23). However, the respondents do not agree with the statement that *People of lower education mostly use SN websites* (PI = 0.39, SD = 0.24).

Table 12. Students' opinion about social networking websites.

Evaluate these statements about social networking websites (SN websites)	**LT**			**RUS**			**SLO**			**Total**		
	PI	N	SD	PI	N	SD	PI	N	SD	PI	N	SD
1. SN websites distract people from reality	0.65	915	0.24	0.74	211	0.24	0.71	214	0.19	0.67	1340	0.23
2. SN websites earn a lot of money using free personal information	0.63	913	0.21	0.57	211	0.22	0,75	214	0.19	0.64	1338	0.21
3. People of lower education mostly use SN websites	0.38	916	0.23	0.44	211	0.27	0.41	214	0.23	0.39	1341	0.24
4. People taking part in SN websites contribute to ICT development	0.57	904	0.20	0.54	211	0.21	0,59	214	0.20	0.57	1329	0.20
5. SN websites help to make friends	0.71	915	0.20	0.75	211	0.20	0.60	214	0.23	0.70	1340	0.21
6. SN websites is a perfect means of communication	0.76	915	0.19	0.78	211	0.20	0.70	214	0.19	0.76	1340	0.19
7. SN websites can encourage the youth for suicide	0.53	915	0.25	0.50	211	0.27	0.63	214	0.23	0.54	1340	0.25
8. SN websites dehumanise society	0.55	915	0.23	0.51	210	0.27	0.70	214	0.21	0.57	1339	0.24
9. SN websites encourage people estrangement	0.60	914	0.25	0.52	210	0.23	0.67	214	0.19	0.60	1338	0.24
10. Staying in SN websites is more fashionable than useful	0.66	913	0.25	0.51	210	0.26	0.68	214	0.24	0.64	1337	0.26
11. Communication in virtual space gives bigger opportunities	0.61	916	0.22	0.42	209	0.25	0.57	214	0.22	0.57	1339	0.23

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12. Constant staying in virtual environment causes damage to person's socialization	0.67	915	0.24	0.68	210	0.24	0.74	214	0.20	0.68	1339	0.23
13. Communication in virtual space will never substitute direct peoples' relations	0.89	914	0.17	0.93	210	0.14	0.84	214	0.22	0.89	1338	0.18
14. Most people belonging to SN websites don't know, who they share information with about themselves, their hobbies and life	0.73	915	0.22	0.64	210	0.24	0.77	214	0.20	0.72	1339	0.22
15. SN websites is a reliable computer device	0.45	914	0.22	0.46	210	0.22	0.57	214	0.22	0.47	1338	0.22
16. Information conveyed by SN websites can have negative influence on teenagers' behaviour and health	0.72	916	0.21	0.73	210	0.22	0.79	214	0.18	0.73	1340	0.21
17. SN websites make negative influence on pupils' marks and ability to concentrate	0.73	913	0.21	0.72	210	0.23	0.73	214	0.20	0.73	1337	0.21
18. One can find a lot of useful information in SN websites	0.67	915	0.22	0.73	210	0.22	0.76	214	0.20	0.69	1339	0.22
19. SN websites is a good means of spending your leisure time	0.62	916	0.26	0.54	210	0.25	0.60	214	0.24	0.60	1340	0.25
20. SN websites is good possibility to find out various news	0.75	916	0.20	0.78	210	0.19	0.75	214	0.19	0.76	1340	0.19
21. SN websites is a good thing for those, who don't perceive what privacy is	0.61	915	0.24	0.53	209	0.22	0.57	214	0.27	0.59	1338	0.25
22. This is a good opportunity to learn, improve, communicate with	0.66	915	0.23	0.71	210	0.22	0.60	214	0.24	0.66	1339	0.23

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the whole world without going out from home												
23. SN websites is a wonderful means of relaxation	0.60	917	0.25	0.58	210	0.23	0.59	214	0.23	0.59	1341	0.23
24. SN websites provide national and international knowledge	0.63	917	0.23	0.51	210	0.24	0.60	214	0.24	0.61	1341	0.24
25. SN websites is a perfect means for self-advertisement	0.74	916	0.21	0.70	210	0.25	0.67	214	0.23	0.73	1340	0.22
26. SN websites save time, allow acting more effectively	0.56	917	0.26	0.52	210	0.31	0.55	214	0.25	0.55	1341	0.27

(PI – popularity index, $0 \leq PI \leq 1$; SD - standard deviation)

The other statements are valued rather highly and similarly by all country respondents. This shows that SN website evaluation is not and cannot be unequivocal, that social networking websites is a multidimensional construct, embracing both positive and negative influence upon the personality and their socialisation. It is obvious, that SNW both positive and negative influence on every personality and on all society is not an unequivocal phenomenon. Therefore, its evaluation cannot be unequivocal as well. It is determined by various reasons, which should be discerned and investigated in more detail.

DISCUSSION

Various country scientists actively analyse interest and usage of ICT and SN questions and various organizations, business companies are interested in this, because modern man actively uses the technologies. Technological environment is becoming a serious challenge, one has to be able to adapt in it and apply it for life demands. Qualitative and quantitative consumers' parameters are very different, vary in a very wide range, therefore permanent, scientific researches of a current condition are necessary (observation and prognosis). It is also obvious, that the youth is the most progressive and technologically most susceptible inhabitant group in various countries, therefore scientific research focusing in this direction is grounded. Carrying out these researches, it is important to ascertain who and why and on what purpose visit social networks, what information channels interest the youth most and why, what youth demands are most urgent and so on.

The research studies show that the students like SN websites (Ploderer, Howard, Thomas, 2010; Lampe, Donghee, Vitak, Ellison, Wash, 2011; Balog, Pribeanu, Lamanauskas, Šlekienė, 2013). On the one hand, students are active SN consumers, on the other hand – the usage of SN in educational sense (e.g., for study needs) is still a rare phenomenon. Though a rapid development of SNW takes place, their usage question in the academic area, remains controversial. The newest research studies show that despite the fact that a major part of university students have personal profiles in networking websites, a rather significant gap remains between students and teachers' attitude to the

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usage of such networking websites (Malesky, Peters, 2012). Teachers/lecturers obviously remain more conservative in this respect.

Thus, the carried out three country university students' questionnaire about SNW usage showed, that regardless of ICT progress and expansion in a general sense, SNW usage remains controversial. There exist concrete differences of the usage of social networks (Lamanauskas, Šlekienė, Ragulienė, Iordache, Pribeanu, Bilek, Cavas, Mazurok, 2013). It is likely, that not only ICT development level determines it, but also society's social-cultural context, different mentality, traditions and so on. This presupposes exhaustive and deeper research demand under the influence of cross-cultural contexts on SN usage. In other words, the youth, in fact, is „plunged" into ICT, however, resultativeness in a qualitative sense causes anxiety. Consumers, in fact, cannot categorically claim, that SN are useful, as equally they cannot claim, that SN are characterized only by negative effect. One can notice, that SN is not only an ordinary technological instrument. SN obviously form and change the youth's values. Russian researchers emphasize, that the youth value attitude transformation is taking place intensively in the country. In researchers' opinion, information has to be analysed and accepted as a value, under the influence of which a young man is developing as a personality (Zamorskyj, 2013). Social network information is like the newest communication instrument, especially in the youth population and therefore, it has to be purposefully corrected seeking to form positive basic values of today's youth (Pleshakov, 2005; Khovalyg, 2007; Zamorskyj, 2013).

It is totally understandable, that rapid development of technologies can't to not influence educational practice. However, the question of effective usage of new technologies for educational purposes remains open. Undoubtedly, we have to prepare young generation to be sufficiently literate in digital, networking-based society (Fernandez-Villavicencio, 2010; Pollara, Zhu, 2011).

CONCLUSION

It has been stated, that the biggest part of Lithuanian, Slovenian and Russian respondents, having participated in the research, use the internet even a few times a day. More than half of them visit social networking websites also a few times a day. It is obvious, that using the internet and visiting social networking websites are closely and directly related things. Social networks are popular among the youth of the countries, having participated in the research. Lithuanian respondents valued the popularity of social networks slightly less than Slovenian and Russian students.

It has been asserted, that though the respondents know quite a lot of social networking sites, the most frequently visited and most popular are three: *You Tube, Facebook, Google+.* Social networking site *Facebook* is mostly used only by Slovenian and Lithuanian respondents; however, among Russian students it is not popular. Absolutely all Russian respondents, having participated in the research, use national social networking site *Vkontakte,* which is the most popular in the country. Not a small part of Lithuanian respondents also participate in national networking sites, such as: *Klase*, *One and so on*, however, they are not popular comparing with *You Tube, Facebook, Google+.* Slovenian respondents did not point out any national SNW.

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The most important SNW functions for all country respondents are communication and learning and exchanging information. The least popular in social networking sites are games (on-line), flirting and spying. *Evaluation or "Read.Watch.Listen" technology is more important for Russian respondents,* Lithuanian and Slovenian youth are less interested in it. It causes worry, that of all country respondents, having participated in the research, more than half only partly know how social networking websites use published personal and another type of information and not so few – don't know at all. Thus, ways should be sought, how to present information in a more suitable way.

It has been stated, that the respondents of all countries Lithuania, Slovenia and Russia, having participated in the research are active users of social networks and discern both positive and negative influence on the personality and its socialisation. They rather highly value and acknowledge usefulness of social networks both for communication and leisure, and for social and information obtaining needs. On the other hand, the respondents accentuate, that communication in virtual environment will never substitute real communication. Russian respondents expressed the biggest worry about the communication in virtual environment.

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Conference Papers

Section:
Information Technologies Supporting Learning

Flexible View Definitions to Enhance E-learning Resources Availability

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Abstract

An e-learning data warehouse is nourished by view definitions built upon heterogeneous, distributed, and autonomous e-learning information sources. It is frequently analysed and/or mined by e-learning actors such as educators and learners for decision making various reasons and purposes. The above e-learning view definitions, which represent considerable educational information resources, can become undefined when the underlying e-learning information sources change their schemas accordingly to their autonomy characteristics. This obviously decreases e-learning resources availability and consequently affects analysis and mining efficiency. In this paper, we propose to study the issues of using agent's based architecture to achieve the e-learning data warehouse maintenance under schema changes by automatically restoring affected view definitions. This is ensured by offering a solution that guarantee view definitions' flexibility which implicitly optimizes e-learning resources availability by automatically finding replacements, using in a first step static agents and in second step mobile ones, for affected components belonging to view definitions and representing critical information necessary for analysis and/or mining.

Keywords

Data warehouse, View definition, Synchronization, E-learning resources, Schema changes, Agents.

INTRODUCTION

The E-learning Data Warehouse (EDW) is built by gathering shared data from E-learning Information Sources (EISs) and integrating them into one personalized deposit according to e-learning actors' needs in order to have persistent information about the e-learning resources. One of the significant tasks of an e-learning Data Warehouse Maintenance System (e-DWMS) is to update the materialized views during the dynamic changes touching EISs' data. Moreover, beyond the updates of data, we note that the changes of schema are also somewhat frequent in the distributed information sources such as in the e-learning domain (Breslin, et al., 1997), (Saliah-Hassane, et al., 2006) (Sheehy, et al., 2006) . A change of schema could occur for many reasons and at any time during EISs' life cycles. In fact, EISs, in such environments, can change continuously not only contents but also their schemas which may render view definitions built among them incorrect, and consequently decrease significantly e-learning resources availability.

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The solution, we propose, has the goal to preserve the maximum number of view definitions instead of being completely confused with each EIS schema change. This is performed thanks to meta knowledge about information space formed by EIS, to view knowledge about user space constituted by potential evolving view definitions, and view synchronization algorithms (Rundensteiner, et al., 1997),(Zhang, et al., 1997). Previous works (Lee, et al., 1997),(Rundensteiner, et al., 1997), related to data warehouse maintenance under schema changes, adopt a centralized framework for maintaining view definitions under schemas changes, which is not suitable for distributed and dynamic environments. In fact, e-DWMS was implemented as a compact module including administration, detection and synchronization. For these reasons, our system evolved to integrate new design, functionalities and technologies. In spite of centralized framework, Agent-e-DWMS framework is distributed using static agents (Nasr, 2010) to solve the problem of view synchronization in distributed collaborative learning environments. In Agent-e-DWMS, a static agent (Franklin, et al., 2006) is an autonomous entity that pursuits its own goals and objectives, and resides only in the system where it starts execution. If it needs information from another system or needs to interact with agents in another system, it uses a communication mechanism such as messaging or remote procedure calling. The remainder of this paper is organized as follows. In section 2, we detail the problem and foundations of view definition maintenance under schemas changes. We also illustrate the maintenance process by some running examples showing how e-learning resources availability may be affected and corrected when possible. In section 3, we describe our solution based on static agents. We also explain agents' roles and interaction leading to view definitions survival and implicitly to resources availability enhancement. In section 4, we improve the solution by integrating agent mobility model (Bordini, et al., 2010) which takes into account the system components partition. In section 5, we describe and discuss the implementation. Finally, we conclude and present future work.

VIEW MAINTENANCE UNDER SCHEMA CHANGES

In order to increase e-learning information resources availability, we propose a solution to solve the problem of view inflexibility. This solution has the goal to preserve the maximum number of affected view definitions by the occurrence of EISs' schema changes. This implicitly allows the view definition evolving which is usually carried out by skilled IT such developers. We assume that EISs are integrated in the e-learning system via a package which translates their structures into a relational common model. E-DWMS includes two basic modelling tools: a model that permits to user the expression of view definition evolution via an extended SQL called Evolvable SQL (E-SQL) and a Model for the Information Source Description (MISD) of the EISs and the relationships between them (Rundensteiner, et al., 1997). This model will be exploited to describe information necessary for seeking suitable substitution for the affected view definition components (attributes, relations, and conditions). The View Knowledge Base (VKB), which contains views definition expressed with preferences by users and described by E-SQL and the Meta Knowledge Base (MKB) revealed by MISD, represent the base for any operation of view rewriting or view synchronization process.

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The Meta Knowledge Base

The e-DWMS constitutes an intermediary between the e-learning actors' space called EDW and the information space including the participating EISs. When an EIS joins the e-DWMS, it provides its structure and its data model. This information, also called descriptive knowledge, is stored into the MKB with respect to the MISD, or any other knowledge representation models such graphs. As well, the relationships between EISs, also called substitution rules, have to be added manually and/or generated automatically, then inserted into the MKB. This information constitutes the key platform for finding affected view definitions components substitutions. The e-learning system associated knowledge is stored into the MKB and constitutes two main classes:

- The descriptive knowledge composed by a set of EISs schemas. In Table 1, we give an example of an e-learning system composed of three universities collaborating to provide common e-learning resources for an e-learning large community. Each university forms an EISi having its proper schemas and contents. This example will be used in the rest of this paper.

Table 1: EISs

EIS1	Course (Course-Id, Name, Duration). Professor (Prof-Id, Name, Phone-Number, Address, Title, Diplomas, E-mail). Student (Stud-Id, Name, Level, Nationality). Course-Ref (Course-Id, Ref-Id). Stud-Course (Stud-Id, Course-Id). Teach-Course (Prof-Id, Course-Id). Reference (Ref-Id, Authors, Availability, Subject).
EIS2	Course (Course-Id, Name, Duration). Professor (Prof-Id, Name, Phone-Number, Address, Title, E-mail). Student (Stud-Id, Branch-Id, Name, Level, Nationality). Stud-Course (Stud-Id, Course-Id). Teach-Course(Prof-Id, Course-Id). Branch (Branch-Id, Name, Duration). Course-Med (Med-Id, Course-Id). Media (Med-Id, Type, Brand). Publication (Pub-Id, Publication-Date, Subject, Volume). Prof-Pub (Pub-Id, Prof-Id).
EIS3	…

- The substitution knowledge class describing relations between EISs and composed by a set of rules or constraints such as join constraints (Table 2), type integrity constraints (Table 3), and partial\complete constraints as shown in Table 4.

Table 2: Join constraints.

JC	Join Constraints
JC1	EIS1.Course.Name=EIS2.Course.Name
JC2	EIS1.Course.Name=EIS3.Course.Name
JC3	EIS1.Professor.Title=EIS2.Professor.Title
JC4	EIS1.Professor.Title= EIS3.Professor.Title
JC5	EIS2.Media.Type=EIS3.Media.Type
JC6	EIS1.Professor.Prof-Id= EIS2.Professor.Prof-Id

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Table 3: EISi Type Integrity Constraints

EIS1	**TCEIS1.**Professor(Prof-Id,Name,Phone-Number,Address,Title,Diplomas,E-mail)=Professor(Prof-Id,Name,Phone-Number,Address,Title,Diplomas,E-mail)⊆Prof-Id(Number)×Name(String)×Phone-Number(Number)× Address (String)× Title(String)×Diplomas(String)× E-mail(String) **TCEIS1.**Course(Course-Id,Name,Duration)=Course(Course-Id,Name,Duration)⊆ Course-Id(Number)× Name(String)× Duration(Number) **TCEIS1.**Student(Stud-Id,Name,Level,Nationality)=Student(Stud-Id,Name, Level,Nationality)⊆Stud-Id(Number)× Name(String)×Level(String)× Nationality(String) **TCEIS1.**Course-Ref(Course-Id,Ref-Id)=Course-Ref(Course-Id,Ref-Id) ⊆ Course-Id(Number)×Ref-Id(Number) …
EIS2	**TCEIS2.**Professor(Prof-Id,Name,Phone-Number,Address,Title,E-mail) = Professor(Prof-Id,Name,Phone-Number,Address,Title,Diplomas,E-mail)⊆Prof-Id(Number)×Name(String)×Phone-Number(Number)× Address(String)×Title(String)×E-mail(String) **TCEIS2.**Course(Course-Id,Name,Duration)=Course(Course-Id,Name,Duration) ⊆€Course-Id(Number)× Name(String)×Duration(Number) **TCEIS2.**Student(Stud-Id,Name,Branch-Id,Level,Nationality)=Student(Stud-Id,Name,Level,Nationality)⊆Stud-Id(Number)×Name(String)×Level(String)×Branch-Id(Number)×Nationality(String) **TCEIS2.**Stud-Course(Stud-Id,Course-Id)=Stud-Course(Stud-Id,Course-Id) ⊆Stud-Id(String)×Course-Id(String) …
…	…

Table 4: Partial/Complete Information Constraints

PC1	EIS1.Professor,EIS2.Professor**=(**πProf-Id,Name,Phone-Number,Address,Title,E-mail(EIS1.Professor)⊆πProf-Id,Name,Phone-Number,Address,Title,E-mail(EIS2.Professor))
PC2	EIS3.Media,EIS2.Media=(πMed-Id,Type(EIS3.Media)⊆πMed-Id,Type(EIS2.Media))
PC3	EIS1.Student,EIS2.Student=(πStud-Id,Name,Level,Nationality(EIS1.Student)⊇πStud-Id,Name,Level,Nationality(EIS2.Student)

The View Knowledge Base (VKB)

A language is proposed to include user preferences into view definition. It is considered as close to SELECT-FROM-WHERE SQL but enriched by specifications defined by the view definitions' writer in order to indicate how those latter can evolve after schema changes such as attributes, relations or e-learning information sources deletion. The defined views are then stored into a structure called View Knowledge Base and respect the following syntax:

VIEW V [(Local_Column_List)][(VE =['⊇' | '⊆' | '≡ ' | '≈'] **AS**

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```
     SELECTED ATTRIBUTES Attribute_Name [(AD = [true | false], AR =
[true | false])]
     [, Attribute_Name [(AD = [true |false], AR = [true | false])] .. .
]
     SELECTED RELATIONS Relation_Name [(RD = [true | false], RR = [true
| false])]
     [,Relation_Name [(RD = [true | false], RR = [true | false])] … ]
     CONDITIONS Clause_Primitive [(CD = [true | false], CR = [true |
false])]
     [, Primitive_Clause [(CD = [true | false], CR = [true | false])]
... ]
```

Each view definition component (Attribute (A), Relation (R), or Condition(C) has two evolution parameters: Dispensable (D) and Replaceable (R). Consequently:

- If Attribute is Dispensable then AD = true else AD = false (default value).
- If Attribute is Replaceable then AR = true else AR = false (default value).
- If Relation is Dispensable then RD = true else AD = false (default value).
- If Relation is Replaceable then RR = true else AR = false (default value).
- If Condition is Dispensable then CD = true else AD = false (default value).
- If Condition is Replaceable then CR = true else AR = false (default value).

It should be noted that the replacement view extent can be equivalent, a superset or a subset of the initial view extent. To represent this characteristic, a parameter called VE (View Extent) is used in each view definition. VE values are presented in the following:

- V≡V' means that V'is equal to V.
- V⊇V' means that V' is a super set of V.
- V⊆V' means thatV' is a subset of V.
- V⊆V' means indifference.

To illustrate the use of E-SQL view definitions for querying e-learning information sources in order to gather information for the e-learning Data Warehouse, we present some examples showing the impact of schema changes on resources unavailability and the solution to this problem performed by view synchronization algorithms, thanks to knowledge stored in the MKB and VKB.

Example 1

Suppose that some users need to have names and emails of professors belonging to EIS1 in order to recruit some of them, or to organize with their help, a kind of a seminar. The following view definition permits to query a common EDW including information gathered from collaborating e-learning information sources. It states that users want the list of assistant professors whatever they teach.

```
SQL View 1:
CREATE VIEW V AS
SELECT P.Name, P.E-mail
FROM EIS1.Professor P
WHERE P.Title = "Assistant Professor";
```


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Knowing that collaborating e-learning information sources are autonomous, EIS1 administrator may delete “Title” and/or the “E-mail” attributes from “Professor” relation, for a design or security reasons. Obviously, V becomes undefined and couldn’t work anymore, and decrease resources availability.

The solution increasing resources availability comes from view synchronization process which have the role to find replacements for disappeared components, and rewrite view definition thanks to Knowledge stored in the MKB and preferences embedded in view definitions based E-SQL (see E-SQL view 1).

The semantic of the following example, states that users may accept the replacements of EIS1 assistant professors by assistant professors, either from EIS2.Professor, or EIS3.Professor, if EIS1.Professor is deleted. They would also accept professors E-mail from EIS2.Professor, if the E-mail attribute is deleted.

```
E-SQL View 1:
CREATE VIEW V1 VE = '⊇'AS
SELECT P.Name, P.E-mail (AD=false, AR=true)
FROM EIS1.Professor P(RD = false, RR=true)
WHERE (P.Title = "Assistant Professor") (CD = false, CR = true);
```

Example 2

The following query (View 2) permits to obtain list of students learning the course "algorithmic", from the relation EIS1.Student. However they would accept information belonging to EIS2.Student in the case of unavailability information from the first source.

```
E-SQL View 2:
CREATE VIEW V2 VE = '⊆'AS
SELECT S.Name (AD=false, AR=true), S.Stud-Id (AD=false, AR=true)
FROM EIS1.Student S (RD = false, RR=true), EIS1.Stud-Course SC (RD
= false,
RR=true),
EIS1.Course C (RD = false, RR=true)
WHERE (SC.Stud-Id = S.Stud-Id) (CD = false, CR = true) and
(C.Course Id=SC.Course-
Id)
(CD = false, CR =true) and (C.Name=" Algorithmic") (CD = false, CR
= true);
```

Example 3

The following query permits to get the list of courses taught using a media type =”X” from EIS2.Media, and may accept to have this information from EIS3.Media in the case of EIS2.Media deletion.

```
E-SQL view3:
CREATE VIEW V3 VE = '⊆'AS
SELECT C.Name (AD=false, AR=true)
FROM EIS1.Course C (RD = false, RR=true), EIS1.Media M (RD =
false, RR=true),
EIS1.Course-Med CM (RD =false, RR=true)
WHERE (C.Course-Id = CM.Course-id) (CD = false, CR = true) and
(CM.Med-id =
M.Med-Id)
(CD = false, CR = true) and ( M.Name=" X") (CD = false, CR =
true);
```


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Example 4

The following query permits the get the list of shared courses between e-learning information sources EIS1, EIS2, and EIS3. It can give only common courses between EIS1 and EIS2 in the case of EIS3 deletion.

```
E-SQL View 4:
CREATE VIEW V4 VE = '≈'AS
SELECT C1.Name (AD=false, AR=true)
FROM EIS1.Course C1 (RD = false, RR=false), EIS2.Course C2(RD =
false, RR=false),
EIS3.Course C3 (RD = false, RR=true)
WHERE (C1.Name = C2.Name) (CD = false, CR = false) and   (C1.Name
=C3.Name)
(CD = true, CR = true);
```

We mention that, due to the integration of the e-learning resources into the EDW, the above view definitions give results independently on networks traffics, faults or costs. Moreover, affected view definitions by schema changes may survive, thanks to repairing process which takes into account user preferences. These too facts contribute considerably into the enhancement of e-learning resources availability.

Note that e-learning information sources participating to such systems may increase and consequently the possibilities of resources substitutions may also increase. This means that the collaboration between e-learning users' community and availability factors may increase in an e-learning dynamic environment where information sources schemas evolve frequently.

View synchronization

The view synchronization (Rundensteiner, et al., 1997) consists in determining legal rewritings for the affected views, referring to the rules or constraints embodied into the MKB. These rules enable substitutions retrieval for the affected view definition components while respecting preference parameters described into the VKB. The view rewriting is legal when it is compatible with the current information space. This rewriting have to preserve the information presented by the initial view definition according to preferences parameters associated to the view definition components and the possibilities of substitutions offered by the MISD.

Example 5

In the case of E-mail attribute deletion from EIS1.Professor relation, using partial/complete constraints, view synchronization algorithms may replace the affected attribute by EIS2 E-mail attribute. This is due to the fact that the two attributes have a same type and EIS2.Professor relation is a subset of EIS1.Professor relation. Consequently, the E-SQL view 1 becomes:

```
E-SQL View 1':
CREATE VIEW V1' VE = '⊇'AS
SELECT P.Name (AD=false, AR=true), P2.E-mail (AD=false, AR=true)
FROM EIS1.Professor P (RD = false, RR=true), EIS2.Professor P2 (RD
= false, RR=true)
WHERE (P.Title = "Assistant Professor") (CD = false, CR = true)
and (P.Prof-
Id=P2.Prof-Id);
```


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In the case of EIS1.Professor relation deletion, synchronization algorithms may replace EIS1.Professor relation by EIS2.Professor, thanks to partial/complete constraints established between them.

```
E-SQL View 1'':
CREATE VIEW V1'' VE = '⊇'AS
SELECT P2.Name, P2.E-mail (AD=false, AR=true)
FROM EIS2.Professor P2 (RD = false, RR=true)
WHERE (P2.Title = "Assistant Professor") (CD = false, CR = true);
```

AGENT-E-DWMS

Agent-e-DWNS architecture is distributed on five entities: the Server Agent, the Detector Agent, the MKB Agent, the VKB Agent and the View Synchronizer Agent. Communication between agents (Chaib-draa, et al., 1997) can be ensured either by message sending or by agent migration. In our model communication will be guaranteed by the traditional message sending. In fact, all the e-learning agents of the model know each other directly via their identifier, names and sites. Thus, any agent of the system can communicate directly with any other agent.

Dispatching e-DWMS Tasks

The Server Agent is the heart of the e-DWMS. It has the role of initializing the system and dispatching e-DWMS tasks on Detector, MKB, VKB and View Synchronizer Agents.

In fact, the Server Agent supervises the correct functioning of all the other agents' instances deciding on their creation, suspension and ending allowing coordination and synchronization between them. In other words, it plays the role of the manager of all the Agent-e-DWMS. When the collaborative learning system is triggered, the Server Agent starts by creating the various agents of the model.

Detecting e-DWMS affected EIS schemas

The Detector Agent is an agent implemented into each e- learning information source. It is responsible of the detection of changes which have occurred on the level of the structures of the participating e-learning information source to the system. Indeed, it traverses an e-learning information source with an aim to detect a change by comparing the schema of the source at moment t and at moment t-1. Its mission consists on, transmitting any schema change occurred in the e-learning information source, to the Server Agent.

Affected e-learning Rules Determination

The MKB Agent processes the data received from the Server Agent. This latter transmits to it any schema changes occurred into any e-learning information sources. After that, the MKB Agent analyses the Meta Knowledge Base in order to detect the whole unit of affected knowledge or rules by the schema changes received to send them to the Sever Agent.

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Affected e-learning Query Computing

The VKB Agent has the role of detecting the subset of views definitions affected by occurred schema changes. In fact, following the received changes, VKB Agent checks within the VKB to determine the set of views definitions which contain one or more components affected by the changes. After that, the VKB Agent transmits the result, composed by the affected views definitions, to the Sever Agent.

Affected e-learning Query Rewriting

After the reception of the affected rules, the affected knowledge and the affected views definitions from the Server Agent, the View Synchronizer Agent starts to check if it is possible to determine a legal rewritings for the affected views in order to create new views definitions compatibles with the current state of the information space. For that, it refers to the e-learning users preferences expressed into the E-SQL affected views received.

When the synchronization process is well done, the View Synchronizer Agent transmits its results to the MKB Agent and the VKB Agent in order to update respectively the MKB e-learning rules and the VKB views definitions, according to the new e-learning information space state.

MOBILE E-DWMS

Mobile-e-DWMS evolves Agent-e-DWMS framework to become more adapted to dynamic environments which are characterized by a great number of educational information sources. Each one has a huge mass of information that cannot be implemented in a single machine, but in a local or wide network. In fact, an e-learning information source can be distributed on many machines forming a network. It is the same thing for the VKB, the MKB and their associated management and analysis tools. Even the collaborative learning data warehouse can be divided into many data marts according to repartition criteria related to evolving users requirements. Therefore, Agent-e-DWMS detector agent, MKB agent and VKB agent have be replaced by mobile ones to become able to migrate between machines where EISs, MKB, VKB, and EDW components reside. Concerning the View Synchronizer Agent and the Server Agent, they don't need to be mobile because they don't move from one machine to another to accomplish their associated tasks. Mobile-e-DWMS keeps the same agents' communication requirements; however by adding the mobility paradigm, e-DWMS agents evolve towards new dimensions. In fact:

- An EIS can be distributed in a local or wide network. For that reason, the Detector Agent should become a mobile one able to move from one machine to another of EISs' network to find all occurring schema changes triggered accordingly to EISs' local requirements.
- The MKB can be also distributed in a local or wide network. To compute affected knowledge, the MKB agent is replaced by a mobile one capable to look into all MKB components residing in different machines, compute affected rules and knowledge and transmit it to the Server Agent.
- The VKB can be distributed in a local or wide network. To compute affected views, the VKB agent becomes a mobile one able to look into all VKB components

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distributed in different machines, compute affected views and transmit it to the Server Agent.

- The role of the View Synchronizer agent states the same as in the Agent-e-DWMS which consist on finding legal rewritings for affected views using the MKB information and views' preferences. Moreover, it transmits obtained results to the Mobile VKB agent and the Mobile MKB agent in order to update respectively the MKB and the VKB.

CONCLUSION AND FUTURE WORKS

In this paper, at best of our knowledge, we are the first to exploit view definition flexibility to optimize e-learning informational resources availability and sharing. This was ensured essentially by view synchronization concepts which make view definitions, embedding e-learning resources, survive thanks to their flexibility. We also, studied the issues of using static and mobile agents to achieve e-learning data warehouse maintenance under schema changes. We focus on agents' collaboration leading not only to the availability optimization of e-learning informational resources, but also to the increasing of the system components autonomy, avoiding network saturation and to the decreasing of a variety of costs such as communication and running times. Future work will focus on the maintenance of a new type of view definitions based on spatio-temporal components. This kind of saptio-temporal view definitions will enhance analysis and/or mining by taking into account space and time characteristics indispensable in emerging mobile and decisional applications related to e-learning domain.

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Automatic Parameterized Generation of Test

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Abstract

The contribution deals with a proposal and implementation of a test generator from the prepared tasks of varied topics. The structure of questions in the individual tests can be controlled by input parameters which are described in the proposal. Then a simple format of an introductory bank of tasks containing, among others, also basic elements of the mathematical typesetting is proposed and described. Control information is also part of the input data which is complemented by parameters for each question influencing its listing in the generated tests. Together with the proposed modular architecture of the generator basic objects of its construction are described on the basis of the principles of the object-oriented programming and of the application of polymorphism by which flexible functionality of the generator is ensured. In the following part the process of solving a combination of the test questions according to the set parameters by means of the methods called depth-first search of tree and backtracking is illustrated. In the end the possibilities of choice of various output formats of the generated tests and the functionality of comparing the congruence of tests and the choice of the best test combinations are shown. The generator outputs are represented by an example of tasks generated in the required format, by a final matrix of the comparison of the congruence of the generated tests and by a proposal of a suitable combination of tests with regard to the requirement of minimizing the congruence between different test groups.

Keywords

Automatic test generation. Object-Oriented Programming. Backtracking. Depth-first search of tree. XSL transformation.

INTRODUCTION

The process of the evaluation of the gained knowledge and skills is an important and integral part of the educational process supporting a suitable way of the knowledge transfer and it ensures that students understand the studied matter correctly and they gain the required knowledge. Knowledge testing is one of the most widespread tools of the evaluation process. Test creation is the basic issue in this process. The creation of the test questions, i.e. building the question bank itself is a topic closely related to the test creation. This self-contained issue has been dealt for example in (Gangur, 2011). Once the question bank is created, it is necessary to generate a test out of it. There are a number of tools, both self-contained and based on e-learning systems that are able to generate tests by means of random choice with regard to the question bank structure. This structure

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enables the questions to be divided according to the level of difficulty and the coverage of various issues tested.

This contribution presents a proposal of the individual parts important for implementing a tool for automatic test generation according to the set requirements related to the structure (score, number of questions, issues tested) and the requirements concerning the mutual relations of the tests, i.e. the disparity of their contents. The proposal of the above generator is based on a few input requirements for the basic characteristics and the generator functionality:

- The simple control mechanism when setting parameters and generating tests;
- The simple and fast way of inserting questions for the individual fields;
- The possibility of applying the ready-made sources of questions in the text format without the necessity of any further extensive modification;
- The possibility of a simple modification of questions with the help of freely available tools;
- The possibility of parameterizing the structure of the text contents, i.e. a possibility of determining the total score in the test and the number of questions stemming from the individual fields;
- The possibility of inserting simple mathematical text (subscript, superscript, sum, integral, fraction);
- The possibility of ensuring minimum congruence of the test contents with regard to random choice of questions from the question bank.

The above requirements were the starting points in the process of searching for such a system or, as the case may be, in applying the principles of the already designed and publicised systems.

In the first section of this paper the related work is presented, the second section introduces the functionality of the generator and the following three describe the methods and algorithm of the generator implementation. Next the results of test generating process are presented and the last section states the conclusion.

RELATED WORK

The issue of automated test generating has been dealt with in a number of publications. Automated generating test questions directly from a chosen text can be seen as a special issue in this direction (Zeng et al., 2013). Contributions dealing with this topic concentrate mainly on generating questions from the English texts (Sung et al., 2013). Automated creation of adaptive tests with regard to the level of knowledge of the individual students is an independent field in which intensive research is being carried out (Kapusta et al., 2010).

Seemingly simple issues of automated test generation controlled by parameterized requirements concerning the test structure are not paid so much attention with regard to the quantity of publications on this topic. In (Yang et al., 2008) a proposal and implementation of a robust system with adaptive elements for administration and a follow up selection of test questions from the database with regard to the previous test results is

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described. The system enables a random choice of the test questions with regard to the set parameters, such as the percentage of the required type of questions (e.g. multichoice, open questions) or the fields (knowledge points) out of which questions are selected. In the key issue of the choice of questions the system uses a complicated mechanism of arithmetic calculations which ensure meeting the set requirements for the test structure. The system is extensive and with regard to the process of choosing the questions and feeding the question database it may seem difficult for the users.

None of the above systems deals with the problem of insertion and namely the typesetting of the mathematical text. The authors in (Tomas and Leal, 2013) deal with the issues of the mathematical text by means of an external application. So as to finalize the creation of the tests the above authors use some functionalities of a web application for the presentation and evaluation of the mathematical expressions.

The above described systems meet the basic requirements for the test creation from the randomly chosen questions with regard to the set parameters of difficulty and coverage of various fields of issues to be studied. These are complex and extensive systems covering a number of other functionalities and requiring time consuming creation of a question bank. In most cases generators do not deal with the issue of the mathematical text typesetting and they are not quite flexible in the matter of the choice of the generated tests output format. The majority of the above stated tools as well as other examined instruments only generate online web tests.

THE FUNCTIONALITY OF THE GENERATOR

In this part and the following ones a proposal for an automatic test generator will be presented along with methods and algorithms of implementation of such a generator.

The following parameters were set as the basic input generator parameters which determine even other parameters of the system functionality:

- The total number of questions stemming from the individual thematic fields;
- The total score stemming from the individual thematic fields;
- The format of the resulting tests;
- The total number of the generated tests;
- The number of the tests in a package to be used simultaneously.

By means of the first two parameters it is possible to select the quantity of questions stemming from the given field in the entire test and at the same time to select its difficulty by a suitable combination of the number of questions and the score for the given thematic field. The generator supports the distributed creation of the individual fields of questions by various creators who can save the final question bank in an online repository of questions used by the generator. The administrator then controls generating the final tests. This approach enables, in some special cases (entrance tests and such like), hiding the contents of the complete test from the individual creators and letting only one authorized person create the test.

The strength of the generator consists in the possibility of selecting a template for generating the required output format. The test itself is generated in the proposed

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universal XML format, and by means of the XSLT processor it is, with the help of the inserted transformation template, transformed into the required output format (Kosek, 2010). The possibility of selecting this output format is flexible and it enables the user to create his/her own template and to generate his/her own output format.

The parameters determining the total number of the generated tests and the number of the tests in a package to be used simultaneously also control, among other things, the format of other generator outputs, namely the calculation of the mutual percentage congruence of the tests and the choice of the most suitable combinations of tests to be used simultaneously. The test questions are selected randomly and some questions, with regard to the required total number of questions in comparison with the number in the bank of a given field, may be repeated in the tests.

The above report is the basis for the administrator's decision in case of the written tests meant for a larger number of tests in more groups when tests are given simultaneously in more varieties to one group and to the individual groups in various rounds between which there is a time lag. The administrator, with the help of these calculations, tries to compile the tests so that there are tests with the lowest level of congruence of questions between the individual rounds.

Even the question banks stemming from the individual fields can be listed in the generator outputs. The possibility of simple creation of such a question bank by means of freely available editors is one of the requirements for the generator functionality.

The control information related to the individual questions can be seen as another parameter influencing the test compilation. It determines, apart from the evaluation of a question by scoring, also listing a question in a group of questions. The group of questions enables similar questions not to be listed in one test and, at the same time, to list more questions with the joint settings in one group (see section The question input format and control information).

Congruence of tests

As support for the prevention of undesirable cooperation among the testees the generator considers the percentage congruence of tests and proposes combinations of the individual test varieties to be grouped together. The percentage congruence of two varieties is defined as a ratio of the number of identical questions in the considered varieties and the total number of questions.

The proposal for the composition of varieties in the individual rounds, i.e. the test packages, results from the criterion of the maximum congruence of varieties in a package and the minimum congruence between the individual rounds so that in the time gap between the rounds the testees from one round may pass on as little information related to the particular questions as possible to the testees in the following round. The test packages, n-tuples, are generated with regard to the number of the n varieties in the n-tuple and the average of this n-tuple is determined as a *(sum of all concordances in the group between one another)/(n*(n-1)/2)*. The combination of the mutually disjoint packages with the maximum overall average congruence is then selected.

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MODULAR ARCHITECTURE OF THE SYSTEM

With regard to the required functionality of the system the generator application shall be proposed in a few independent modules:

- The pre-processor regulating the input text files with regard to the required set of characters and coding;
- The parser of the input file with questions for the given field;
- The generator of the test (tests) according to the set parameters (number of questions and points for each field);
- The transformer into the output format according to the set template;
- The post-processor carrying out further adjustments to the transformer output.

In the above described application the pre-processor is part of the parser module and it belongs to the overwritable methods (see the next subsection). These are easily modifiable methods with regard to the format of the input file of the question bank. The parser processes the input file and divides it into the individual questions, and in each of them it reads and parses the control information from the introductory tag and then it divides the question into the settings itself and, as the case may be, into the possibilities of answers to the multichoice questions. All this structured information is stored in the inner structure of the generator which is the output of the parser module.

A recursive algorithm is the core of the Generator module and it selects the test questions for each field according to the set parameters of the number of questions and the total score for these questions (see section The algorithm of the test construction). The output of the generator is the test compiled according to the set parameters which is then generated in the universal XML format. Further parameters of the generator may be as follows: settings of the way in which questions are mixed, mixing the possibilities of answers in case of a multichoice question, inserting answers for checking the solution.

In the next step the Transformer module transfers the test from the universal XML format, according to the template inserted by the test administrator, into the required output format (e.g. LaTeX (LaTeX, 2013), AcroTeX (AcroTeX, 2014), MoodleXML (MoodleXML, 2013)). The core of this module is a XSLT processor which transforms the input XML test according to the XSL template into the output format (Kosek, 2010).

Using the object-oriented programming as the support of modularity

The modular structure of the application is supported by the structure of the programme code built on the principles of the object-oriented programming (OOP). The base of the application consists in the following three classes – Parser, Generator and Transformer which perform the functions of the main modules described in the previous part.

The polymorphism of the OOP is applied mainly in the Parser which can be adapted flexibly according to the format of the input question bank. The base of the Parser class is an abstract class parser_base. It contains three empty overwritable methods ***text_preprocessing()***, ***text_parsing()*** and ***question_parsing()***. The derived classes – descendants – implement parsers for various formats of the input question bank. These parsers originate by overwriting the method of the pre-processor (***text_preprocessing()***)

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and the methods of the parser of the input text (***text_parsing()***) and the parser of the individual questions (***question_parsing()***) with regard to the given format of the input question bank.

Apart from the above described methods the abstract class contains methods implementing the workflow processing of the input question bank and creating a list of structured questions in the inner data structure of the generator.

And similarly, as in the case of the parser, the OOP polymorphism is also applied in the class implementing possible post-processing of the output data. In this case only the method carrying out further data processing is overwritten (e.g. in case when the transformer output is in the LaTeX format, the post-processor enables generating the PDF output).

THE QUESTION INPUT FORMAT AND CONTROL INFORMATION

The current version of the generator uses the Aiken question format (Aiken, 2013) and it can be extended by the possibility of the questions with a short or numerical answer and by the possibility of inserting more correct answers in case of the multichoice questions.

Each question is introduced by a tag with an abbreviation of the question field to which the question belongs (see listing). The tag contains control information influencing the listing of questions in the compiled test. Within this information the question bank creator determines the evaluation of the question by score and the group to which the creator lists the question.

```
<OV score="2" group="381"> The objective function for achieving the
highest total possible number of the manufactured products in the
linear mathematical model of an optimization task for the above stated
settings can have the following from:

A) <math>\max z = \sum\limits_{i=1}^{n} w_i</math>
B) <math>\max z = c_j \sum\limits_{i=1}^{n} w_i</math>
C) <math>\max z = \sum\limits_{i=1}^{n} c_{ij} w_{ij}</math>
D) <math>\max z = \sum\limits_{i=1}^{n} \sum\limits_{k=1}^ {p} b_{jk}
w_j</math>
E) <math>\max z = \sum\limits_{i=1}^{n} c_j w_j</math>
ANSWER: A
```

The numerical code identifying the group is important. The digits of this code control the listing of the question in the stage of constructing the test according to the following scheme:

- Group 0 – the question can be listed without limitation;
- Group <1-99> - questions with the same number are not listed together in one test;
- Group <100-999> - Group questions. Mostly it is more questions with joint settings;
    - Questions with the same first digit and different second digit are not listed in the same test;

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- Questions with the same first and second digit belong to the same group and either all of them are listed in the test or none of them at all;
- The last digit determines the order of questions in the group. The first one is often a question with the joint settings.

The mathematical text typesetting

The generator enables inserting the mathematical text in the text of questions or, as the case may be, also the exact listing (e.g. algorithm listing and such like) as well as a figure in the JPEG format as a complement to the task settings. The tags <math>, <code> a <image> enable this. By means of the tag <math> the question creator inserts the LaTeX notation of the mathematical expressions (see listing). The tag <code> enables the exact listing of the entered text namely in case of using characters <,> which introduce the tags with the question control information. The tag <image> contains the name of the file of the figure which is inserted under the text of the settings, or next to the possibilities of the answers in case of a multichoice question.

THE ALGORITHM OF THE TEST CONSTRUCTION

In case we require the compilation of the test out of the questions based on the set criteria and with regard to the question control information (group) the algorithm of the recursive depth-first search of tree is applied. It is the so called backtracking algorithm which selects, out of the questions for the given field, one or more questions (according to the group number) and it always checks whether the criteria of the total number of questions and the required total score are met. If one of these parameters is exceeded, it recurs by one question (more questions) and selects another one.

The core of this algorithm is the **combination** recursive function. The input in this function, when it is called for the first time, is the list of the question bank suitable for the given field. Random permutation and question selection is applied in case of this list and therefore the order of questions and the depth-first search of tree are always different. The following listing shows the headline of the applied function and its first call.

```
function combination($list, $current_list, $num_points, $deep)
new_test_list = combination($question_bank, Array(), 0, 0)
```

In case of further recursive calls of the function this list is entered in the function without the questions that had already been used. In this sense, the current list is also an input parameter in which selected questions are stored (in case of the first call the list is empty). Other parameters are: the score of the questions currently inserted into the test and the depth of tree which represents the number of questions in the compiled test. Upon the first call both the values are null. With each question (group of questions) being added the depth of tree gets higher.

Out of the list of free questions the recursive function call creates the rest of the list of the tested questions. The recursion ends upon achieving the required score and the number of questions for the given field. In case of the retrospective finishing of the individual calls of the function a list of the test questions is formed starting from the back and moving forward and at each level this tail of the list is added to the currently selected

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question or the question group and like this a new tail of the list is created at the given call level.

If, upon the function call, the values of score or number of questions are exceeded, the selected question (group of questions) is not accepted and another question in the list of free questions is chosen, until the list is empty. After that the algorithm recurs back by one level of the call (backtracking) and it selects another question out of the list of the free questions at the given level.

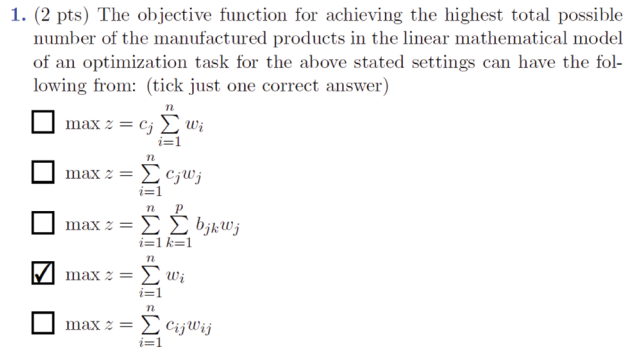
By means of the above described procedure of backtracking the depth-first search of tree is implemented. Upon returning back to the first call level the whole list of questions according to the set criteria is created if the finishing condition is met.

GENERATOR OUTPUTS

The transformer module enables setting the transforming XSL template and also determining the format of the final output file (Kosek, 2010). The current version offers the following generator outputs:

- Creating a list of questions from one field and its transformation to formats MoodleXML, LaTeX, AcroTeX (interactive PDF);
- Creating a test by the combination of questions from various fields according to the set criteria and their transformation to formats LaTeX or AcroTeX;
- Creating a test only from one field according to the set criteria and their transformation to formats LaTeX or AcroTeX;
- In case of TeX format (LaTeX and AcroTeX) it is possible to create PDF documents by means of the post-processor methods;
- Together with the generated questions the system always generates even the teacher's version with the correct answers;
- When generating more tests the system calculates their percentage congruence and proposes compiling the n-tuples for various rounds of the test settings with regard to the criterion of the least congruence between the tests in the individual rounds.

Figure 1 shows the question in the final test in the interactive PDF format.


1. (2 pts) The objective function for achieving the highest total possible number of the manufactured products in the linear mathematical model of an optimization task for the above stated settings can have the following from: (tick just one correct answer)

- ☐ $\max z = c_j \sum_{i=1}^{n} w_i$
- ☐ $\max z = \sum_{i=1}^{n} c_j w_j$
- ☐ $\max z = \sum_{i=1}^{n} \sum_{k=1}^{p} b_{jk} w_j$
- ☑ $\max z = \sum_{i=1}^{n} w_i$
- ☐ $\max z = \sum_{i=1}^{n} c_{ij} w_{ij}$

Figure 1: Part of a test in the output interactive PDF format AcroTeX (Source: own)

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The following Table 1 shows the output in which the percentage congruence of 8 varieties (A-H) of the generated tests is compared.

Table 1: A comparison of congruence between the individual test varieties

Ver./Ver.	A	B	C	D	E	F	G	H
A	-	7.84	0	7.84	7.84	9.8	9.8	9.8
B	7.84	-	0	7.84	7.84	7.84	13.73	9.8
C	0	0	-	0	0	3.92	1.96	3.92
D	7.84	7.84	0	-	7.84	9.8	11.76	7.84
E	7.84	7.84	0	7.84	-	13.73	7.84	9.8
F	9.8	7.84	3.92	9.8	13.73	-	7.84	7.84
G	9.8	13.73	1.96	11.76	7.84	7.84	-	7.84
H	9.8	9.8	3.92	7.84	9.8	7.84	7.84	-

In the following output a proposal of the possibilities for 4 rounds is calculated, always containing two varieties in such a way that the congruence between rounds, between which there is a time gap, is as small as possible, i.e. the number of identical questions is as low as possible.

Round 1: A, F - 9.8%

Round 2: B, G - 13.73%

Round 3: C, H - 3.92%

Round 4: D, E - 7.84%

CONCLUSION

The contribution describes the functionality and the process of solving the implementation of the generator of questions stemming from the set fields by means of a combination of questions according to the set criteria, i.e. namely the number of questions in the test for the given field and the overall scoring of questions in the given field.

The advantage of the proposed generator consists in the possibility of choosing the output generator and creating a list of questions or tests for various purposes. In the current version it is possible to generate questions in the MoodleTeX format and import them into a question bank in LMS Moodle, and further it is possible to create examination tests in the PDF format in a student's or teacher's version (with the correct answers) or, as the case may be, even practice tests in the interactive PDF format with the possibility of checking the answers immediately.

As far as our future plans are concerned we intend to consider other related issues and possible functionalities of the system. They are as follows:

- Improvement of the control system and modifications of the Czech language coding with reference to the input texts;

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- Dealing with the combinatorial explosion in relation to the depth-first search of tree depending on the increasing number of questions;
- Improved online application of the generator functions through the Web interface;
- Continuous development of other transformation templates meant to fit the required output formats.

Currently, the system is a useful helper namely in the process of preparing tests stemming from various fields, for example from the sphere of the entrance examination procedure. This process requires more authors co-operating on the assignment. The generator enables decentralized creation of tasks in the individual fields and the subsequent central generation of the final tests by one administrator only.

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Towards a Smart School Laboratory

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Abstract

In this paper architecture of a smart school laboratory is proposed. It is based on technologies of Smart Environment and Multi-Agent Systems employed to improve comfort, effectiveness and safety during conducting of laboratory work with any technological equipment (e.g., computers, machine tools and so on).

Keywords

Ambient Intelligence. Artificial Intelligence. Smart Environment. Context Awareness. Sensor Networks. Tutoring Systems. Multi-Agent Systems. Expert Systems.

INTRODUCTION

Nowadays many applications of Ambient Intelligence or Smart Environment are developing in different universities and research centres, e.g. for health caring, services for elderly people, enhancement of comfort of offices and home (Weber, Rabaey and Arts, 2005; Remagnino, Foresti and Ellis, 2005; Greenfield, 2006; Kainulainen, 2006; Hashimoto, 2007; Lee, et al., 2007; Nakashima, Aghajan and Augusto, 2010; Gavrilov, 2012). Known different projects aiming to development of smart environment may be divided between two kinds: 1) special smart environment oriented to solve enough narrow tasks such as assisting of elderly or disabled people and 2) general-purpose smart environment for improvement of comfort for home and office.

Examples of first kind of projects are ALARM-NET (Wood, et al., 2006), SOPRANO (Klein, Schmidt and Lauer, 2007; Sixsmith, et al., 2010), PERSONA (Tazari, and Ploesser, 2003), SC3 (Asad, et al., 2010). Second kind of them are represented by OXIGEN (Brown, 2001), AMIGO (Georgantas, et al., 2005; Haeb-Umbach, Kladis and Schmalenstroeer, 2005). All these and another projects and approaches to development of ambient intelligence are based on three basic technologies:

- sensing technology where information on user and surrounding environment are perceived and collected, in particular location sensing technology (Timar, et al., 2003; Hightower and Borriello, 2001),
- context aware computing (Ngo, et al., 2004; Hung, Hung and Lee, 2004; Kiani et al., 2005) technology where such information are processed and properly presented to users as different services,

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- wireless network technologies where information are collected from sensors and distributed to customers – services and users (Shorey and Ananda, 2006).

In our paper we suggest usage of ambient intelligence technologies and multi-agent technology for development of smart school laboratory to conduct laboratory works in universities and colleges. This approach to development of computer-aided learning systems is novel. All current existing or developing learning systems are oriented on support of learning process, including storing and search information, testing of knowledge, combination and coordination of different sources of knowledge, visualization and simulation of real processes, hardware and software for presentation of materials and interaction between students and teacher. Examples of such system are: MetaTutor (Azevedo et al., 2012), ACE (Specht and Oppermann, 1998), Online (Pat, 1997) and ISABEL (Garruzzo, Rosaci and Sarnu, 2007). Last some years any investigators propose so called "ubiquitous learning environment" aiming to provide mobile WEB-based distant learning. This concept assumes usage of technologies of smart environment adapting to workplace and current activity of learner. But this one is oriented on assisting of learning like above computer-aided learning systems. In (Mikulecky, 2012) good review of different approaches to solve this task is offered. In particular, there author wrote summarization of characteristics of context-aware and ubiquitous learning suggested in (Yang, Okamoto and Tseng, 2008) in the following eight aspects:

- *Mobility*: The continuousness of computing while learners move from one position to another.
- *Location awareness*: The identification of learners' locations
- *Interoperability*: The interoperable operation between different standards of learning resources, services, and platforms.
- *Seamlessness*: The provision of everlasting service sessions under any connection with any device.
- *Situation awareness*: The detection of learners' various situated scenarios, and the knowledge of what learners are doing with whom at what time and where.
- *Social awareness*: The awareness of learners' social relationship, including what do they know? What are they doing at a moment? What are their knowledge competence and social familiarity?
- *Adaptability*: The adjustability of learning materials and services depending on learners' accessibility, preferences, and need at a moment.
- *Pervasiveness*: The provision of intuitive and transparent way of accessing learning materials and services, predicting what learners need before their explicit expressions.

In contrast to approaches wrote in (Mikulecky, 2012) our system can improve comfort and safety of work in laboratory for students and teacher (helps to conduct or organize but not to learn) and may be collaborate with learning systems similar to MetaTutor or systems implementing of concept of ubiquitous learning environment. However, all above characteristics must be provided by our system too.

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SCENARIOS

The Smart School Laboratory aims to solve following tasks:

- Help teacher to conduct laboratory work with enough large group of students:
  - to inform personally every students about details of work,
  - to advise each student, if necessary,
  - to watch current state of laboratory work as a whole and relating with every student,
  - to estimate results of work of students,
- Help student to make required sequence of steps to make laboratory work,
- Help student to keep orderliness in work,
- Predict and avoid dangerous situations working with equipment,
- Store statistics of conducting laboratory work for estimation by teacher and further analysis.

During conducting of laboratory work may be different activity scenarios of system and participants. Examples of some of them are below.

Scenario 1. Access of student to laboratory work (for case if the laboratory aims to study informaion technologies by computer).

The student sits down on chair in front of computer. By pressure sensor in chair and recognition of student near computer the computer and software for testing of needed knowledge for laboratory work is starting. If student passed test with enough good results the software for laboratory work is starting. Otherwise may be different actions: denied in access to work, repeat test with another set of questions or start of training course to access student to laboratory work. In all cases information about results of testing and decision are saving in Database and transmitting to teacher.

Scenario 2. Absence of student near work place.

If any student is absent near work place during a long time (except time period for rest), e.g. more then 10 minute, system reminds student (through his smartphone) to continue to work and send message about this case to teacher. Besides system keep information about this case in Database.

Scenario 3. Coming of teacher out free laboratory after complicated laboratory work.

In this case system checks close or not windows, sen off of climate control system, light, media projector and another equipment, check of lost flash memory in computers (if it is laboratory for information technologies).

Scenario 4. Recognition of dangerous noise from equipment.

This scenario may be used if laboratory contents any machine tools. I this case system must be learnt to recognize strange and dangerous noise which may be result of predangerous situation. In case of recognition of this one the system must recognize concrete equipment as source of noice and shut down this equipment.

Scenario 5. Climate control.

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During laboratory work the system gets information about temperature and humidity from corresponding sensors. If these parameters exceed the bound of determined values for enough comfort the system set on or off climate control equipment.

Proposed Architecture

Structure of hardware for smart laboratory for study of different information technologies is shown in Figure 1. Here are local wire and wireless networks.

Proposed architecture of middleware consists of knowledge and some subsystems (Figure 2).

Knowledge consists of knowledge base for decision making in respect to possible scenarios and context describing current situation.

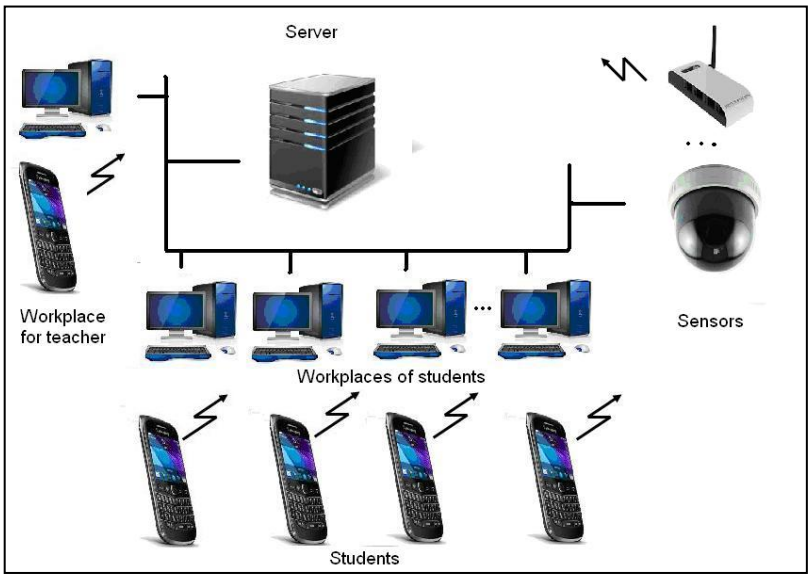


Figure 1: Hardware of smart laboratory.

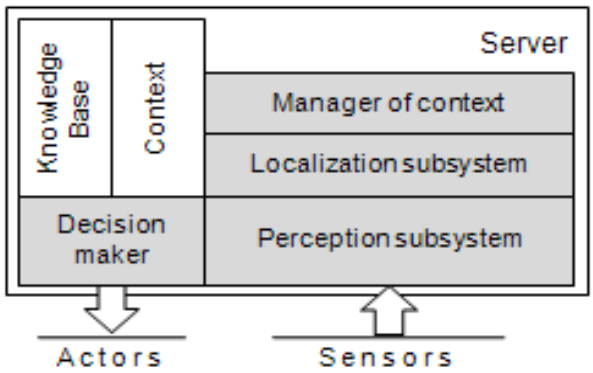


Figure 2: Architecture of smart school laboratory.

Decision making aims to manage smart objects by actors. In this architecture we mean as smart objects computers or computer based equipment (actions with any programs, output of messages and so on), switches (of light, hitting, energy and so on), media projector, smartphones and so on.

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Decision maker may be implemented as hybrid expert system (HES) using frames and rules connecting with linguistic variables recognized by perception subsystems. Architecture of such hybrid expert systems ESWin was developing in (Gavrilov and Novickaya, 2001; Gavrilov and Chistykov, 2005; Gavrilov, 2010). In particular, in (Gavrilov, 2010) was shown possible usage of ESWin for implementation of smart home. Decision maker is oriented on solving of such kinds of task as:

- high level of object or situation recognition,
- issue of recommendations to make laboratory work and to avoid disadvantages or dangers relating with equipment,
- prediction of dangerous situations and shutting off different equipment in these cases.

For example, any rule used in decision maker corresponding to scenario 2 may be looked as "If Student X is absent and Time of absence X > 10 minutes then send message to student X 'please come back to work place' and send to teacher 'Student X is absent more than 10 minutes'". Besides information about this case writes to database to keep for further analyzing.

For implementation of decision maker employing tool ESWin above rule can be formalized as:

```
RULE 1
=(Student. Name; Any)
=(Name. State; Absence)
>(Name. Time of state; 10)
DO
MS(Action. Message to student; Please, come back to work place)
MS(Action. Message to teacher; Student 'Name is absent in
laboratory)
=(Name. Event; Absence more than 10)
ENDR
```

Here first condition of rule aims to connect any student being current context with his frame. Name of frame (Name) is replaced by name of student and rule began to work with frame describing of any concrete student. Last conclusion in rule aims to keep of remark about behavior of this student during laboratory work to use in future. If frame describing of student is connecting with data base then this remark is appending in table as record describing event dealing with this student. Message "Absence more than 10" is wrote into pole "Event" and another poles are filling by information about time and data of the event.

For implementation using ESWin the context consists of frames describing states of different objects and agents of smart laboratory, for example, frame with information about any student:

```
FRAME=Ivanov
 State: Present
 Time of state: 35
 Step of work: 2
 Number of workplace: 4
 Grade for begin to work: 70
 Grade for completed work:
ENDF
```


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This frame-instance is produced from frame-prototype (Name is replaced by real surname of student):

```
FRAME=Name
 State: (Present, Absent)
 Time of state (number):
 Step of work (number):
 Number of workplace (number):
 Grade for begin to work (number): 70
 Grade for completed work (number):
ENDF
```

Perception subsystem aims to recognize images (objects, situations, activity and so on), obtained from different sensors through wireless sensor network. We mean as sensors following devices: video or photo cameras, light and temperature sensors, pressure sensors in chairs, sensors in doors and windows, RFID sensors and so on. Beside as sources of information for this subsystem may be computer or smartphone. In this case data for recognition and decision making may be already previously processed by corresponding “intelligent sensor” and may be ignore and transmit to another subsystem by recognition subsystem without processing. Recognition subsystem may be implemented as set of neural networks or as Bayesian network.

Localization subsystem aims to recognize, store and track of location of students and teacher, appearance and disappearance of students and teacher inside room. Te recognize location may be used approach based on neural networks recognizing location described by signal strength vector from some sources (Ahmad, et al, 2008). But instead radio signals proposed in these articles may be used ultrasound signals. Alternative approach to calculate location may be based on distributed visual system (Tosic and Frossard, 2007).

Context manager uses recognized information to append and change context in which the decision maker, localization and recognition subsystems are solving their tasks.

Context contents description of states of dynamically changing parameters of laboratory such as: locations of each student and teacher with their identification information, current step of laboratory work on every equipment, relations between students and equipment, list of students whom must work this laboratory work and information about absence of anybody, recognized activity of students and teacher (e.g., sitting, writing, reading, coming to another equipment or student, coming out room, coming into room, producing of strong noise by student, any another unknown/unrecognized activity and so on).

This architecture may be implemented as multi-agent system. For example, for laboratory of information technologies we can select following main kinds of agent: Computer, Visual Sensor, Audio Sensor (microphone), Pressure Sensor, Light Sensor, Smartphone, Window Agent. Any agent can produce messages and be in any states. Agents can be implemented as software inside corresponding smart objects or in server. Possible messages and states are shown in Table 1. Some of them are active agents (e.g., Computer and Smartphone) which can solve of any tasks or parts of tasks of subsystem Decision Maker.

Besides some agents in Table 1 can receive and execute commands from system, e.g. Computer and Smartphone. Such agents may be viewed as combination of sensors and

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actors. Besides there are some agents-actors, for example, Light Switch, Climate Control and so on.

To prepare such system to use is serious problem. This system joins symbolic knowledge represented by rules or/and frames and trained different classifiers based on neural networks or/and Bayesian networks. These knowledge are very varied from one application to another. So important part of this system will be any software to help of building of smart laboratory (Smart Laboratory Builder), combined capabilities for teaching of system and formalization of knowledge. Building of SLB may be based on principles employing context and natural language suggested in (Gavrilov, 2008, 2009) and set of frames and rules like in expert toolkit Eswin with alternative or additional tools based on ontologies (Uschold and Gruninger, 1996).

Table 1. Messages and states of agents.

Agent	Messages	States
Computer	Turn on or off. Insertion of flash memory or taking out. Start of any program. Complete of any program. Enter of string from keyboard. Try to start software being foreign for laboratory work.	Is working or no. Flash-memory is connected or no. Running any determined program or no.
Visual Sensor	Appearance of user. Disappearance of user. Any activity is recognized.	User is existing or no. One user or more. Recognized activity of user.
Audio Sensor	Loud noise. Recognized any phrase.	Turn on or off. Speech. Noise (not speech)
Pressure Sensor	Set on. Set off.	Anybody is Sitting. Free.
Light Sensor	Increase of light. Decrease of light.	Low, normal or high level of light.
Smartphone	Question (command) from available set to access to system.	Inside or outside room. Location in room.
Window Agent	Opening or closing window.	Opened or closed window.

CONCLUSION

Proposed architecture of smart school laboratory will provide improvement of organization of conducting students and teacher work; will increase safety using different complex and dangerous equipment. Such system may provide for teacher opportunity to have 2-3 classes simultaneously using smartphone for real time communication with smart laboratories and students.

Now experimental development and implementation of this architecture is planning. As experimental testing area we intend two school laboratories: for study of information technologies and for study of technological machines.

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The Use of Own E-testing System in the Multimedia Course

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Abstract

The article presents our experience using a testing system with centrally located database of questions which were specifically created according to needs of the Multimedia course at the Matej Bel University, Department of informatics. This course has already being taught for 17 years. Most of the systems which we have worked with have the possibility to randomly generate a test with given total number of points only in the case that all questions were awarded with the same number of points. The problem was if we wanted to use more complex questions like multi-choice answers or choosing questions from different categories. We have already been using our e-testing system for four years and our experience is positive. During last four years together 210 students of Applied Informatics study programme and Teacher training in Informatics study programme took part in this testing system. Thanks to its use we have faster, more effective and more objective way of collecting feedback from students. So our aim is to present the mid-results of its use in wider community.

Keywords

Verification of knowledge. Didactic test. Test system. Web application. Database. Test generation. Computer security.

INTRODUCTION

The use of digital technologies in testing has its strengths and oportunities but also weaknesses and threats. Verification using on-line testing is therefore condemned for never lasting discussion and search of new methods to enhance it.

Each learning process has its own life cycle, which is reflected in the preparation of electronic teaching materials and electronic training courses. His last and very important phase is the verification of knowledge, as presented ADDIE model (Analysis, Design, Development, Implementation, Evaluation). (Škrinárová, 2011). The teacher should have the feedback to know if the way he serves the information to the students is effective and correct or if it is necessary to improve or completely change them. The development of digital technologies affects the educational process in all its phases. Their support is not only in preparation, presentation and the use of IT in laboratories. They have their undisputable role also in verification of teaching process. The whole process can be controlled remotely from other part of the globe using the internet. *"E-testing is a rapidly*

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growing area of e-assessment involving the delivery of examinations and assessments on screen, either using local systems or web-based systems." (web page e-Testing).

To use the terminology, a test is a standardized procedure which induces an activity which is evaluated and compared with results of others. Didactic test is a modern means of testing and evaluating of teaching results of individuals. It is used for measuring the quality and the quantity of knowledge as well. (Rosa, 2007)

There are more terms connected with verification in pedagogy, e.g. examination, evaluation and classification. Examination is a process in which results of the educational process are measured: what a student knows and does not know, what he knows compared to what he should know. So the level of reaching educational objectives is being found out. Evaluation means to say conclusions, i.e. evaluating of educational process results. Classification is the result of evaluation. (Turek, 1995)

E-TESTING

Testing with computers is nowadays one of the widely used ways of getting feedback. It is a type of automatized testing in which intervention of the examiner is not necessary. When teacher creates questions for testing the whole executional role is passed to the testing system which creates test from the set of test questions, processes the test and evaluates it. In comparison to classical testing, much time and energy is saved this way. Indisputable advantage is also that it protects against errors caused by inattention or tiredness of the evaluator. (Varga, 2011).

Problems of e-testing are described and solved in literature from various points of view. E.g. architecture of testing systems (Kultan, 2006), creation of didactic tests (Pulpán, 1991; Turek, 1995; Rosa, 2007), validity and reliability of tests (Jacková, 2006), formative testing (Deutsch et al., 2012; Ćukušić et al., 2014), measurement of learning outcomes (Butaš, 2009), feedback influence (Škrinárová et al., 2013), collaborative learning (Wilson, 2003; Denny, 2008), quality of education (Kultan, 2007).

EXISTING E-TESTING SYSTEMS

Market gives us many products which can be used in e-testing; some of them as standalone application, other as complete e-learning packages. Most of quality systems are not for free. The price corresponds with options they give and buying the whole package means that we get everything we need for e-learning. Maybe just one exception is only Moodle which is used in many Slovak schools thanks to its open source availability. (Lenhart, 2005)

Moodle

Moodle[1] is an open-source software which can be used by teacher for creating on-line courses a tests. Moodle is written in PHP language and can be supported by more types of databases, mainly the MySQL system. System for making tests is a standalone module which works as an extension.

[1] Moodle is available at http://download.moodle.org

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PeerWise

„PeerWise is a web-based system that allows multiple-choice question banks to be built solely from student input. The system provides a number of intrinsic reward structures that encourage students to contribute high-quality questions in the complete absence of instructor moderation.“ (Denny, 2008). This system is a tool for collaboration learning. It is also free software.

iTester

iTester is implemented in the e-learnig system iTutor but it is also possible to buy it alone. We can use the system to create structured database of questions and to automatically create tests. Questions are inserted intuitively, user edits the type of the question, question which is asked or other attributes. Questions can be put into more categories. Questions are generated randomly using rules, which can be given. Biggest advantage is the possibility of multimedia use in the questions. One of other advantages is the possibility of setting weight for questions, setting restrictions for test authors and test users, length of the test and controlling the flow of the test.

MyGradeBook

MyGradeBook is an advanced testing system which is the follower of the QuizLab. Advantage of this system is the use of classes into which tests can set. Author can set beginning and end of the test and number of course for which the test is created. Author can also set weight for each test and create more tests for one course. Questions are not awarded with points, just the whole test is awarded percentually. Author can give scale for evaluation using percents. Results of the test are sent by e-mail to the teacher.

WebQuizXP

It is a testing system used to create on-line quizzes, tests and queries for collecting data. To use it one must download the application and install it. Author of the test can add pictures, equations, formulae to the question. Each question is given a score for correct, incorrect or no answer. Created test can be published either locally in the computer, on the given webpage, or on the www.webpage.it. To upload the tests one can use implemented FTP client. Test results are stored in Microsoft Access database and application can work together with other Microsoft Office applications.

QuizMaker

QuizMaker is a payed web testing system made by ProProfs and used for testing the knowledge. There are two possibilities when creating the test. The first is the classic test with scores for each question used for student testing. The second is the personal quiz in which survey for employees or a survey of satisfaction can be created.

Comparing the systems

From the systems presented above, we can say that iTester gives the most possibilities for the examiner and offers wide scale of questions for testing. When we compare the cost and performance, the QuizMaker comes as the least valuable because one would await more from paid system. (Varga, 2011). PeerWise is free, but it is not intended for typical student testing by a teacher.

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Kultan (2006) compares types, requirements and the use of these testing systems: HotPotatoes, tPilot,WebQuizWriter and Questionmark Perception.

INTRODUCTION OF OWN SYSTEM FOR TESTING

Specific needs of our Multimedia course did not allow us to use already mentioned products from the area of e-testing. This course has being taught at the Department of Computer Science at the Matej Bel University already 17 years. Most of the systems which we have worked with have the possibility to randomly generate a test with given total number of points only in the case that all questions were awarded with the same number of points. The problem was if we wanted to use more complex questions like multi-choice answers or choosing questions from different categories.

Because our department has the potential in the area of internet services, databases and information security, we decided to develop our own system for testing. This was done in master thesis of Peter Varga which was led by one of the authors of this article. We will introduce some used technologies in this part of the article.

Apache is one of the most used web servers and together with PHP scripting language and MySQL database server serves as a base for creating dynamic web pages and other more complicated applications. (Lacko, 2005). We used this solution for our system. Traditional internet technologies were put together. This means XHTML 1.0 Transitional and CSS to differ contents from style. Functionality was done with PHP. To administer the database system, we used traditional graphical interface phpMyAdmin. Other software suits were also used to create graphical interface (Adobe Photoshop CS3), to create web pages (Macromedia HomeSite+ 5.5), to easily create cascading stylesheets (TopStyle3).

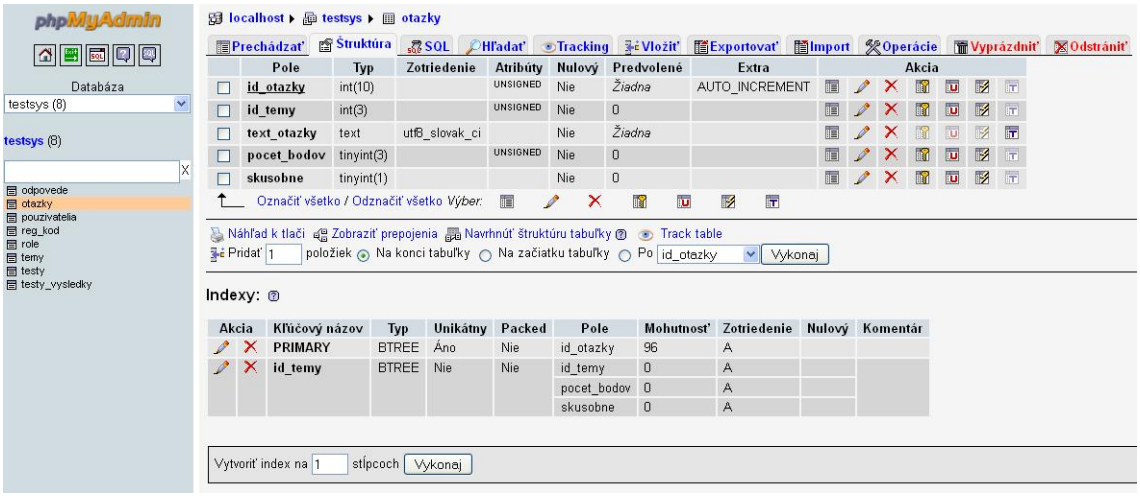


Figure 1: Database creation using phpMyAdmin (Varga, 2011)

Requirements

Our aim was to create a web system used for testing and to ease the teachers' work when assessing students at the end of the semester. We used the existing requirements which can already be found in literature (Rosa, 2007):

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- to allow input questions into database easily – input different types of questions using web interface,
- security – system must be properly secured, only authorized users have granted access,
- automatically generated tests from the question bank – after giving basic instructions the test is generated,
- automatic evaluation and scoring,
- simple management of questions in the database – editing or deleting of questions is always possible,
- simple management of students – teacher as an administrator is authorized to add, delete and edit information about students,
- possibility to give authorization for different user roles.

User roles

Important requirement for the application was the definition of roles for different users. These give authorization for them in the system. This means the actions which the user may perform and to which resources has access. The system for now has two roles: "student" and "teacher".

The role "student" is given after registration automatically to everybody except teacher. Student is authorized to do these actions:

- registration to the system,
- logging into the system,
- changing the registration data,
- accessing the test,
- filling the test and sending it for assessment.

The role "teacher" contains also the role of the administrator of the system. It is the only role which allows to delete the students and to administer the system. Therefore teacher is authorised to do these actions:

- create and edit tests,
- insert and edit questions in the test,
- administer students,
- access the assessment of students.

Database

The backbone of web testing system is a relational database. (Naramore, 2006) All the data is stored here, information about students, tests and all questions for tests. The structure of our database can be seen on Fig.2. It consists from 7 tables: role, user, test, test_result, topic, question, answer.

Generating questions for test

The main idea for this system was that the system generates test without the interaction of the teacher just from the questions in the database. The teacher only sets maximum number of points which can test have. This property of the system was crucial

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and came from the requirement which is usual in many courses in university teaching. To finish a course student usually needs some points from practical session and some strictly given points from theoretical part in the form of test.

When generating the test, an algorithm evenly takes questions from different topics where we have different questions with different scores. The algorithm takes questions from all topics in the course. We can describe the algorithm in these steps:

Step 1: Take a question with the highest score from each topic.

Step 2: If the question from each topic is taken, take a question from any topic. Do not exceed the maximum points for the test given by the teacher.

Step 3: Continue with the step 2 if the test does not have enough points for questions.

The test is generated separately for each student. The more questions in the database are, the bigger probability is that two students will not have the same test.

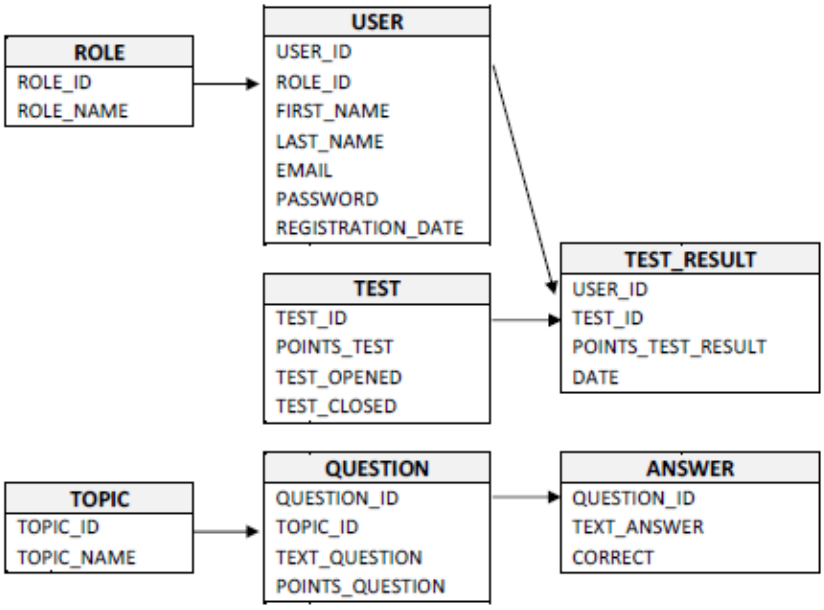


Figure 2: Database model (Varga, 2011)

Security of the system

In the process of creation we also put accent on validity of tests and security as we do not want the data being accessed by any unauthorized person. Validation grants that data which is inserted to the system meet given data types and do not violate the consistency of the application. (Rychnovský, 2005) We tried to avoid therefore that the user enters data in unexpected form like text input instead of number.

Another part of system security is the design and realization of access rights. As there are just two roles in the system, specific rights are only for the teacher who serves as an administrator of the system. This is also the only person that has access to the question base.

Only registered students have access to the system. Access with login and password is the basic protection which avoids an unauthorized access. The e-mail address of a student serves as his login. The password is set by a student after his registration to the system.

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Administration of the system

As the student does the registration by himself one would mind, that anybody could register and would make problems with administration. To avoid this, students need to fill in the registration form a registration code which they receive from the teacher. The registration is impossible without it. Required registration data are: Name, Surname, E-mail, Password, Password confirmation, Registration code.

After the registration is completed, student can log in using the login form (Fig.3). E-mail address of the student serves as login name. This form works both for student and teacher. Student gets active available tests. To start testing, he just chooses the link and the test is generated.

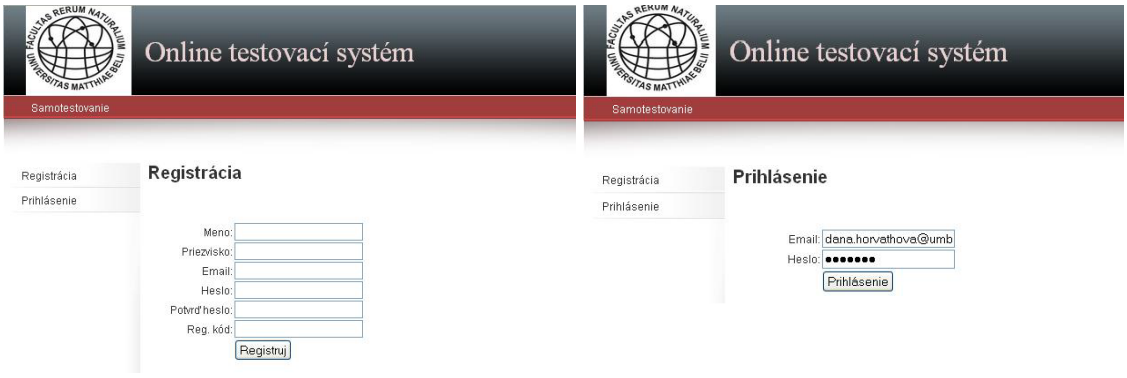


Figure 3 Registration and login form (Varga, 2011)

In the section "Zoznam testov" (List of tests) teacher has the list of all tests which have been created. Each test can be accessed, modified or deleted. New test can be created from the menu. The list of topics for our tests can be seen on Fig.4.



Figure 4 List of topics (Varga, 2011)



Figure 5 Question editing (Varga, 2011)

The form for inserting questions into the test gives the teacher possibility to add different types of questions: multiple choice with one correct answer, multiple choice with multiple correct answers, multiple choice with no correct answer, yes/no question (Fig. 5).

If the teacher wants to see results of a student, the list of students (Fig. 6) is accessed where all the tests and their results which the student has taken are found.

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Figure 6 List of students and the results of a student (Varga, 2011)

RESULTS

During last four years together 210 students of Applied Informatics study programme and Teacher training in Informatics study programme took part in the testing system.

Before we used the system the preparation of the test for each group of students took at least 20 minutes. Thereafter each test had to be corrected which means at least 10 minutes for each student. This was also subject to teacher's concentration which means that correction of the test was not error free.

After the implementation of the system the main part of teacher's work is the creation of topics and questions. But this has to be done only once for any subject and later teacher just upgrades the questions which are saved. The teacher then just assists while students fill the test. Ideally the students are logged out from other internet resources and the use of monitoring software like NetOp can help the teacher even more. When the student sends the test for assessment, there are just seconds to find out the result of testing. This is the biggest time spare compared to previous way of testing.

In the testing phase of the system many problems had to be solved. For example lost connection to the server before the test was corrected, or overflow of the variable where the number of students was stored etc. These problems were corrected and therefore there are only improvements in front of us.

DISCUSSION

Our testing system was implemented to an electronic environment under the security system of the university precisely to replace paper forms of testing. Given the many advantages compared to conventional testing, we have not even attempted to produce output test on paper. Similarly, we have not yet even thought about exporting tests to other systems, for example to the LMS. Of course, the creation, editing, or deleting questions in the test, can teacher realize very easy and flexible.

Very good idea seems to be branching questions to subquestion according the programmed learning principle, mentioned in (Gangur, et al., 2012).

To discuss the results and look into the future we can look at different areas where this system could be used. The first idea for this system was the multimedia course and its

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specification. To use the system in other courses we could add some other types of questions.

We would like to add questions where any multimedia content could be inserted. This means pictures, sound and video files which would enhance the clearness of the question. Other possibility of question types can be question where one finds relation between two terms, question to write all possible terms which are connected with given term, question where the student has to fill a mind map etc.

We also await that the testing process will be affected by "artificial intelligence" which could automatically correct questions with open answer. Similarily the AI could be used in generating questions "on the fly" depending on students answers. If student answers correctly questions from some topic the system may ask questions from a different one.

CONCLUSION

We have shown that e-testing systems can help teachers as well as students. If they are used correctly from the pedagogy point of view they can help to improve the quality of education. Nowadays there are various possibilities for choosing or creating own e-testing system that suits the needs of an educator. If we create our own system it could fill our special requirements better. In addition, creating own testing system helps students of Applied Informatics to understand various aspects and stages of development the system.

We have already been using our e-testing system for four years and our experience is positive. Thanks to its use we have faster, more effective and more objective way of collecting feedback from students. We will continue using this system and plan to improve it to be able to use it also for other courses to make it universal testing system.

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Collection and Analysis of Data on the Hearing Impaired People and Their Needs in Education

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Abstract

Handicapped citizens are an integral part of our society, unfortunately are often disadvantaged and faced with barriers. We believe that research into various aspects of their life is needed and help to improve their happiness and quality of life. This paper focuses on a group of hearing impaired citizens in the Pardubice region. With the help of the questionnaire survey the necessary data about various areas of their everyday life was collected. The data was analysed and subsequently searched hidden information revealing the connection between their educational attainments, quality of life and type of disability. We found that there are still evidently barriers in everyday life of hearing impaired citizens. They have lower educational attainment, also significantly less access to the Internet and the resulting lower access to information. It was also found that hearing impaired citizens prefer specialized educational institutions for their own education. On the other hand, courses and retraining were found as the least suitable form of education. We believe that detailed research is needed in this field at regional and national level.

Keywords

Hearing impaired people. Education. Educational attainment. Quality of life. Data. Pardubice region. Questionnaire.

INTRODUCTION

This paper deals with the problems of the hearing impaired population of the Pardubice region. With the help of the questionnaire survey was gathered the necessary data about their education, disabilities, preferences and everyday life. The aim was to explore the link between quality of life (QL), level of education, disability and analyse them.

Education is important in life of everybody and has strong influence on our well-being. In (Virtič, 2012) is stated "The access to higher education is becoming a necessary element in expanding economic prosperity and improving the QL". In the past, several research studies aimed at examining the impact of education on the quality of human life were published. These include work Education and the Subjective QL (Ross, 1997), where it was examined whether education affects subjective QL. Two representative national U.S. samples were analysed here. The authors report: "In this research we asked two

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questions: Does education matter to subjective QL, and if it does, what are the mechanisms by which education affects well-being? In answer to the first, we find that the well-educated have lower levels of emotional and physical distress than the poorly educated. Compared with the well-educated people, the poorly educated have higher levels of depression, anxiety, malaise, aches and pains, and, to a lesser extent, anger. Poorly educated persons have lower levels of enjoyment, hope, happiness, fitness, and energy".

Another study is "Association between educational level and health related QL in Spanish adults" (Regidor et al, 1999). Authors analysed here data from the National Survey on Drug Use carried out within the framework of the National Plan on Drugs. Population aged 15 years or older residing in Spain was the sampling universe.

„The results of this study show that, in general, persons with a high educational level (the third level) rate their health status higher than persons with a low educational level (no education completed or first level education)." Another outcome of this study is the assumption "The influence of educational level on the different dimensions of perceived health may vary by sex".

Some government offices and institutions are also dealing with this issue. For example based on information from Education Commission of the States (Education, 2014) low levels of education among the adult population in a USA have been shown to negatively affect the following:

- Per-capita income and the strength of the state's economy.
- Health of the state's population.
- The well-being of children.
- The rate of violent crime.
- Voting rates.
- Preparation level of the workforce.

Quality of Life for People with Disabilities

Very specific area of QL research is measurement, analysis and modelling of QL for people with disabilities (Claes et al, 2009) in this case hearing impaired persons. Many articles dealt with deaf people problems (Gilman et al, 2004; Grigore et al, 2010; Saeed and Mawman, 2010). The specific issue is the education of disabled. Their education enhances the QL and the possibility to integrate them into life and get a job. Distance learning is appropriate way of education for some groups of disabled people (Smyrnova-Trybulska, 2010). Another article on this topic is (Vilkonis, 2010). Hence, the research was aimed at finding out the need for distance learning at a comprehensive school of Lithuania as well as target groups of students. The research was based on qualitative research methodology. Authors found out that the "need for distance learning is primarily associated with students whose ability to participate in conventional classes on school premises for a longer or a shorter period is limited by health problems or congenital or acquired disabilities". Index of distance learning popularity for the students with special needs and special education needs (they could be grouped in terms of learning difficulties, intellectual development, physical or mental disabilities, behavioural disorders or some

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other adversities, for example, students with autism spectrum disorders when a person cannot learn in a team) is 0.75 in this work.

When we talk about hearing, we mean the ability to detect sound thanks to the aural analyser – our ears. Our brain is able to perceive this sound due to the cranial nerve, which leads them from our ears. We can divide our ear into four parts – outer ear, middle ear, inner ear and nerve tracks. Damage to the human ear can be also called as impaired hearing or other abnormalities. People who suffer from the impaired hearing, aural handicap are called people with hearing disability. The hearing disability covers variable groups of people differing from groups and degrees of hearing disability. In this research, we work with three groups of hearing-impaired (Horáková, 2006):

- Deaf people.
- Hard-of-hearing people.
- Deafened people.

Hard-of-hearing means the state, when the hearing ability is becoming less and less during the life, according to (Bulová, 1998). Deafened people are persons who lost hearing ability during their lifetime. If the person deafened after the basic speech development (which means after the age of 7), the ability to speak is not lost. It remains the same but the person needs the systematic care. Hearing disability is one of the most common somatic-functional disabilities in the human society. Deaf people lost hearing ability from their birth.

Our work is based on facts that are mentioned above, but it must reflect many differences. For example, obtaining information from the hearing impaired people is difficult, so we prepared special questionnaires to suit their abilities and language specifics. The necessary data was then obtained through a questionnaire survey of hearing impaired persons in the Pardubice region (NUTS 3 region). In the studied Pardubice region the number of the people with hearing impairment is (Mandys, 2009): 739 deaf people and 4844 hard of hearing people.

METHODS

The most difficult phase of the work was to obtain data from hearing impaired citizens. Questionnaires are the most used methods for data collection from respondents. There are two basic types: self administered and interview (Research methods, 2014; Panuš, Jonášová and Michálek, 2012). Given that we have worked with hearing impaired persons, we used a special procedure. The first step was designing the questionnaire, second pilot survey and the subsequent adaptation of the questionnaires (must be suitable for the disabled people), third was questionnaire survey.

In the first step, we solved the format of the questionnaire and for whom it is intended. We have used clearly formulated closed questions. An example of such questions is as follows:

Your age is:
1) 20 or less
2) 21-35
3) 36-50

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4) 51-65
5) 66 and more

If the question allow more than one answer, respondent could select multiple answers yes (or no). For a few questions, were used a Likert scale (for example for "frequency of use selected services" were used suitable five – level Likert item) (Vagias, 2006). Questionnaire had a total of 39 questions.

In the second phase we conducted a pilot survey. Subsequently, some questions were modified and graphical form of questionnaires was adapted.

It turned out to be very difficult to obtain a sufficient number of hearing impaired respondents in the third step. Many disabled people are very careful. Although questionnaires distributed training people (who know sign language), we received back 108 questionnaires. It is not a large sample but at a regional level provides relevant information and the power of this sample is sufficient.

The analysis and data processing was performed using SW IBM SPSS Modeler (IBM, 2014).

RESULTS

First, it is appropriate to characterize the studied group of hearing impaired people. The questionnaire survey was able to get a total of 108 completed questionnaires. The data was transformed into electronic form, pre-processed and the data matrix D (108×39) was an output. Some attribute values were empty (no answer in the questionnaire). In this case list wise deletion was used (Allison, 2001). Since the questionnaire was extensive, we will focus only on selected attributes and their analysis.

Structure of respondents by type of disability is shown in the Figure 1. Most of the respondents belonged to the group "hard of hearing", the smallest group of respondents are "deafened". Proportion of respondents by gender is balanced (50% male, 47.3% female, 2.7% no answer).

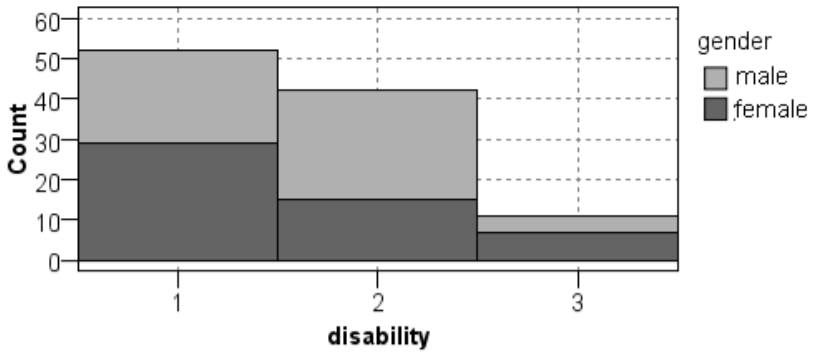


Figure 1: Respondents by disability and gender (disability takes values 1- hard of hearing, 2 - deaf and 3 - deafened)

Structure of respondents by highest level of education we see in Figure 2. It is obvious that very few people with higher education and vice versa large group of low-educated are

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between disabled people. Secondary and tertiary level of education has only 19.5% of respondents (in the whole population of the Czech Republic it is 48% people with secondary and tertiary education (Czech statistical office, 2014)). This is confirmed by another study in the UK (Office, 2012). Here 26% of adults with impairments stated they had no formal qualifications compared with 12% of adults without impairments. Adults without impairment were more likely to have a degree level qualification compared with adults with impairment (26% and 15% respectively). Also in the US study (Cornell, 2011) is among hearing impaired people 16% having completed tertiary education (compared with 31.2% of the normal population) and 18% with the lowest education (compared to 10.6% of the normal population).

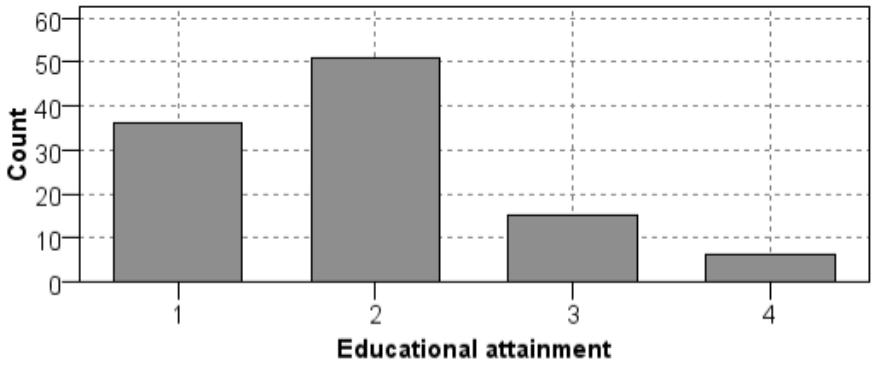


Figure 2: Respondents by educational attainment (we used here modified OECD-classification ISCED. The questionnaire set four options of educational attainment: 1 - primary (ISCED level 0,1), 2 – skilled (ISCED level 2,3C), 3 - secondary (ISCED level 3A-B,4 5B), 4 - tertiary level-university (ISCED level 5A,6)

Many studies tried to describe the importance of the Internet for education (Virtič, 2012; Černá and Poulová, 2009), web-based educational activities (Balogh, Turčáni and Burianová, 2010), and a using of an adaptive hypermedia systems (Kapusta, Munk and Turčáni, 2009).

Given that distance education usually need students to use the Internet (as an appropriate form of education for the disabled), we focused on the degree of use of these technology between disabled people. 70% of the entire population was active internet users in 2013 in the Czech Republic (Czech statistical office, 2013). But in Figure 3 we can see, that the quite different situation is between hearing impaired people. Only 33.3% of hearing impaired people are active internet users. This evidently reduces their access to education and information. This finding would be appropriate in the future to verify and further analyze.

Currently, there are a variety of education methods of hearing impaired persons. For the purpose of the questionnaire, we divided it into four groups. Specific modules in further education (education-modules) are in the first group. In the second one specialized educational institutions (education-special) are included. Common educational modules - retraining, courses (education common) belong to the third one, and an integration into the regular school system (education-integration) is content of the fourth one. We wondered subjective opinion of respondents on this topic. In the Figure 4 their opinions are displayed. Although there is frequent answer “I do not know”, some preferences are obvious. Respondents most frequently agree with education in specialized educational

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institutions. For this type of education are also the least negative responses. The least positive evaluation has common educational modules. Negative responses are mainly for common educational modules and for integration into the regular school system (mainly from respondents who are diagnosed deaf). Based on respondents' opinions can be argued that the preferred educational method for hearing disabled people are specialized educational institutions. This should be further verified in other groups of handicapped people and confronted with the state policy in this area.

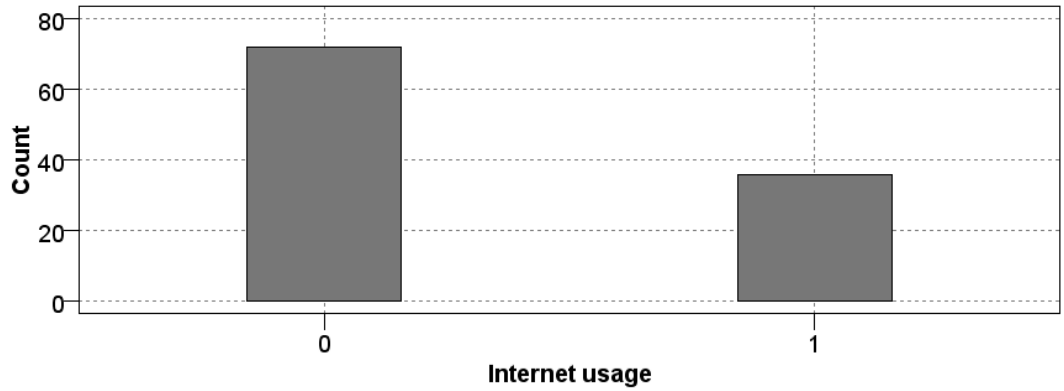


Figure 3: Internet users between hearing disabled (0- does not use the internet, 1- use of internet)

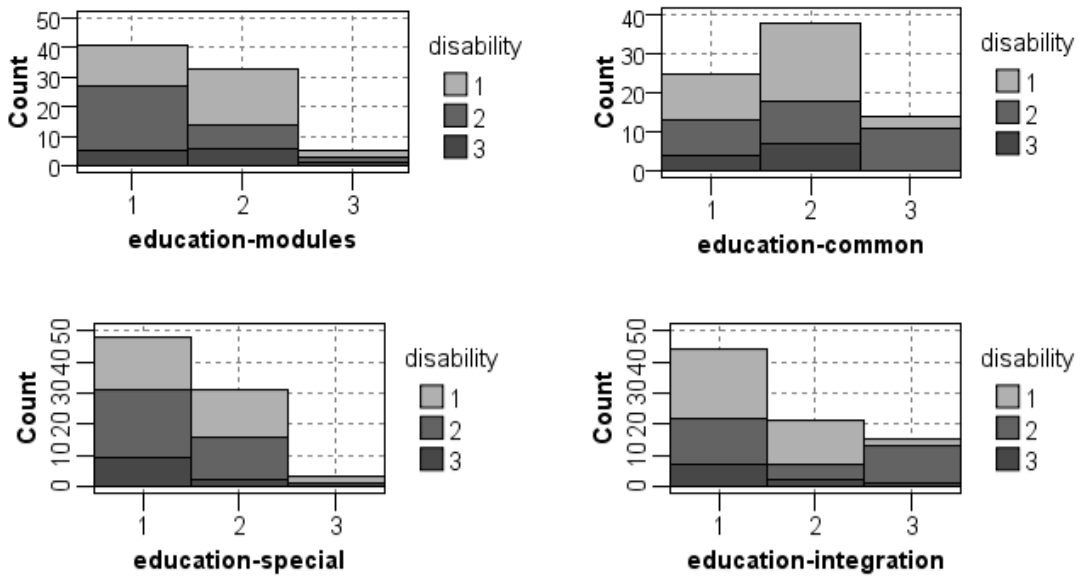


Figure 4: Preferred education methods (on the X - axis are values 1- yes, 2 - I do not know, 3 – no; disability takes values 1- hard of hearing , 2 - deaf and 3 - deafened)

DISCUSSION AND CONCLUSION

The data obtained directly from the respondents of the questionnaire survey (persons with hearing disabilities) are a valuable source of information about their life, preferences, problems and needs. These data are useful as a basis for the detailed analysis. Despite some problems, mainly due to the specifics of a group of hearing impaired people, we

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were able to collect 108 questionnaires. The survey was conducted at the regional level - in the Pardubice region (the Czech Republic). It does not therefore represent a nationwide situation.

It turns out that there are still evidently barriers in everyday life of hearing impaired citizens. Compared to the general population hearing disabled use the Internet much less. Seventy percent of the entire population in the Czech Republic was active Internet users (year 2013), in contrast, only 33% of hearing disabled were Internet users. There is an obvious barrier to get access to information, but also to distance learning via the Internet.

Another difference from the general population is in educational attainment. Educational attainment of hearing impaired citizens of the Pardubice region is significantly lower. For example secondary and tertiary level of education has only 19.5% of respondents (in the Czech Republic the general population is 48% people with secondary and tertiary education). Based on (Ross, 1997, Regidor et al, 1999, Education, 2014), educational attainment has negative impact among others on quality of life, per capita income, the ability to get employment. Further research on these negatives would be very much needed at both regional and national levels. The aim would then be looking for ways to improve the QL for the hearing impaired, increasing their educational attainment.

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Benefits of E-learning in the Education of Geoinformation Technologies at the Faculty of Economics and Administration University of Pardubice

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Abstract

Geoinformation technologies are taught in several courses in all study programmes at the Faculty of Economics and Administration University of Pardubice. Students acquire a wide range of knowledge and practical skills that can help them to succeed in the labour market. This article deals with benefits of introduction of distance learning in teaching geoinformation technologies at the faculty. Distance education methods increase current knowledge and skills of students, especially in the field of geographic information systems, remote sensing and global positioning and navigation systems.

Keywords

Innovation of teaching. E-learning. Geographic Information Systems. Remote Sensing. Global Positioning Systems.

INTRODUCTION

Geoinformation technologies are taught in several different subjects within all study programmes at the Faculty of Economics and Administration University of Pardubice. The aim of the courses is to allow students to acquire theoretical knowledge and practical skills in the field of geoinformation technologies which will increase their chance of finding a job at the labour market because spatial decision-making is very important (Šimonová and Kopáčková, 2009). The modern geoinformation technologies are also very interesting for students (Klimešová, 2006).

At the faculty, geoinformation technologies are taught within the following subjects Geographic Information Systems I, Geographic Information Systems II, Cartography, Spatial Analysis of Area, Map Server Services and Introduction into Information Systems. All of the subbjects follow the latest trends in the field (Farmer and Komárková, 2009, 2010). E-learning management system (LMS) Moodle has been implemented to support the teaching process.

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METHODS

Software engineering methods were used to propose and design the courses available in LMS Moodle.

Statistical methods were used to evaluate obtained results, i.e. student's evaluation. Namely, Kolmogorov-Smirnovov test was used.

IMPLEMENTATION OF LEARNING MANAGEMENT SYSTEM

At present, a suitable LMS belongs to inevitable parts of teaching process. Selection and implementation of the LMS into teaching process at the faculty was run in three phases, as stated by Kopecký (2012a, 2012b). The first phase consisted of description of the current state and identification of the future needs with respect to the given sustainability conditions and development of modern technologies. The second phase was dedicated to market research in the area of LMS software, installation options, and preparation of the technical equipment and testing of particular software tools. The third one was comprised of an evaluation and final implementation of the selected product.

LMS systems support creation, use and management of e-courses by providing a minimum set of educational tools to facilitate learning, communication and collaboration, for example (Kopecký, 2012a, 2012b):

- Communication tools which support discussion, file exchange, internal e-mail correspondence, chat, video streaming, etc.;
- Productivity tools to support learning, enabling such work offline, insert your own notes, use the calendar, help, etc.;
- Tools to support collaboration of students, e.g. support of a team work;
- Set of supporting tools to help in the process of administration and management of the course, e.g.: administration tools (for keeping students' records, files/directories, and contacts) and management tools (tools for the management and monitoring of students' work).

Based on the market research, the following systems were selected for the testing: iTutor, eDoceo, Eden, Uniform, Barborka, Workplace, Moodle, and Blackboard.

Analysis of the survey of needs of the students for communication and education was conducted as the next step. According to its results, the following evaluation criteria for the comparison of LMS were chosen:

- Online communication tool - allowing communication between the tutor and the student in real time;
- Off-line communication tools - to facilitate communication between students and tutors with a considerable time lag;
- Tools for productivity - provides tools to streamline and simplify the work of students;
- Creation of learning materials - providing tools for creating learning materials and possibilities of prepared templates;

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- Types of tests - the variability of test questions, answers, and the possibility of a self-test;
- Tasks - making short correspondence tasks and tasks performed directly in the application;
- Test parameters - the possibility of entering into the test time limit and variability evaluation;
- Price of the system - parameter expressing the cost of the acquisition of the system.

Another survey was used to assign weight of importance to each criterion. The criterion "price of the system" is one of the most important parameters influencing decision-making in the selection of the LMS system without consideration of any other requirements. Since it is not easy to compare modular systems in terms of price, this parameter is measured only according to the total purchase costs.

Process of choice was very complex, it involved many criterions. Purchase price and subsequent maintenance costs are important parameters during the decision-making process because they influence sustainability of the system. Chosen LMS Moodle is an open source system. It will be maintained by faculty's technician and financed from financial resources of faculty. Vast global communities developing this system, and references from other universities in the Czech Republic, belong to positives as well.

Basic server for LMS was set up in a virtual environment because strategy of the University of Pardubice in is to virtualize. Virtualization brings many benefits such as saving energy and money, for merging multiple physical servers into single one, simpler hardware maintenance, easy migration, etc.

Linux was chosen as an operating system for running LMS, specifically Linux distribution CentOS 6. The reason for choosing Linux was its price, support from the Information Centre (IC) of the University of Pardubice (it manages all Linux servers) and the set of rules for the deployment of new servers for similar purposes. The type of distribution was chosen on the basis of consultation, rules and knowledge of the IC workers. At the time of deployment, release 6 was the latest one. SSH (Secure Shell) has been set up for security reasons after the basic installation.

The following server components are necessary for LMS:

- Webserver;
- PHP;
- MySQL Database system.

The standard installation of Apache Web Server, version 2.2.15 was a normal installation from the official repositories. Apache Web Server was kept in default settings. The Webserver is designed for one website and therefore it is not necessary to set the virtual host. Furthermore, only important identification information such as name of the web server, and contact administrator were modified.

MySQL is a sufficient database system for running Moodle LMS. First, it is recommended because it is multiplatform, free and sufficiently satisfies the requirements of the system for comfortable running Moodle LMS.

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PHP is scripting programming language used to create dynamic web pages and it is used for LMS Moodle. Installing the server is similar to Apache and MySQL. It uses the installation script with the source from the official repositories.

LMS Moodle

The first phase featured the downloaded installation package to install Moodle in the pre-space Web server and set the file permissions. Furthermore, the launch of the new database was made. Next, the working directory for Moodle ("moodledata") was created. It is necessary to safe this directory against unwanted hacking.

The initial installation is performed via the web interface. Each part of the web server is checked during the installation. In most cases, it is necessary to intervene in the PHP settings. The default settings do not allow all extension, but some of them Moodle needs for its operation. These particular extensions are displayed on the screen after you enable these extensions (php.ini file) and reload the page. The following important information for future running of LMS During has to be completed:

- Language Pack primarily used for Moodle;
- E-mail of the LMS administrator;
- The path to the working directory Moodle;
- Proxy server settings;
- Time zone.

LMS Moodle operation

After the installation the functionality of the system was tested. The following basic functionalities of LMS Moodle:

- Users - create a user account name, user name, password, email, city, state, assigning roles. Test login to the new account.
- Communication - in relation to the newly created user will be verification e-mail communication system with the user and the control functionality of the communication link LMS, hence the server itself. And also check user authentication and authorization.
- Cron - Setting daemon that runs automated built-in functions mostly backup courses, backup, control of LMS and updates its components, control of user accounts and other rules defined by the system administrator, required for the safe operation of the LMS.
- Security - Check the security level on the server side (system updates, secure communication, the firewall settings), adjust the level of complexity of passwords , control of well -defined paths for storing logs, both about the problem and the individual events running on the server, secondly servers and that alone LMS Moodle . These logs are very important for debugging problems with LMS and total control events on the server and the possibilities to detect a possible attack on the whole system and discredit the server.

The next step was to set the LMS Moodle user authentication system. For security reasons, server, hence the university network, it was decided to deploy Shibboleth Service

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Provider (SP). This extension is used to authenticate users against a central database managed by the organization. It is a module that is automatic in the web server, in our case Apache. As the University of Pardubice is involved in this project and the IDP (Identity Providers), the choice was a logical step to facilitate the access of users (academic staff, students) to the LMS Moodle and also extra level of security of the entire server.

COURSES DESIGN

Geographical Information Systems

An e-learning support is a part of the course Geographic Information Systems I. Due to the complexity of some procedures within the geospatial technology students are welcome video-tutorials.

The structure of e-learning support is following:

- Study Material - pdf document;
- Interactive Crossword;
- Interactive test;
- Space for submission of the task;
- Data - zip archive.

Examples of exercises in which the LMS is used:

- Introduction to ArcGIS Desktop environment
- Rendering of layers;
- Attribute queries;
- Spatial queries;
- Creation of map outputs;
- Spatial functions;
- Editing;
- Network analysis;
- The digital terrain model;
- Comprehensive practice.

Navigation Technologies

Teaching of navigation technology is a part of the course Geographic Information Systems II. The course was re-designed for e-learning support. The course environment is shown in Figure 1.

The structure of e-learning course is following:

- Forum;
- Study text - pdf file;
- Teaching texts - pptx file;
- Videos;
- Text for exercise - pdf file;

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- Text for exercise - pptx file;
- Task submission.

E-learning support includes topics in the structure:

- History and Present of GPS - Getting Started Garmin GPSmap 60CSx;
- GPS segments - Maps Garmin GPSmap 60CSx;
- GPS devices - Compass and Altimeter Garmin GPSmap 60CSx;
- CZEPOS - Body Garmin GPSmap 60CSx;
- Accuracy of GPS - Garmin GPSmap 60CSx Routes;
- Coordinate Format - Navigation Garmin GPSmap 60CSx.



Figure 1: E-learning text of GPS technologies within the scope of Geographic Information Systems II subject

Digital Image Processing

In the course Geographical Information Systems II it is used IDRISI Andes for teaching of the basic principles of remote sensing data processing. This software is available for an unlimited number of licenses (Campus License). E-learning course familiarizes users with the most important methods of image processing as the main concepts of geographic information systems, thereby increasing its contribution to the development of the educational process and in particular facilitates and accelerates its involvement in teaching. There are also available textbooks for older versions of IDRISI on which participated author of this article, Sedlák and Voženílek (2004), a Sedlák and Hobza (2006). E-learning course for the subject Geographic Information Systems II dealing with digital image processing environment IDRISI fully complements the work with this system.

The structure of e-learning support is following:

- Entering exercises pdf file;
- Data - zip archive;
- Interactive test;
- Fun teaching (crossword);
- Space for submission of the task;
- Chat;

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- Forum;
- Poll.

E-learning support includes topics:

- Spatial image enhancement;
- Spectral image enhancement;
- Unsupervised image classification;
- Spectral index.

The Cadastre

The Cadastre belongs to the topics covered by Geographic Information Systems II. E-learning course for teaching Cadastre aims to explain to students the concept of the Cadastre, its history and the presence of the Cadastre as a publicly accessible database of information about real estate and statutory rights to property (see Fig. 2). With the real estate, the students will encounter in their professional and personal lives, the course approaches the procedure for deposit in the Cadastre, logging and reporting changes and information that can be from the property as a publicly accessible database to obtain.

The structure of e-learning course is following:

- Instructional text - html document;
- Interactive test.

E-learning support includes topics:

- History of the Cadastre;
- The Cadastre of the Czech Republic;
- The Cadastre map;
- Legal Questions of the Cadastre;
- Types of controls.

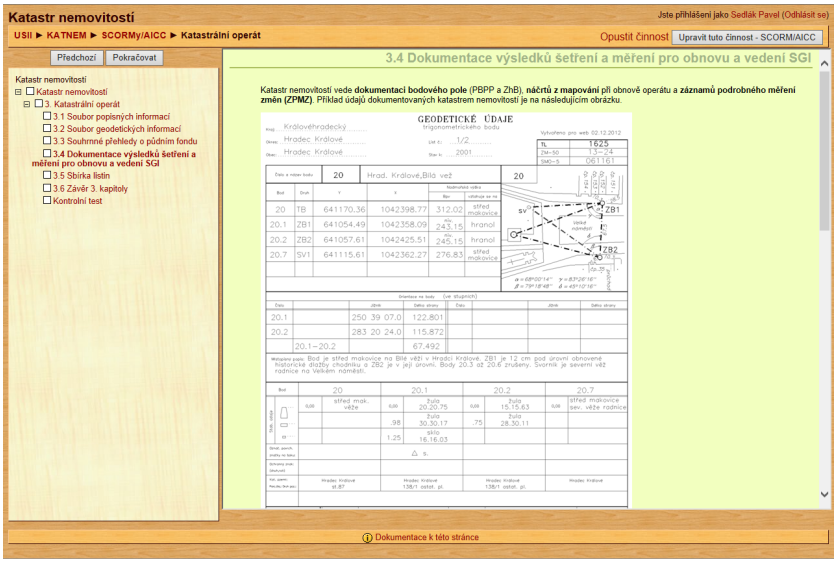


Figure 2: E-learning course of the topic Cadastre within the scope of the Geographic Information Systems II

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Cartography

Distance learning is also used in the course of cartography.

The structure of e-learning support is following:

- Exercises instructions - document html;
- Data - zip archive;
- Tool for submission of the exercise.

E-learning support includes topics:

- Introduction to the exercise of cartography;
- Colour for expressing of the quantity;
- Quantitative grid;
- Qualitative grid;
- Cartodiagram;
- Evaluation of the map.

RESULTS

Students attend pre-defined classes in the given terms at the university, with intensive lectures and consultations on the given subjects. They receive study materials in various forms, including electronic form. A communication after the terms was conducted mostly by e-mail. If special software was necessary, the presence of the students at the university and direct consultation with a tutor was requested.

After the introduction of e-learning courses it is possible to define the benefits of geoinformation technologies learning:

- Possibility of self-study in the extent to which student needs;
- Significant increase comfort while studying with access to software needed for study - even outside of the faculty classroom;
- Control of the tasks assigned by the tutor, fast response, easy and individual student leadership;
- Time flexibility for both the student and the teacher;
- Closest coherence of student-tutor and student-student by using of the LMS;
- Promotion of multimedia materials;
- Possibility of on-line communication in the study group and both student - student and the student - tutor;
- Self-testing, which improves learning process;
- Availability of data sets required for the exercise;
- Availability of video-guides;
- Outcome evaluation in the study group (assessment map);
- Possibility of storage of tasks in process.

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DISCUSSION

An innovation of subjects focused on geoinformation technologies was begun in the academic year 2008/2009 and it was finished in 2001/12. Interactive and multi-media e-learning study supporting materials were created during this period. These materials allowed to extend topics covered by the subjects. Study results of the students of the GIS1 and GIS2 subjects were evaluated before and after the innovation. The final results are provided in the following table 1.

Table 1 – Results of the students

Subject	Form	Academic Year	Evaluation					
			1	1,5	2	2,5	3	4
GIS1	Full Time	2007/2008	7	15	35	14	30	26
	Full Time	2012/2013	8	6	3	2	8	5
	Part Time	2007/2008	2	2	6	5	12	15
	Part Time	2012/2013	4	0	7	3	3	2
GIS2	Full Time	2007/2008	7	12	8	10	11	0
	Full Time	2012/2013	25	12	7	6	9	1
	Part Time	2007/2008	1	1	2	3	6	1
	Part Time	2012/2013	0	1	2	0	2	0

The Kolmogorov–Smirnov nonparametric test was used to statistically compare the above described data. This test was used because of a small number of records within each group of observation. The results can be found in the following table 2.

Table 2 – Results of the Kolmogorov–Smirnov nonparametric test

Subject	Form	Academic Year	p-value
GIS1	Full Time	2007/2008	P<0.10
	Full Time	2012/2013	
	Part Time	2007/2008	P<0.05
	Part Time	2012/2013	
GIS2	Full Time	2007/2008	P<0.05
	Full Time	2012/2013	
	Part Time	2007/2008	p>0.10
	Part Time	2012/2013	

Based on the above proved results, it is possible to state that the innovation resulted into successful results. It is possible to state that the innovation of GIS1 and GIS2 subjects resulted into an improvement of students' results (statistical significance 5 %). The influence in the other subjects may not be proofed because of the influence of the small amount of involved students.

Results of this test clearly illustrate and influence of the innovation of study materials into the results of the students (see Table 3).

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Table 3 – Rusults of the Statistical Evaluaton

Subject	Academic Year	p-value	t-**value**
GIS1	2007/2008	2,92	0,0039
	2012/2013		
GIS2	2007/2008	2,91	0,0043
	2012/2013		

According tom the given results it can be concluded that the innovation significantly influenced study results of the students.

CONCLUSION

The implementation of distance learning methods results to maximum increase in the degree of comfort with access to software needed for the study, the closest relationship of student-tutor and student-student through LMS. The system greatly expands learning opportunities, study support by multimedia materials, the possibility of on-line communication in the study group and also both student-student and student-tutor. The system simplified both the self-testing, that improves the quality of education, and testing tutor-student. System allows simple tasks control by assigned tutor, seamless and easy responses, and individual student leadership. The big advantage is the flexibility of time from both the student and the tutor.

Equally important benefit of distance learning is the involvement of other top geoinformation technologies in teaching courses focused on spatial information utilization. With help of distance learning courses, students can be more familiar with the methods of GIS and GPS technologies; they get practical experience in working with GPS, the Cadastre and other programming tools and cartography.

This is directly related to the majority of students of master study program System Engineering and Informatics. Czech and foreign students at the Faculty of Economics and Administration University of Pardubice can now with help of courses acquaint with modern professional geoinformation technologies for collecting, processing and visualization of all types of spatial data. Czech and foreign students through the facilities of the faculty can acquaint with modern technologies for the professional processing of all types of spatial data. Along with deeper knowledge and greater practical skills the possibility of graduates in the labour market increases.

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Simulating Personalized Learning in Electronic Environment

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Abstract

The principles of the theory of personalized learning realized in the electronic environment have been formulated at the Department of Information and Communication Technologies of the Pedagogical Faculty of the University of Ostrava by a group of enthusiasts, who have specialized in this particular field of research for the last five years. During this time they have succeeded in developing the adaptive LMS (based on theoretical foundations), which enables small scale experiments and verification. The developed adaptive system is not yet ready to be included in the education process. It is a tool for experiments of all kinds, tests, and verification of formulated rules, theories and ideas, which form individual parts of the complex theory of personalized learning. Before the adaptive system can be included in the actual education process, it is necessary to verify the formulations of adaptive rules and algorithms, which are the fundamentals of the new approach to effective learning. This article describes the phase of simulating and modeling of the theoretically prepared adaptive process in the modeling tool, which has all the required parameters and has been created especially for the occasion. The experiments are being conducted on groups of virtual students and by using a virtual study material.

Keywords

Adaptive education. Simulation. Modeling. E-learning. Personalized learning.

INTRODUCTION

If we are to describe the time we are living in, the terms that come to mind would be information, digital, society of lifelong learning, society of knowledge, society of networks, and many others. The indisputable reason for this state of the world is the enormous development of science and technology in the second half of the 20th century; mostly the development of information and communication technologies (ICT). The development of ICT is reflected not only in industry, but also in education (Kostolányová, 2012). Apart from incorporating ICT into typical education, serious attention is also being paid to an already common way of learning – e-learning. In recent years, e-learning has not been limited only to its traditional form, but the possibilities of the e-learning environment have been used for the realization of the so-called personally tailored education.

It is a well-known fact that mass education in school may be boring for some students or may hinder them. For some students, on the other hand, it may be too fast, which

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makes it impossible for them to understand everything. Other students are satisfied with the pace of education, but they may not be satisfied with the teaching style of a particular teacher. Therefore, such students come to dislike the teachers and subjects they teach, which results in them having worse results (Brusilovský, 2003;Chang, 2009). Neither mass education in the classroom nor classic e-learning can take into account the needs of an individual. The suggested reasons lead to the idea of the optimization of the learning process through the use of individualization of education. Individualization of education represents each student's way of learning with regard to their previous knowledge, skills and their learning style (Kolb, 1984;Jeong, 2012). Basically, it means adjusting the pace of education to students' time schedule and their intellectual limits. In a typical classroom and as part of full-time education such adjustment is virtually impossible to achieve. It is impossible to treat each student individually. The teacher can only modify the teaching so much that it suits the majority of students in the classroom. He/she cannot, however, treat each student individually.

The issue of individualization of education can be solved in several ways. As far as the technical viewpoint is concerned, the principles of neutron networks or expert systems can be applied. As for the categorization of the view on the type of individualization, the process of education can be adjusted according to different criteria, e.g. learning styles, multiple intelligences, special educational needs, talent, etc.(Milková, Petránek, Janečka;2012).

If we put together the essence and principle of e-learning and the request for personalized learning, we gain a brand new research area – automatic adaptive learning. This phrase basically means going through an electronic study course, which suits student's preferences. Optimal adaptive process will respect students' differences based on their learning style and with regard to their changing knowledge and skills during the course of the study in the course. On the basis of identification of personal characteristics and qualities, the students will be provided with a study material that suits them the most (Kostolányová, Šarmanová, Takács; 2010; 2011).

We assume that personally tailored education accenting student's requirements, preferences, and positive sides of learning (we do not support surface learning, remembering without understanding, etc.) will become an optimal and effective form of education. It will make new knowledge easier to remember and more permanent.

PRINCIPLE AND THEORY OF ADAPTIVE EDUCATION

When the model of adaptive education was being designed, it was divided into several partial issues. The adaptive personalized education system has three main parts: the Author module (for authors of adaptive study materials), the Student module (for students with particular learning qualities), and the Virtual Teacher module (for rules and adaptive algorithms for compiling the optimal education process and education control) (Kostolányová, 2012).

When the rules of the theory of adaptive education were being formulated, the three main parts were further divided into partial issues:

- Which student's learning characteristics and qualities do we have to know to be able to determine his/her learning style? And how do we learn those qualities?

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- How must be a study material structured to be suitable for adaptation according to student's learning characteristics?
- How should a (virtual) teacher teach when facing a student of a particular type?

After a considerable research of information sources dealing with the topic of learning styles, the issue of finding out **student's qualities and characteristics** and determining his/her learning style has been solved by creating a questionnaire. The questionnaire has been created to fit the qualities that can be taken into account in e-learning. These are the qualities of sensory preference, learning tactics, conception of the depth of curriculum, etc. Combinations of values of these qualities define student's learning style.

A personally tailored **study material** that suits student's qualities and characteristics will be created. For the creation of the adaptable study material, a methodology for creating adaptive study materials has been developed (Kostolányová, 2012). According to the methodology the parts of the study material (commentary, explanatory, testing, revision, etc.) are created in several sensory variants (verbal, auditive, kinaesthetic, visual). The variants differ in the depth of curriculum and they are structured into partial sections – layers. These parts of a study material are adaptable to the needs of a particular student. Creating different variants of a study material is much more demanding for an author than creating a distance study text.

Adaptive education will take place in the electronic environment and will be based on the evaluation of student's learning style and assigning the most suitable study material. This assigning of the study material is done according to the defined expert pedagogical rules and two algorithms. The rules have been defined by the pedagogues and psychologists on the basis of generally true pedagogical and didactic principles and pedagogical experience. These rules cannot be entirely "debugged" in real education – there are not enough adaptive study materials (creation of which is much more demanding than creating common distance learning textbook) and there are never all types of students present in the classroom. Since we are trying to develop a universal adaptive system that can be used for teaching of any subject, it is necessary that the proposed principle and controlling system be simulated in general terms. Consequently, a standalone module, which will enable modeling and simulation of education without using study materials, has been designed and implemented to the developed LMS Barborka (its adaptive version is being developed at the Department of Information and Communication Technologies of the Pedagogical Faculty of the University of Ostrava). This way, the education for all types of students is subsequently being simulated. Accuracy of the formulation of elementary rules and the algorithm for determining the so-called personal teaching style (the succession of layers and depths of a study material) is being verified.

ADAPTIVE EDUCATION CONTROL PRINCIPLE

Information about student's learning style (values of individual qualities determining the learning style) and about the structure of the study material (metadata about individual parts of the study material) is the input to the controlling educational program called the Virtual Teacher (VT). On the basis of the given information, its first task is to establish the optimal teaching style. To be able to control, the Virtual Teacher needs pedagogical-psychological knowledge (theoretical outlet of adaptive education), which

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helps it compile a detailed plan of the process of education. The Virtual Teacher is a specific kind of expert system, which contains basic pedagogical rules from which it compiles the optimal teaching style for a particular student and the optimal way through a particular study material. It is so constructed that even a teacher, who is not an IT specialist, could use it to create and realize the adaptive way of teaching.

The process of education control is demanding and either the author, the teacher or the student cannot see it. To be able to verify the accuracy of the suggested rules and adaptive algorithms, it is necessary (from the point of view of informatics) to simulate these suggested processes and solutions.

The Virtual Teacher's (the core of the adaptive education control principle) main functions are the following:

- Finds a learning style for a logged in student (a group of characteristics that influence his/her learning process).
- On the basis of student's learning style, it determines his/her personal education style (universal process which will suit the student the most).
- The Virtual Teacher applies personal education style to each frame of the actual lesson, i.e. determines the actual education style of the lesson. It replaces the non-existing variants and layers with the most similar ones; if there are no replacements available, it leaves out theoretical parts.
- Knowing the optimal plan of going through an AVS lesson, the Virtual Teacher controls the process of education, i.e. it gradually offers a student frames of the chosen depth and sensory form, and in them the given sequence of the chosen layers.
- Another task of the Virtual Teacher is to control system reactions to the student's incorrect answers. If the student answers the testing questions correctly, it follows the actual education style. However, if the student answers incorrectly, the situation must be solved accordingly (in the context of the situation).
- The Virtual Teacher records the process of adaptive education all the time.

Because entry questionnaires for testing students only divide students into individual groups according to the values of the tested qualities, and because pedagogical rules may not always be set in an optimal way, the system enables the student to control education him/herself. The student can choose the individual parts of education in a different order than what the system offers to him/her. To secure that the information about the education process (either controlled by the system or modified by the student) is responded to, the Virtual Teacher records all student's actions to the protocol. The protocol records the time spent on the individual parts of education, the time spent on thinking about the answer, the time spent on solving the tasks; it also records student's changeovers to partial sections of education and the deviation from the order as suggested by the system. The protocol is the important source of further information. When statistically analyzed, we can gain the feedback on individual students, types of students, the quality of study materials, and the accuracy of the rules and governing algorithms of the Virtual Teacher. The protocol results analyses can retroactively influence all the information, which then can be used to improve the quality of the system functions.

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ADAPTIVE EDUCATION MODELING

To be able to debug the Virtual Teacher's main functions (creating student's personal education style and actual education style), we need to define all the basic types of virtual students and all the variants and layers of the study material (Hubálovský, Milková,;2010). The virtual student is the student for whom we can set values of his/her learning characteristics that determine his/her learning style. The same can be said about the virtual study material. The variants represented in the virtual study material will be recorded in the form of metadata (Kostolányová, Takács; 2013).

Virtual students are gradually assigned values of the learning quality. By combining their values (we are considering 2-4 values for each quality) we obtain approximately 2000 possible types of students. We simulate education for these types individually or for their groups with the same value of one or several qualities. We model the virtual study material by using its metadata.

After analyzing the available modeling tools we have decided to create our own modeling tool that enables solving of our problem and that records specific parameters of adaptive education. To determine the personal education style and the actual education style, the tool uses the mentioned expert rules and algorithms. It can visualize going through the study material for different types of students and by doing so it enables the control of their education styles. At the same time, the tool is a blueprint for an analysis of the frequency of going through the individual parts of the study material. Student's personal education style and then the actual education style (in case the study material is not comprehensively ideal) are recorded into a pattern made up of all the theoretically possible education layers in 3 depths of interpretation and 4 sensory variants. The Virtual Teacher records the suggested education process as a broken line connecting the individual layers in the suggested order and depth (see Figure 1). We will name the chart the trace of adaptive education process; in short, the trace of education. Each trace corresponds to one education style for one type of student. The tool can mark more traces of education with a certain common parameter (each of the individual characteristics of the education style will gradually be the parameter).

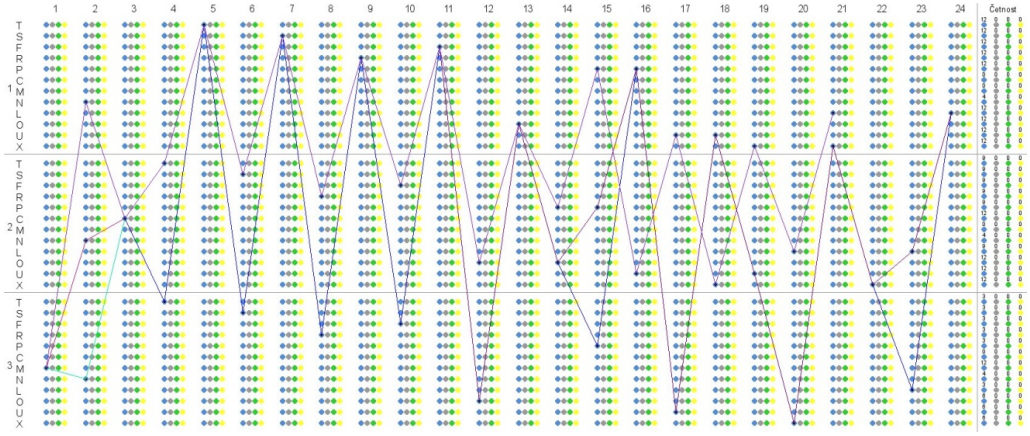


Figure 1 – Trace of Adaptive Education Process

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SIMULATING THE CREATION OF PERSONAL EDUCATION STYLE

All main types of virtual students and all variants and layers of the study material must be defined before the process of simulation of personal education style begins. During the pilot modeling of the education process, elementary expert rules are tested first. The individual qualities of students are added gradually. Focusing on some of the qualities, we will explain the process of modeling and simulating. The chosen qualities are: motivation, approach to learning, depth of learning, autoregulation, success. The values of the individual qualities are set to 3 values (0, 50, 100 or -100, 0, 100); minimum, average, maximum (Kostolányová, 2013)..

The individual elementary rules have gradually been modeled as follows:

- Simulation of education for the student that is "average" in all the qualities (his/her personal education style represents the "typical" education used mostly in textbooks)
- Simulation of education when setting the value of one tested quality to high and low; controlling the functionality and accuracy of the suggested expert rules. At first, we choose this technique for one student, then for a group of students with a given value of the monitored quality and with other qualities being average.

The results of the simulation – individual traces of the education style – will be analyzed in detail. We observe the logic and accuracy of the sequence of the chosen layers of the study material, which constitute the education process of a particular student and are visualized by the so-called trace of the education process. If the chart does not correspond with the expert's ideas, we register the error in the rules or in the algorithm for the assignment of the study material. Using the same modeling tool we verify if the rules are accurately suggested for the combination of student's characteristics. Combinations of two, three, or four qualities in all possible variants have gradually been chosen for modeling. For example, for two qualities – motivation and autoregulation – the following combinations have been tested: average values for both motivation and autoregulation, low motivation and high autoregulation, high motivation and low autoregulation, etc.



Figure 2 – Testing of the Chosen Characteristics (Motivation and Autoregulation)

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SIMULATING THE CREATION OF ACTUAL EDUCATION STYLE

The creation of the actual education style will be the next step in approximating the real education process. In the real education process the Virtual Teacher does not have at its disposal the ideal study material containing all the layers in all the variants. In this part of modeling, if we do not have at our disposal the theoretically complete study material, we focus on the use of the proper substitutions of variants and layers of the study material.

It is necessary to explore the existing variants and layers in the algorithm that determines the actual education style. If any of them is missing, the situation needs to be addressed. Two solutions have been suggested: to replace the missing layer with the "closest" one if it exists; or leave it out completely if there is no other version of it.

In the pattern the missing parts of the study material are marked by a small black dot. The existing layers of particular sensory variants are marked in color (see Figure 3).

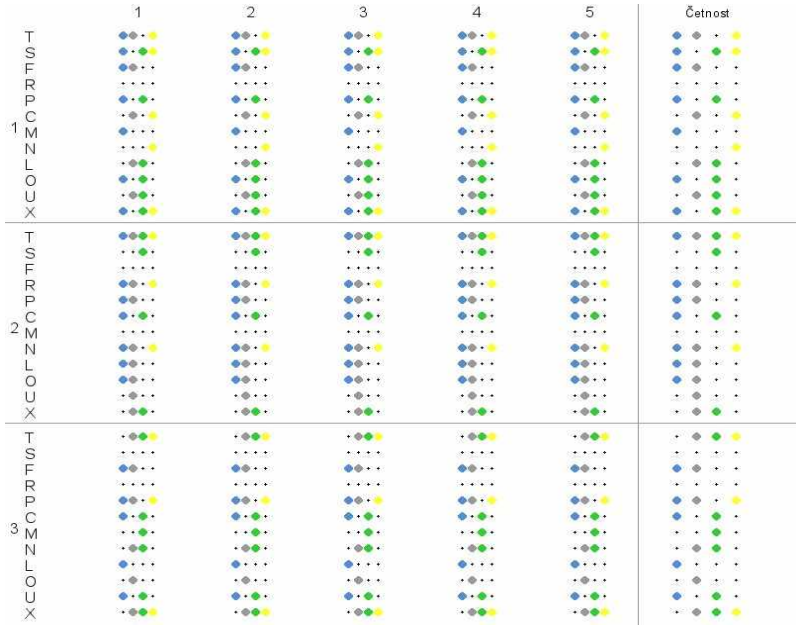


Figure 3 – Pattern of the Incomplete Study Material

IMPLEMENTATION OF THE ADAPTIVE EDUCATION SIMULATION MODULE INTO ADAPTIVE LMS

A function has been designed and realized for setting a particular simulation. This function enables the user to choose one student, a group of students, or a particular study material and launch the simulation. There is a simple form (see Figure 4) for setting a structure of the model of the study material. Implicitly, all the forms have the value 1 (there is a layer); when the expert wants the study material to have different structure, he/she simply changes the set.

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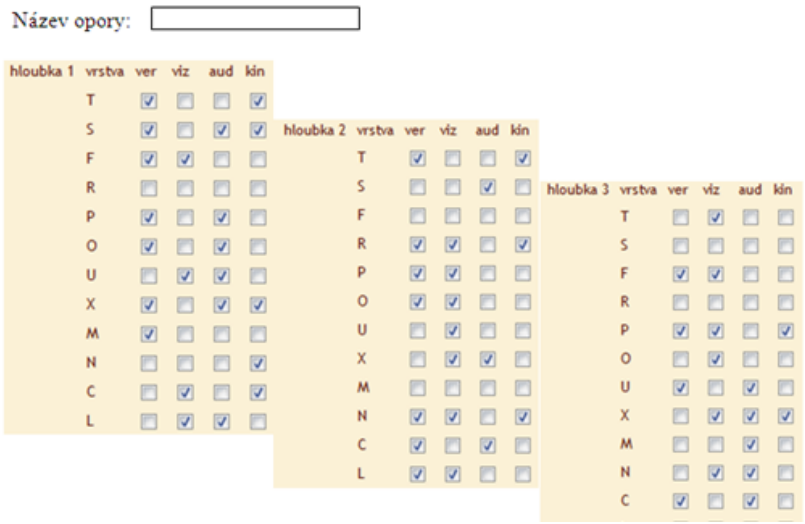


Figure 4 – Study Material Model Expert Setting Form

When modeling the complex process of adaptive education, student's personal education style is projected first (the given student having the ideal study material), then this style is transformed into his/her actual education style (according to the structure of the used study material). At first, we will conduct simulation of education for the student who has all the qualities "average". At the same time we hope that this student has one sensory perception (e.g. 100% verbal, 100% auditive, etc.). His/her personal education style should be "typical", the one used in most textbooks. After verifying the personal education style, we will verify if or how each quality of the education style changes according to the expert's assumptions (if the tested quality has a different value – high or low – than the average). We will choose and test one student with the set value (high or low), the trace should then reflect only this value. Then we will choose all students, which have the chosen value of the tested quality and different remaining qualities, and test if the trace of the corresponding part of the education has changed or not.

If any of the charts differs from the expert's conception of the personal education style, we will note the error. The error might be for example an incorrectly formulated expert rule or the incorrect functioning of the personal education style algorithm. In conclusion, we will analyze the errors we have found and suggest their correction.

RESULTS

No errors have been detected in the formulation of the rules or in the OVStyl algorithm during the process of modeling of the elementary and complex expert rules. The problems occurred only when we combined two particular qualities – depth of the approach to study and student's success. From the pedagogical point of view, this situation has not been sufficiently analyzed as there remain imperfections in the formulation of the rules according to the preferred approach to learning in connection with student's success. Pedagogical consideration of the discovered error led to the reformulation of the rules and to setting the priorities for the chosen rules.

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Apart from the following exceptions, the experiments confirmed many of the correctly realized substitutions or layer omissions:

- When replacing the missing layer, it was duplicated instead of left out,
- As far as the missing preferred sensory variant is concerned, it was replaced by another sensory variant instead of the second most preferred variant.

The errors found have been removed by controlling the layer duplication and by deleting the repeated layer from the AVS. The repair of the AVStyl algorithm consisted in substituting the missing sensory layer by student's second strongest sensory variant. In connection with the AVStyl repair, the problem of some of the student's identical sensory values has been solved: in such a case the replacement is searched for "from left to right" – so the replacements are searched for in the following sequence: verbal → visual → auditive → kinaesthetic.

DISCUSSION

The current version of the Virtual teacher respects student's education style. However, not all of the student's qualities are ideal. If we take the domain of the individual qualities into account, it is evident that some qualities can have incorrect values (learning by heart without understanding, surface learning, etc.). In the future, "**student's ideal education style**" needs to be defined, by which we mean psychologists' recommendation not to encourage student's bad learning habits even if it is his/her preferred education style at the time. This will not represent the return to the unified education for all students, only the elimination of the negative education qualities.

However, this situation must be first solved by the pedagogy and psychology experts. This will be followed by the systemic solution, the suggestion of the suitable algorithms and their realization, the gradual modeling and simulation of the education process and, last but not least, the incorporation of such elaborate system for the adaptation and personalization of education in the electronic environment into practice.

CONCLUSION

The original modeling tool, designed and implemented for simulating the education process with no real students and real study materials needed, fulfilled its function. It enabled the simulation of the compilation of adaptive personalized study material for all the main types of virtual students and by so doing verify their accuracy – agreement with pedagogical rules formulated by the expert in the adaptive education theory.

We can state that modeling of virtual students and virtual study materials, simulation of the preparation of the education process, and visualization of the resulting personalized study material, has been successful and helped discover some errors.

Without the aforementioned simulations, the process of debugging of the expert rules and functions of the Virtual Teacher would most probably take several years to complete. Debugging with real students and adaptive study materials would require the presence of all types of students (because of their learning styles) and the existence of all types of

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study materials. Because creating adaptive study materials is a very demanding process, the authors cannot be expected to be willing to create materials for the harmonization of adaptive education in the near future. Therefore, some of the errors could remain undetected for a very long time.

Personalized adaptive education is the topic of a large number of the PhD. students' dissertations and at the same time it is the main research concern at the Department of Information and Communication Technologies.

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Usability of Computer Models in Chemistry Instruction: Results of Expert Evaluation

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Abstract

Computer models have been penetrating the school chemistry instruction as a result of ICT implementation in education. The computer models of identical content differ in technical processing, interactivity type or degrees of freedom. We suppose that different characteristics provide impact on application the computer models into the process of instruction, on selection of pedagogic design of the lesson and learning objectives – reaching the objectives should be supported by the computer model. Our research included expert evaluation by the two-round Delphi method totally three computer models of acid-base titration presenting the same content in different technical designs. The evaluation form was designed based on questioning and scaling. Computer models were evaluated in three fields in relation to pre-defined set of learning objectives, the level of processing and applicability in the instruction. The expert evaluation was provided by 17 experts in chemistry instruction. The collected data were analysed by quartile graphs. The results of analysis showed (1) the evaluated computer models dispose of different potential in reaching learning objectives in acid-base titration topic in relation to technical design and (2) the different technical design of the computer models of acid-base titration provides impact on the recommended pedagogical design of instruction.

Keywords

Computer Simulation. Computer Supported Chemistry Instruction. Delphi Method. Expert Evaluation.

INTRODUCTION

The steady expansion of ICT means at schools of all levels enables teachers to implement various types of digital learning objects in their lessons. The science instruction closely relates to using models of various types – models, schemas, diagrams, operating models etc. Instructional models provide information, increase the clearness of explanations and make understanding of the topic easier for learners. For several decades the instructional models have been used in the electronic form as computer models.

The computer models work on the basis of the mathematical or formal-logical model, which work as means of visualization or simulation of modelled system behaviour (Balogh, 2012, Bílek, et al., 2007, Ornek, 2008, Turčáni and Magdin, 2012). Computer models differ in the way of processing and technical design. Crucial characteristics of the design include interactivity types and degree of freedom of the computer model. Generally, in computer

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applications the navigation, functional, and adaptive interactivity can be used (Vaněk, 2008). The degree of freedom of the computer model expresses the amount of possible changes in initial settings defined by the user. Frischherz and Schönborn (2004) use two types of computer models – animations and simulations.

Animations are characterized by navigation or functional interactivity and low degree of freedom for the user. They represent the behaviour of a real system without possibility to provide any impact on its functions. Simulations are characterized by the functional and adaptive interactivity with high degree of freedom. Simulations enable users to influence some parameters and observe relating changes in the model behaviour. Lliboutry (1987) differs simulations from animations, being not only the mean of presentation but the method of learning replacing the study of real phenomenon.

The potential of instructional computer models in natural sciences, as it is evident from theoretical studies, lies mainly in providing information on phenomena unobservable by human eye (e.g. on the microscopic level), dangerous, time demanding or very short ones. They could be very effective when learning about topics with dynamic character. *"What makes animations stand out is movement, as opposed to static, still images, and this demonstrates the various relationships within and along a certain process. ... movement will be remembered longer than static images ... visualisation is a vital part in the acquisition of scientific topics, since important relationships between concepts will be pointed out for learners."* (Pinter, Radosav and Čisar, 2012). The use of instructional computer models supporting real learners´ experimental activities also seems to be very effective.

In science lessons they can serve as sources of information, simulators of experimental activities and tools for solving problem tasks or testing hypotheses within the instruction. (Roy, 2004, Bell and Smetana, 2008, Beaufils and Richoux, 2003) *"While interacting with simulations, learners are engaged in processes of scientific reasoning, such as problem definition, hypothesis generation, experimentation, observation, and data interpretation."* (Plass, et al., 2012).

Positive contribution of instructional computer simulations in two crucial fields of the natural sciences, mainly chemistry, instruction: (1) support towards understanding the learning content and improving the learning results, (2) support of experimental activities, which is evident from research studies analysed in Machková and Bílek (2013). The simulations support student-centred learning and understanding phenomena on the micro-level, they aim learners at the principle of laboratory tasks, contribute to mastering experimental skills, experimental data processing, and last but not least, they practise problem solving skills. According to the analysed studies this scenario will succeed under two conditions – the adequate design of the instructional computer simulation and the adequate design of its implementation into the process of instruction. If the computer models are to succeed in facilitating learning, they should participate in principled partnership with instructional design theory like any other instructional technology.

We focused on instructional computer models of the acid-base titration analytic method which are open-accessed on the Internet. Three types out of 35 applications were defined after a detailed analysis of technical and didactic design (Machková and Bílek, 2013). The three types of acid-base titration models differ in technical and didactic design of the same learning content. We suppose the different characteristics provide impact on

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approaches to implementing these computer models in the process of instruction, they influence the pedagogic design of the lesson and learning objectives reaching of them they are expected to support. These ideas resulted in following research questions: (1) Which learning objectives within the acid-base titrations can be reached if the process of instruction is supported by computer models? (2) What pedagogical design of computer models implementation into instruction is most suitable? (3) Is there any relation between differences in evaluation of selected types of computer models and their technical design? The selected computer models underwent the expert evaluation to learn experts (i.e. chemistry teachers, chemistry didacticians) opinions on their potential in the process of instruction.

METHODS

The expert summative evaluation was applied in the research so that to collect information on the quality and potential applicability of computer models. The evaluation was made by experts in chemistry teaching using their analysis of computer models selected by authors. The Delphi method for expert evaluation was applied in two rounds.

The Delphi method was designed in 1960s in the USA as a research method for defining prognoses or evaluating decisions and procedures, being based on repeated and round-by-round corrected experts´ answers to the set questions. Experts´ evaluation and answers are mostly collected by questionnaires sent in several rounds to competent respondents (experts) to express their opinions (provide qualified answers to questions).

The collected answers are analysed and statistic characteristics are set (mostly median, quadrille rate, possibly mean, modus etc.); these data are used in following rounds of evaluation (Bílek, 2008).

In round 1 the experts were asked to fill in the evaluation questionnaire N.1 for each computer model of acid-base titration. The data were analysed and conclusions defined. In round 2, reflecting the above received results, evaluation questionnaire N.2 was designed where experts expressed their dis/agreement to several statements so as the conclusions of round 1 were specified and verified.

Research Tool

The evaluation form for collecting data in round 1 was based on inquiring and scaling being structured in three parts.

In part 1 the application was evaluated from the point of pre-defined set of learning objectives in acid-base titration topic. Experts expressed their opinions on four-level scale *yes (1) – rather yes (2) – rather not (3) – not (4)*, whether the application provides support to reaching learning objectives (LO):

LO1: *Learner is able to describe the procedure of the acid-base titration.*

LO2: *Learner is able to select and name aids necessary for building the titration apparatus.*

LO3: *Learner is able to demonstrate a pH development within the titration by drawing the titration curve.*

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LO4: *Learner is able to define the equivalency point on the titration curve and subtract the consumption of titration solution.*

LO5: *Learner is able to select adequate acid-base equivalency point indicator.*

LO6: *Learner is able to calculate concentration of the analysed solution from collected data.*

In part 2 the quality of learning application was evaluated on the seven-level scale *excellent (6) – very good (5) – good (4) – sufficient (3) – low (2) – very low (1) – completely missing (0)*. Ten fields were included in the quality evaluation: *professionalism, adequacy to learning objectives, adequacy to learners´ level of cognition, clearness, motivation elements, activation and management of pupil´s learning activities, feedback, interactivity, graphical design, technical design.*

In part 3 experts provided recommendations when, where and in what way the application should be used, reflecting *the level of education, the user, form of instruction, phase of the lesson and methods of instruction*.

The evaluation tool was tested in the pilot research. Several experts were addressed on commenting the level of difficulty, understand ability, layout.

In round 2, reflecting the round 1 results, the expert evaluation was provided by questionnaire, where experts expressed their dis/agreement with 12 statements on the five-level scale *agree 1 – 2 – 3 – 4 – 5 disagree,* including the *N – do not know*.

Data analysis

The collected data were processed by the MS Excel application; the absolute values of occurrence were calculated from evaluation in case of inquiring items in form N.1, mean values and agreement rate among evaluators were processed from evaluation in case of scaling items in forms N.1 and N.2. Quartile graphs were used for the survey analysis, statistic differences among data files were set by quartile notch-graphs.

According to Chráska (2007) the quartile graphs provide clear presentations of data files. In the quartile graph the lowest and highest values, lower and upper quartile and median are marked. They are useful for comparison of several small-size and middle-size data files. The notch is a reliability interval where the collected values are expected to occur. If the notches of single graphs do not overlap, the statistically significant difference is detected between single files.

Research object

Totally 35 instructional computer models of acid-base titrations available on the Internet having been analysed from the didactic point of view (Machková and Bílek, 2013), three types of applications were the objects of expert evaluation.

Application 1 simulates the course of acid-base titration. The user goes through the application in several steps – he selects the titration and analysed solution, the acid-base indicator, runs the titration (adds titration solution by clicking the button), subtracts the consumption of titration solution volume, calculates the concentration of analysed solution and inserts the result). The application provides feedback on correctness of calculation. It works as the trainer of experimental activities and calculations. Using the

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Graph button the user can display the titration curve, select from 20 combinations of titration solutions and two acid-base indicators. The application is characterized by degrees of freedom = 39 and the functional and adaptive interactivity is implemented.

In application 2 the user selects the acid setting its concentration, selects the base setting its concentration, taken the previous choices into consideration he selects suitable acid-base indicator, runs the titration by clicking the cock of the burette and observes the drawing the titration curve. The application works as a generator of titration curves according to settings pre-defined by the user who can select from 30 combinations of titration solutions and six acid-base indicators. The application is characterized by degrees of freedom = 179 and the functional and adaptive interactivity is implemented.

Application 3 presents the titration of hydrochloric acid by titration solution of sodium hydroxide. The user operates the presentation by one button, when a certain volume of titration solution is added per one click simultaneously drawing the adequate part of titration curve; when finished the equivalence point is highlighted, the consumption of titration solution and concentration of analysed sample are calculated. Correct solutions are selected from five options. The application is designed as presentation of one task. The application is characterized by degree of freedom = 0 and the navigation and functional interactivity is implemented.

Research Sample

In round 1 of expert evaluation the questionnaire N.1 was disseminated to 19 experts – chemistry teachers of lower and upper secondary schools, experts in chemistry didactics, chemists-analysts were addressed to participate in the research; finally, 17 of them prided their expert evaluations. The sample of respondents included five chemistry teachers of lower secondary schools, seven upper secondary school teachers, two experts in didactics and three chemists-analysts.

In round 2 of expert evaluation the questionnaire N.2 was disseminated to all 17 experts participating in round 1; 15 of them provided their opinions in round 2.

RESULTS

Results are presented in two parts following round 1 and round 2. In round 1 the results are structured in parts 1 – 3, in round 2 are provided in the whole.

Round 1 - results reflecting evaluation questionnaire N.1

Evaluation of the explicitly defined set of learning objectives

In part 1 the acid-base titration was evaluated in context of the pre-defined set of learning objectives within the acid-base titration topic. The results of evaluation whether the application is helpful in the process of reaching learning objectives (see above) are summarized in table 1; the evaluation is based on modus values.

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Table1: Results of evaluation in context of the pre-defined set of learning objectives

Learning objective	Application 1	Application 2	Application 3	Comments
LO1	Yes	Yes	Yes	No statistical differences
LO2	Yes	Rather yes	Yes	No statistical differences
LO3	Rather not	Yes	Yes	Application 1 – statistical differences
LO4	Rather yes	Yes	Yes	Application 1 – statistical differences
LO5	Rather not	Yes	No	Statistical differences in all data samples
LO6	Rather yes	Rather yes	Yes	No statistical differences

Evaluation of the quality of applications

The set of computer models of acid-base titrations was evaluated in ten fields characterizing the technical and didactic design. The results are summarized in table 2; the evaluation is based on modus values.

Table2: Evaluation of the quality of applications

Field of evaluation	Application 1	Application 2	Application 3	Comments
Professionalism	Very good	Excellent	Excellent	Appl. 1 statistically worse
Adequacy to learning objectives	Very good	Excellent	Excellent	Appl. 3 statistically better
Adequacy to learners´ level of cognition	Very good	Very good	Very good	No statistically differences
Clearness	Excellent	Excellent	Excellent	Appl. 3 statistically better
Motivation elements	Excellent	Good	Good	No statistically differences
Activation and management of pupil´s learning	Very good	Very good	Very good	Appl. 3 statistically better
Feedback	Good	Completely missing	Excellent	Appl. 3 statistically better
Interactivity	Excellent	Very good	Very good	Appl. 3 statistically worse
Graphical design	Excellent	Good	Excellent	Appl. 2 statistically worse
Technical design	Excellent	Very good	Excellent	No statistically differences

Evaluation of the usability of applications

Experts provided recommendations when, where and in what way the application should be used, reflecting the level of education, the user, form of instruction, phase of the lesson and methods of instruction.

The importance of pedagogic design (implementation of applications in the process of instruction) was mentioned above. In part 3 of the evaluation questionnaire experts provided recommendations when, where and in what way the application should be used, reflecting the level of education, the user, form of instruction, phase of the lesson and methods of instruction.

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The recommendations are summarized in table 3, i.e. those provided by more than 75 % of evaluators (i.e. by 13-17 experts); recommendations provided by fewer than 25 % of evaluators (i.e. fewer than 4 experts) are written in italics - these ways of implementation of computer simulations (computer dynamically models) were not recommended by experts.

Table3: Recommendation for using of evaluated application in instruction

	Application 1	Application 2	Application 3
Education level	Upper secondary chemistry oriented Grammar school Teachers Training *Lower secondary school*	Upper secondary chemistry oriented Grammar school Teachers Training *Lower secondary school*	Upper secondary non-chemistry oriented Upper secondary chemistry oriented Grammar school Teachers Training
User	Learner	Learner, teacher	Learner, teacher
Organization forms of instruction	Individual activity in class	-	Frontal
Phase of lesson	Fixation *Diagnostic*	Fixation Application *Motivation Diagnostic*	Exposition
Methods of instruction	Class experiment	Class experiment Demonstration experiment	Verbal-illustrative Illustrative Demonstration experiment *Problem-oriented*

Round 2 – results reflecting evaluation questionnaire N.2

Results of expert evaluation

In round 2 of expert evaluation all experts confirm the applications support the process of acquiring the learning content of acid-base titrations, which is included in the topic of Acids and Bases.

In agreement, but not in full agreement, they evaluated the usability of applications, i.e. they agreed on typical ways how the applications can be implemented in the process of instruction. They recommended Application 1 to be used as the trainer of experimental activities and calculations, Application 2 worked as the tool for problem-solving tasks or managed inquiry activities, Application 3 served as a virtual demonstration experiment supporting the exposition phase of the instruction.

Single experts agreed the adequate and coherent combination of activities using the evaluated applications may deepen learners´ knowledge developed during the real laboratory work. And, they all rejected the statement the adequate and coherent combination of activities using the evaluated applications may replace the real learners´ laboratory work.

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DISCUSSION

The evaluated set of computer models provides information on the learning content of acid-base titrations. The main reason why the computer models should be implemented in the process of instruction is they provide such information which is not easy to get in laboratory work in other ways. The most powerful potential of computer model in this case is in forming relations between the real experiment and its visual-sign model, i.e. the course of titration curve. This is a very difficult operation for learners. Experts focused on the question whether selected computer models support the reaching learning objective LO3 – *Learner is able to demonstrate a pH development within the titration by drawing the titration curve.*

Figure 1 displays the most frequent evaluation of this item in single types of computer models and different data distribution presents different rate of experts´ agreement. The evaluation of application 1 performs a statistically significant difference in comparison to applications 2 and 3 where no differences were detected. As all three computer models are of the same content we think the difference is caused by different technical design, in this case in the way and timing of how the titration curve is been displayed (in application 1 the titration curve displays after the titration process is closed, in application 2 the titration curve is drawn simultaneously to the titration, in application 3 the titration curve is drawn step-by-step. Evaluators seem to consider titration curves drawn during the titration more effective to reaching the LO3.

The learning objective LO4 can be evaluated under similar consequences – *Learner is able to define the equivalency point on the titration curve and subtract the consumption of titration solution,* when evaluation of application 1 is statistically significant lower than applications 2 and 3 (see figure 1).

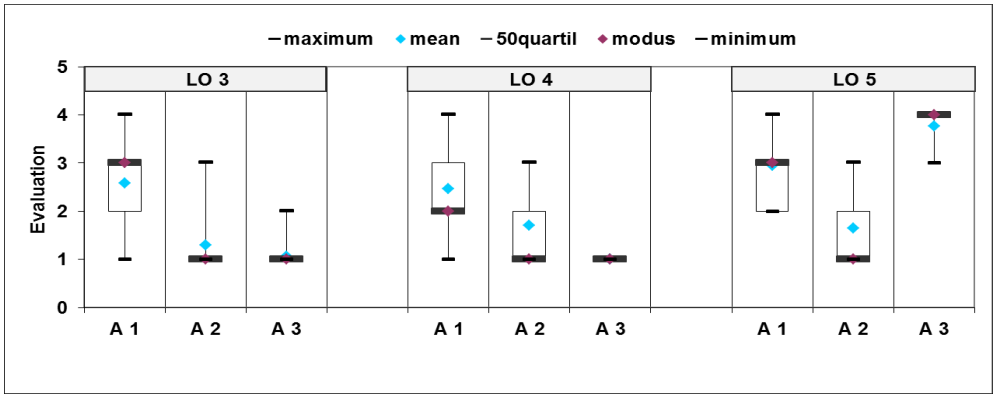


Figure 1: Evaluation of applications contribution to reaching learning objective LO3, LO4, LO5

The statistically significant difference was also detected in evaluation of learning objective LO5 – *Learner is able to select adequate acid-base equivalency point indicator.* All three data files showed statistically significant differences reflecting the number of options in acid-base indicators (degrees of freedom). The higher the number of indicators was, the better evaluation the application received.

If generalizing these results, it can be stated the evaluated computer model have potential to support the process of reaching, which was verified by experts in round 2 of expert evaluation.

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Most experts recommend using these applications at upper secondary and grammar schools and in pre-graduate university preparation of chemistry teachers. Application 3 was recommended for lower secondary schools by 10 evaluators (59 %). This result reflects the relation to quality of clearness (mainly visualisation) which was evaluated significantly higher in application 3 in comparison to applications 1 and 2 (see table 2).

Differences were also detected from the point of applications implementation in various phases of the process of instruction. Experts recommend to use them mainly in exposition, fixation and application phases. Application 3 was preferred for exposition, applications 1 and 2 for fixation and application 2 for applying the newly built knowledge. Here the relation to technical and didactic design of computer models can be also detected. Application 3 provides high level of clearness but presents only one example of acid-base titration. Applications 1 and 2 contain more examples (they have higher degree of freedom). Further on, experts agreed not an application can be used in the diagnostic phase of instruction; this option was considered by two experts with applications 1 and 2, and five experts with application 3. They also agree on application 2 not being suitable for motivation phase of instruction.

The impact of different technical design of computer models was observed in recommended organization forms and methods of instruction. Application 1, which is designer as the trainer of different types of acid-base titrations, is according to experts´ opinions suitable mainly for independent learners´ work by the method of (virtual) learners´ experiment, as feedback – correct answer check is included in the application. Application 3 which serves for presentation of one example of acid-base titration, suits to frontal teaching supporting the verbal-visual methods as (virtual) demonstration experiment. These results were verified in round 2 of expert evaluation.

Application 2 was designed as the generator of titration curves running according to pre-defined parameters. We expected most experts will consider it suitable for learners´ independent or group work. Further on, we expected experts will discover potential supporting the application of problem method. However, the results showed only 50 % of experts agree with our expectations. The most frequently recommended form was the frontal teaching (70 % of experts) and the most frequently recommended methods were (virtual) learners´ and demonstration experiment (75 % of experts each). This contradiction in expected and received results was included in round 2 of expert evaluation where experts provided their dis/agreement with following statement: *Application 2 can be used as a tool for problem-solving tasks or directed inquiry activities.* Totally 13 experts (87 %) expressed their agreement with this statement; five of 15 experts fully agreed, other eight experts provided *rather yes* option, i.e. they partially agreed to the statement.

In summary we can state each model has its specific role within the process of instruction which relates to the way how the learning content was processed (i.e. technically and didactically designed). This conclusion was verified in round 2 of the expert evaluation when stating agreement with statement: *Adequate and coherent combination of activities using the evaluated applications may deepen learners' knowledge developed during the real laboratory work.*

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CONCLUSION

The presented research results collected from 17 experts in chemistry instruction evaluate the quality and potential of implementation in the process of instruction of three acid-base titration computer models of different technical design. The computer models underwent the evaluation in three fields in relation to the pre-defined set of learning objectives, level of their design and implementation in the process of instruction. The data analysis showed (1) the evaluated computer models provide different potential in supporting the process of reaching the pre-defined learning objectives within the topic of acid-base titrations in relation to their technical design and (2) different technical design of the evaluated acid-base titrations provides impact on recommended pedagogical design of instruction.

These research results can be used by authors of computer learning objects and designers of teaching scenarios. The wide use is expected in teacher university preparation, both in the pre-graduate and post-graduate education.

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Increasing Quality of Visual Presentation of Graphics Software

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Abstract

Visual illustrations are an integral part of e-learning courses and multimedia learning materials. Especially in the field of technical graphics is often very difficult to ensure high-quality graphical output, which is useful in e-learning and when projecting with the data projector. One of the biggest problems are screen captures and outputs of programs such as CAD (Computer Aided Design), which use lines 1 pixel thick. If we store graphics outputs from these programs in the wrong format or low resolution, we can get the low-quality or totally unusable result. Even if the authors of learning materials store the graphic data properly, they can eventually destroy the result when they use the data projector which is wrongly adjusted or uses inappropriate settings. If the authors of e-learning materials respect a few simple principles, they can make a high-quality visual materials that can be used in e-learning systems and also with use of data projector. The article introduces results of experiments, the authors carried out to determine the optimum parameters for saving to image formats. The authors also focused on experimenting in the design of image materials using projectors. The article also shows how the various correction mechanisms of dataprojectors affect the quality of the projected image and the effect on image quality projection in native resolution. In addition to results of the experiments, the paper gives recommendations for teaching practice.

Keywords

E-learning. Data projector. Image. Quality. Digital conversion.

INTRODUCTION

Universities and secondary schools commonly use in teaching technical (and other) subjects professional design and simulation programs. In many cases, the free, demo or cheap EDU versions of these programs are also used on elementary schools. Importance of advanced and powerful hardware and software for the development and construction work is undeniable. Didactic use of these systems quite necessarily encounters a number of problems.

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SIGNIFICANT PROBLEMS OF VISUAL PRESENTATION OF GRAPHICS SOFTWARE

All professional graphics software are generally designed to run on computer screens and used vector graphics settings usually does not allow any line thickness. The teacher often not realize that without proper treatment and teaching without proper adjustment of your monitor and projector projected image looks completely different than the original screen. Example of possible adjustments to image materials for static presentation with layering system image is described in detail on the example of the IDA-Nexis, Multisim and The Constructor (Drtina et al., 2006; Drtina, 2006). The source images were superimposed to to each other in a graphics program Paintbrush for Windows. Superimposed images were the same size, first shifted one pixel to the right. Newly resulting (horizontal spread) image was layered with a shift of one pixel down and in the final treatment we corrected some details. With these adjustments the pixel count of the resulting image increased to 300%.

An important determining factor of presentation possibility is working area of professional software. It usually contains a number of icons, menus and toolkits, which are indeed necessary for the design work, but in the learning process unnecessarily distract attention (if the students just do not learn to control program).

Nevertheless, in practice we can easily get into a situation which is in principle unsolvable. Especially large-scale construction drawings can not be presented as a whole, with the usual data projector. Already the A3 drawing format represents in terms of commonly used imaging technology serious problem. In fact you can not view A3 in size by 100% on the monitor.

An example is a plan of the new building of the Faculty of Natural Sciences of UHK. Its dimensions are 85 × 90 cm. Figure 1 shows a sample of the lower third of the drawing when on-screen display with a resolution of 1204 × 768 px display the entire drawing. Lines in red box represents the drawing part that should be displyed including all the details (Figure 2).

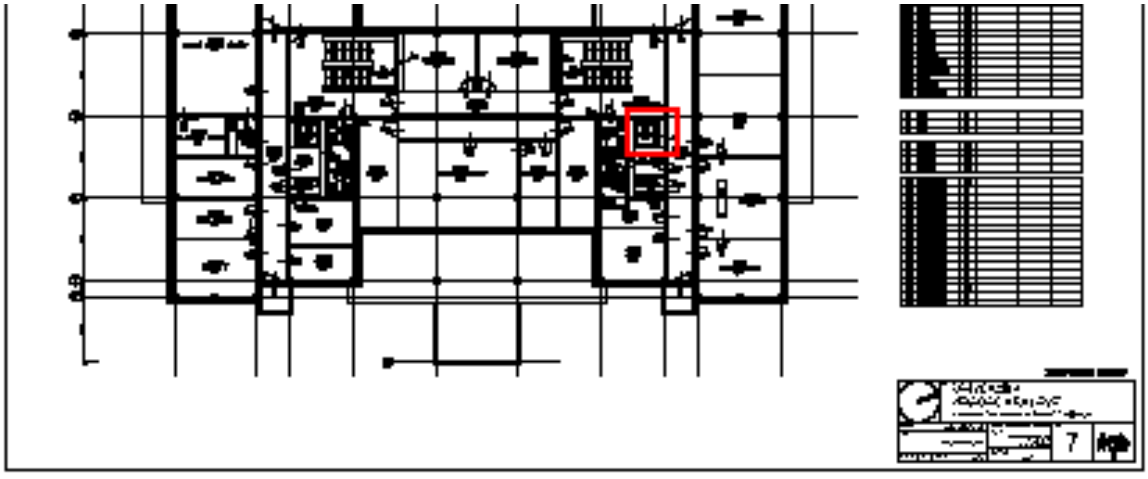


Figure 1: Floor plan of the new building of the Faculty of Natural Sciences UHK
(sample image from the monitor when viewing the entire drawing)

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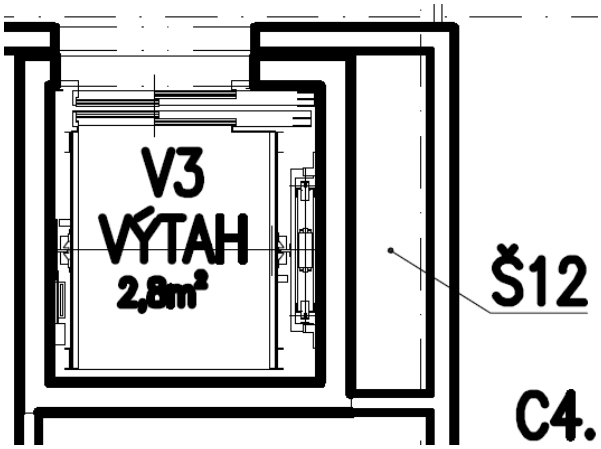


Figure 2: Cutout showing all the details (picture suitable for conventional data projector).

Furthermore, we must count on with the fact that the correct view is possible only with structurally relatively simple units, and the highest possible format is A4. An example of a quite good view can be wireframe Meyer Sound loudspeaker systems MSL4 and rendered image (Fig. 3). Both parts of the image were created in AutoCAD. We can not describe all the design software and bring samples of their display options. However, we can clearly say that constructional a and design software primary assume the large format of print output. Design software intended for direct presentation yet do not exist and maybe will not exist in the future.

In many cases, display problems are caused by ourselves, with excessive effort required to minimize the amount of data that is needed for a given image. This concerns in particular the creation of e-learning courses, where large amounts of data takes up capacity of disk arrays and servers and to transfer them to the user more time is needed. At a time when we reduce the proportion of direct education, create e-learning courses to which transfers the contents of lectures and try to create an extensive multimedia support teaching, one can not ignore the basic requirements of optical information transfer. When direct communication teacher ↔ student is not a problem, any confusion arising from indistinct image can be immediately explained or repeated. When teaching at a distance, this possibility of direct communication at the time is largely lacking and it is for the student to postpone the issue until when it will be able to communicate with the course tutor.

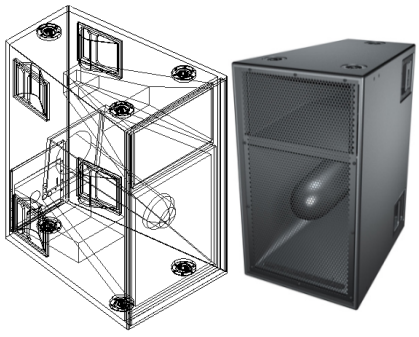


Figure 3: Wireframe and rendered image the mechanical part of MSL4 speaker system (Operating Instructions MSL-4 Self-Powered Loudspeaker System 1999)

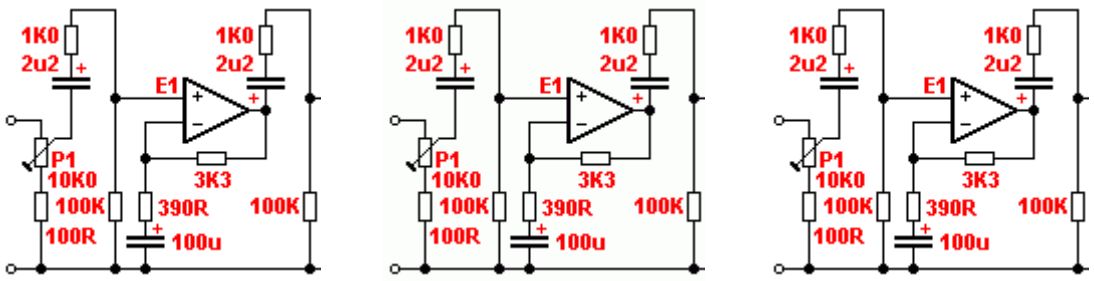
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Converting images to JPG format, as is commonly done and how it primarily offers many graphics programs, while saving up to 80 % of the volume of data, but at the cost of noticeable loss of quality. In lossy compression, which is the real data reduction, without an option to restore the deleted information from the file. Thereby, the most widely used image format JPG, designed especially for digital photography, it is entirely inappropriate for technical drawings and diagrams, ie for images that have sharp edges and contrasting lines. It is clear that even at the highest quality setting for conversion, the resulting image is still significantly worse than the original.

For teaching technical subjects such images are unusable. Nevertheless, we present them almost daily to the students, we use them as printed documents, an insert them in multimedia applications and e-learning courses. Engineering, without exception, require precision in manufacture and in the technical documentation. Such precision must be commonplace not only for secondary and higher technical schools, but especially for universities. And of course it must also be for any images, dedicated to teaching and for presentation to pupils and students.

Path to higher-quality image is not so complicated. In many cases it is sufficient to change the image and get quality images, with a relatively small volume of data. Fig. 4 illustrates converting a source format to BMP formats PNG, GIF and TIFF using the maximum data reduction. It is clear that the pictures from compressed formats are virtually identical to the original.

Especially for web applications is increasingly used graphics format SVG (Scalable Vector Graphics - scalable vector graphics), which was designed just for web graphics area, but little by little this format becoming the industry standard for vector graphics transfer between different platforms and applications. SVG technology is designed to store a combination of vector graphics with bitmap graphics. This not only simplifies maintenance, but it is also possible that the text in the image can be indexed and found by search engines. Syntax of source file SVG is based on XML (Tišnovský, 2014).



a) b) c)
format PNG, size 1 478 B format GIF, size 2 426 B format TIFF, size 8 298 B
Figure 4: Conversion into the formats PNG, GIF and TIFF (Drtina and Maněna, 2008)

COLORS, BRIGHTNESS AND CONTRAST

The main requirements for technical drawing is an accurate representation of a wholly readability. For this reason, it is almost always in contrasting, black and white color

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scheme. For educational purposes in terms of clarity, in justified cases, we recommend the use of colored images.

In preparing image materials we must always kept in mind, for what purpose and what display technology will the material be presented with. Sometimes we mistakenly believe that to show on the monitor, projector, manufacturing overhead transparencies and normal black and white or color printing on paper, only one master is enough. Care must be taken as to the possibilities of color depth of data projector, as well as the differences in color RGB and CMYK systems, further compatibility view color printing in tones of black and white gradation scale. Let's self-critically confess, that we often (mostly from ignorance, sometimes out of convenience) overlook this fact.

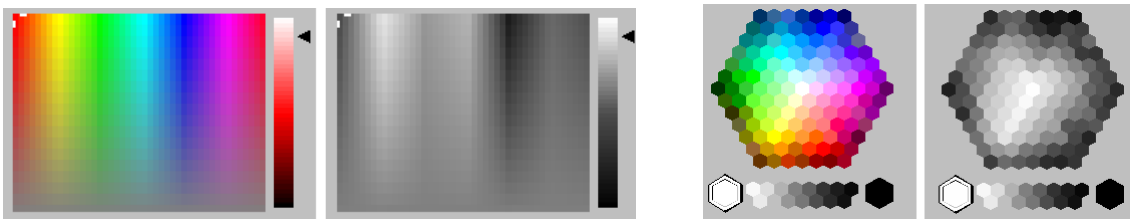


Figure 5: Color palette and color swatches in MS Windows with B & W conversion

The basic color palette in MS Windows has 16,581,376 colors. If we compare this color palette (Figure 5) with its conversion to grayscale colors, we see that in the choice of colors there are significant limitations. Even if the default color palette use swatches with 142 colors, preferably recommended for color graphics website when seeking color compatibility we can not ensure compatibility between color and black and white display. Fig. 5 illustrates that it is clear that the determinants of the choice and use of colors exist in the case of a significantly lower color distinctiveness.

Color display differentiates between three basic types of contrasts: light, color (tone) and saturation. Light contrast of the original image is derived from fundamental vibrant colors, while the black and white conversion is retained the original image impression. A classic example is the light contrast is black and white photography or black and white television picture. Only in this case, initially retains the original color image gradation scale even after conversion to monochrome format and is faithfully reproduced w printing (unless the print device does not have technical limitations).

For color contrast optical resolution is made solely by changing the color tone. For black and white conversion so there may be a critical situation in which the original color depth completely disappears. Image changes to monochrome gray area. Therefore, we must necessarily verify the suitability of colors for black and white conversion before the final treatment of image materials. Saturation contrast used to distinguish vibrant and less deep in color (color blended with white light). In the field of textile arts and design is sometimes marking tone in tone. Black and white conversion preserves color resolution according to the saturation, while the expression on gradation scale may not accurately reflect reality. Examples are shown in Fig. 6

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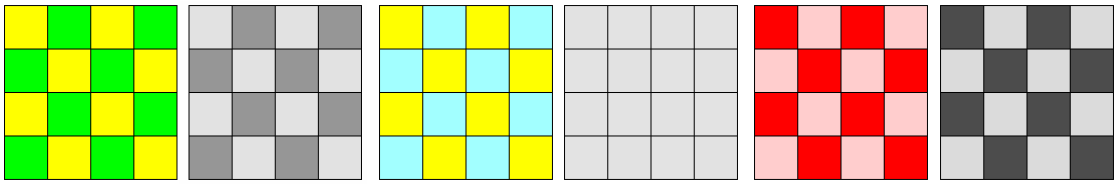


Figure 6: Light, color and saturation contrast and their black & white conversion

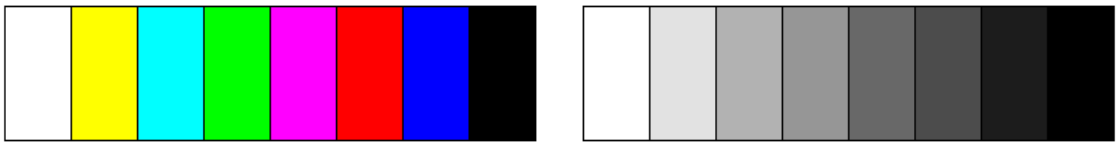


Figure 7: The basic palette of vibrant colors and gradation scale

If you want 100% eliminate problems with color display and monochrome conversion, and without extensive experimentation with color palettes through trial-error (for example, because we want to use one image material for computer presentations, websites and print), it is the easiest, universal way to use a variety of 8-color TV bands (Fig. 7). Technical drawings are usually not so challenging, so we do not have to use more than 8-color resolution.

PROBLEMS OF DIGITAL CONVERSION AND IMAGE CORRECTIONS

Development of personal computers in the 80s of the last century was characterized by using the common television as display unit. To the development of display screen based LCD projectors have become applicable to digital signal processing. Resolution displays first operated on overhead projector and the first projectors was 640 × 480 px. Resolution was fixed for the manufacturer and it had to adapt the video output (today graphics) card computer operation system not otherwise be possible. Today, computer graphics card work with resolutions over 1920 × 1200 px (with special graphic workstations for 4K digital cinema technology and 4096 x 2160 px) and data projectors can, for effective aid digital conversion process virtually all signal standards. It is not always real benefit.

For testing purposes, we chose EB-X6, which is in the school environment very popular. The EB-X6 has an asymmetric light beam and focus the screen image is quite challenging. The projector is equipped with modern E-TORL lamp 170 W, which for the life of 3,000 operating hours gives a lumen output 2200 lumens. The Eco-Mode is the lumen output of the projector 1750 ANSI lumens and lifespan of 4,000 hours. The projector has a Three-chip (3 × 0.63 ") TFT system, native resolution of 1024 × 768 px and using digital conversion can handle resolutions up to 1920 x 1200 px. The test pattern was a working area of the Paintbrush software. It was created on a horizontal line in a thickness of 1 px basic colors, in positive and negative versions (Fig. 8). Video source was mobile workstation HP 6310-X, connected via standard input D-Sub (VGA).

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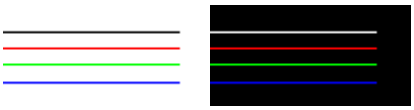


Figure 8: Test patterns (Paintbrush)

Display the on-screen were examined for the output resolution of 800 × 600 px, 1024 × 768 px, 1280 × 1024 px and 1600 × 1200 px.From close-ups of the screen to see how the change in output resolution pitch changing lines on the display matrix TFT chips and how it changes their thickness and contrast. Tests have confirmed our assumption that the digital conversion of video formats still work the same way.Any other resolution that does not match the native resolution of the display unit, causes a change in the thickness and contrast lines, which is usually perceived as subjective image blur.The same situation occurs as well as the LCD and TFT monitors as their native resolution does not correspond with the output resolution of the source image. This confirms the requirement as a condition undistorted transmission of information between the source of information and the recipients (Fig. 9, 10).

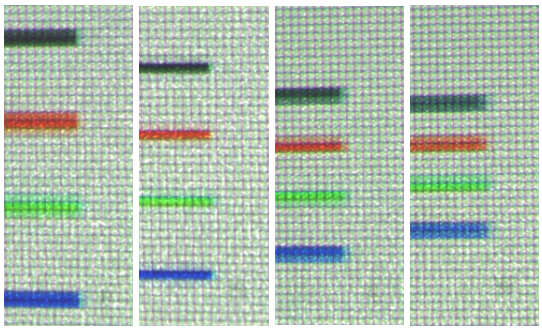


Figure 9: Effect of format conversion at a resolution of 800x600, 1 024x 768, 1280 x 1024, 1600 x 1200 px (positive display)

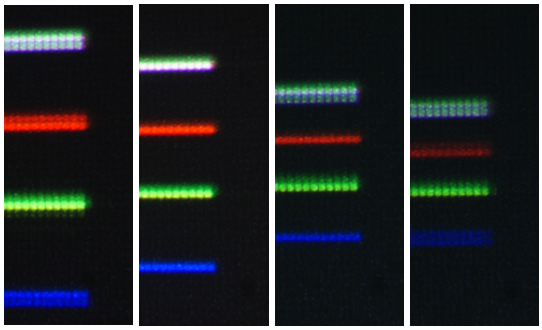


Figure 10: Effect of format conversion at a resolution of 800x600, 1 024x 768, 1280 x 1024, 1600 x 1200 px (negative display)

Comparable situation as the digital conversion of image formats, occurs with digital keystone correction. Trapezoidal (keystone) distortion occurs when the optical axis of the projector is not perpendicular to the plane of the screen. The portable projector is from largely the cause of its location on the table and direction of the optical axis upwards (Fig. 11a), for some fixed installations is causing a projector on the wall and projecting from the left or from the right (Fig. 11b).

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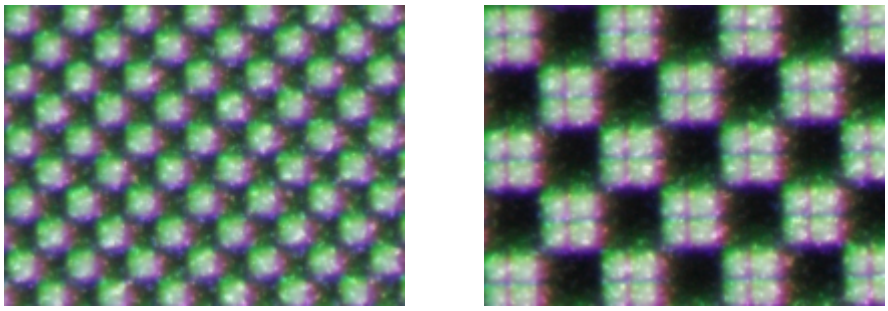
In the worst case there is a combination of both types of trapezoidal distortion (keystone). Data projectors, of course, offer the ability to digitally correct this distortion. As was shown already in projector Philips CBRIGHT XG1-Impact (Drtina, Chrzová and Maněna, 2006), it significantly reduces the image quality.



a) projection from below b) projection from the right

Figure 11: Trapezoidal distortion of the projected image

For investigating the trapezoidal correction were used test screens of Nokia Monitor Test v.1. There are real close-ups in Figure 12. Raster 1 is made up of black and white chess board on a regular turns individual pixels. Raster 2 has a black and white chessboard, where different fields have dimension 2 × 2 pixels.



Raster 1 Raster 2

Figure 12: Raster test images of Nokia Test Monitor v.1

The test results confirmed the initial assumption that the use of trapezoidal correction secondary causes image distortion, as well as the projector Philips. As can be seen from the series of images of the screen, there is the attenuation-corrected image of the fine structure to form a significant disruptive moiré (Fig. 13). Such a situation we consider, especially for educational purposes, unacceptable.

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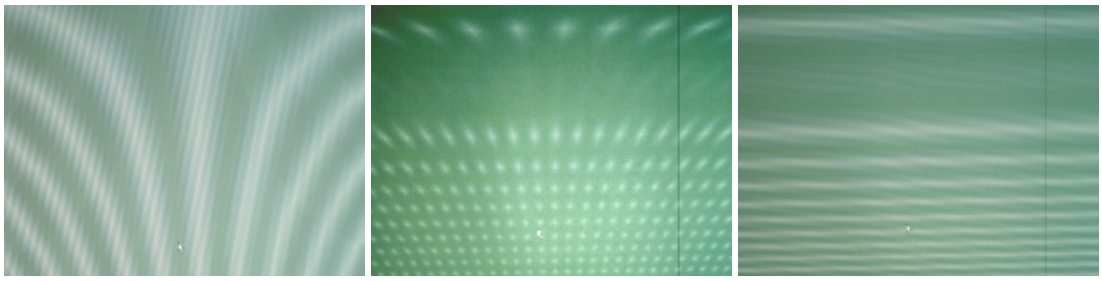


Figure 13: On-screen moiré at various degrees of trapezoidal correction

DISCUSSION

It follows that the presence of digital conversion and correction is a significant negative factor affecting the quality of the optical transmission of information. Nevertheless, the problem of digital conversion and corrections continue pays virtually no attention.Customer is in no way alerted to the problems that cause these corrections. Even in the directions for use of the projector from the manufacturer or dealer when you buy it, but even a supplier of display and projection equipment when you order its installation. Practical experience shows that even professional companies do not pay the necessary attention to this problem. At the improper installation can then seemingly bad image gives the viewer the impression imperfections or hidden defects projector. Problems of digital image conversion and correction often pass over in silence the authors who deal with the audiovisual teaching techniques (Hourová, 2004; Drtina, 2004; Melezinek, 1999; Nikl, 2002; Vrba and Všetulová, 2003).We believe that the problem of digital image conversion and trapezoidal correction is from didactic point of view is so serious that it must be given sufficient attention. An important, but often forgotten condition of quality of the projected image is careful and precise adjustment of the computer monitor and data projector. You can follow according to test patterns. With the correct settings, the image on the computer screen and the image created by the on-screen projector must be virtually identical.

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Multi-Screening and its Impact on the Design of LMS Moodle at Institute of Social Work

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Abstract

The importance of mobile technology in today's society in general is growing. A large number of mobile phone users use a tablet to work with Internet applications. Mobile technologies are increasingly available and are beginning to use for educational purposes. It is therefore necessary to pay attention to the web application designed for the education and the use of mobile phones and tablets. The Institute of Social Work analyze the long term behavior of the users of web applications and the equipment they use. Based on the results of these analyzes will propose improvements that can help users to work with web applications. The article describes the results of long-term research that we conducted in 2013. We found that users use different mobile technologies. On this basis, we experimentally verified the applicability of LMS Moodle to work with these technologies. The approach was that LMS Moodle display for mobile devices same version as desktop browser or display a special version designed for these devices. Research has shown that users use mobile devices with very different parameters. In this situation, it is very advantageous to use so-called responsible design, which allows web application to customize the display content for a large number of different devices. The paper presents the possibility of responsible design in LMS Moodle.

Keywords

E-learning. Design. Multi-screening. M-learning. LMS. Moodle.

INTRODUCTION

We can state that the mobile information and communication technologies play an integral role in the educational area nowadays. They offer new tools for understanding study materials, the contribute to the pupils´ ability to solve problems connected with common life, they reinforce their thinking and abilities to recognize the surrounding world, they support the ability of cooperation in a team and an ability to argue at project learning under using the ICT even in terms of on-line communication. There is permanent increasing users´ number coming to the Internet content not only from standard devices as notebooks, PCs, etc. in terms of an educational process, but they also utilize a diverse kinds of mobile equipment (Hbuálovský, 2013).

„... The mobile phone is not only in the Czech Republic the most used information and communication technology among individuals nowadays. In the second quarter 2011 the mobile phone was used by 94 % individuals above 16 years... (ČSÚ, 2011)" and numbers of

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these users are increasing permanently. There are especially so called smart phones, tablets (e.g. iPad), devices of the tabled PC type and readers of electronic books. This increasing tendency can be observed also among students who, in addition to, often utilize the Internet wireless connection by means of the Eduroam project supported by the CESNET z. s. p. o. association in terms of participated bodies. This connection is free for students in bodies participating in this project. It can be supposed that utilizing the above mentioned equipment intended for access to the Internet applications will obtain much more popularity at students ob both presentation and combined study forms in the future. (Matura, 2012)

The e-learning materials and other Internet resources are unfortunately not prepared for browsing by means of mobile devices in many cases. Because of that it is necessary to find a way of adapting e-learning materials and the LMS in such a way that thy will be usable even if an user comes to them by means these devices.

RESEARCH ON USING MOBILE TECHNOLOGIES AT INSTITUTE OF SOCIAL WORK

During 2013, we analysed the behaviour of users of LMS Moodle and web portal of University of Hradec Králové. We focused on users of Institute of social work. We asked users to fill-in the short questionnaire about their equipment and behaviour. We found out, that over 76 % of users have smartphones or tablets that they use also for browsing the internet. More than 60 % of users would appreciate to have web applications they use daily usable on mobile phones and tablets. The most demanding applications were study information system, web portal and LMS.

We used the Google Analytics tool to analyze which devices and operating systems users use for accessing the web applications. According to our findigs, more than 92 % of users use desktop PC or notebook for acessing the web applications. About 8 % of users use mobile phone or tablet (see Fig. 1).

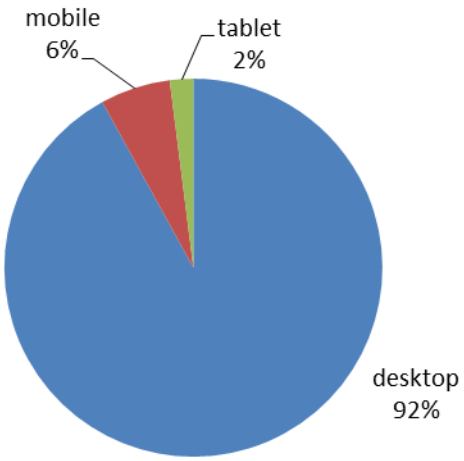


Figure 1: Devices that users use to access the web applications

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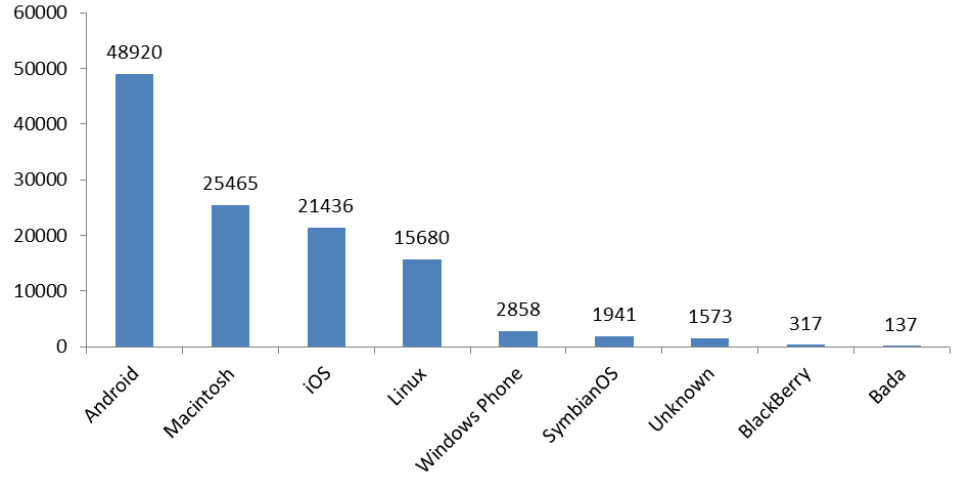


Figure 2: Operating systems of mobile devices that users use to access the web applications (number of visits from these devices during 2013)

The following graph shows mostly used mobile devices for accessing the web applications.

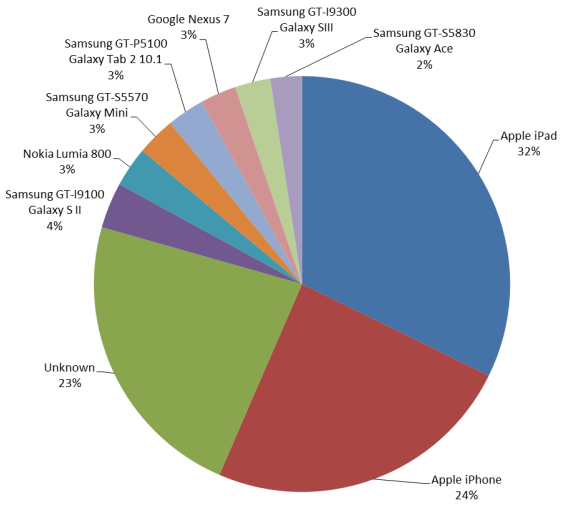


Figure 3: Mobile devices of users (visits from these devices during 2013)

M-LEARNING WITH HELP OF MOBILE THEMES IN LMS MOODLE

Educational processes by means of mobile equipment are in general called as "m-learning" (Lorenz, 2011). As already mentioned above, there are many various devices belonging to the mobile equipment category which can differ in reference to their parameters and presentations of diverse kinds of multimedia contents. A practical example of a m-learning can be demonstrated on the LMS Moodle which allows to adjust diverse kinds of appearances for diverse mobile devices. In addition to, the version for mobile devices has been designed in such a way that allows the automatic detection of devices and displaying and hiding particular elements of the application and adapts the display resolution.

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Thanks to this utility there have been secured legibility and arrangement of the educational content even in devices with the very low resolution, as it is e.g. at mobile phones. As an example we would like to introduce displaying e-learning course in various kinds of devices (iPad 3, iPhone 4S).

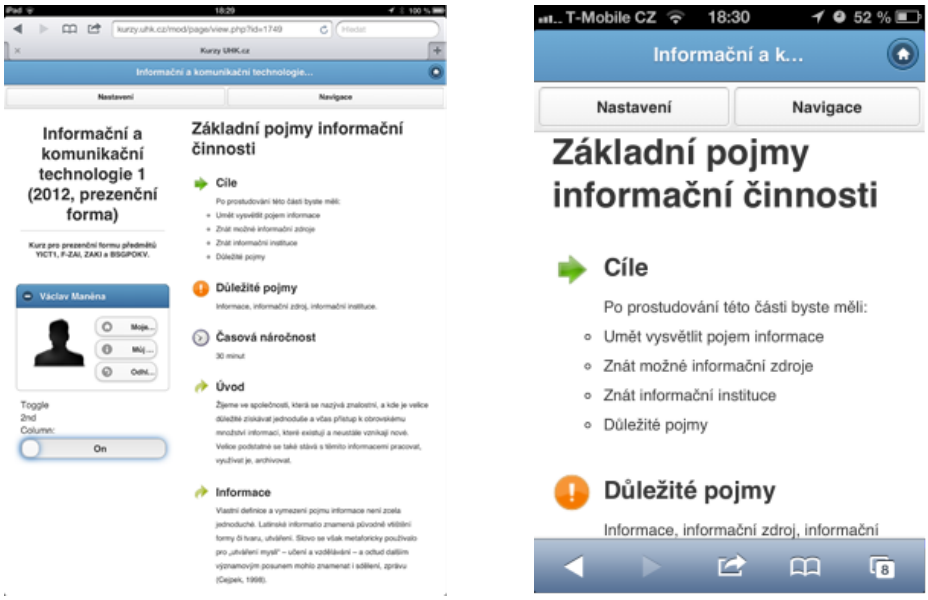


Figure 4: Displaying a learning text in mobile devices of iPad 3 (left) and iPhone 4S (right) Displaying the side strip with a title and references intended for navigations in the course can be disabled by a user.

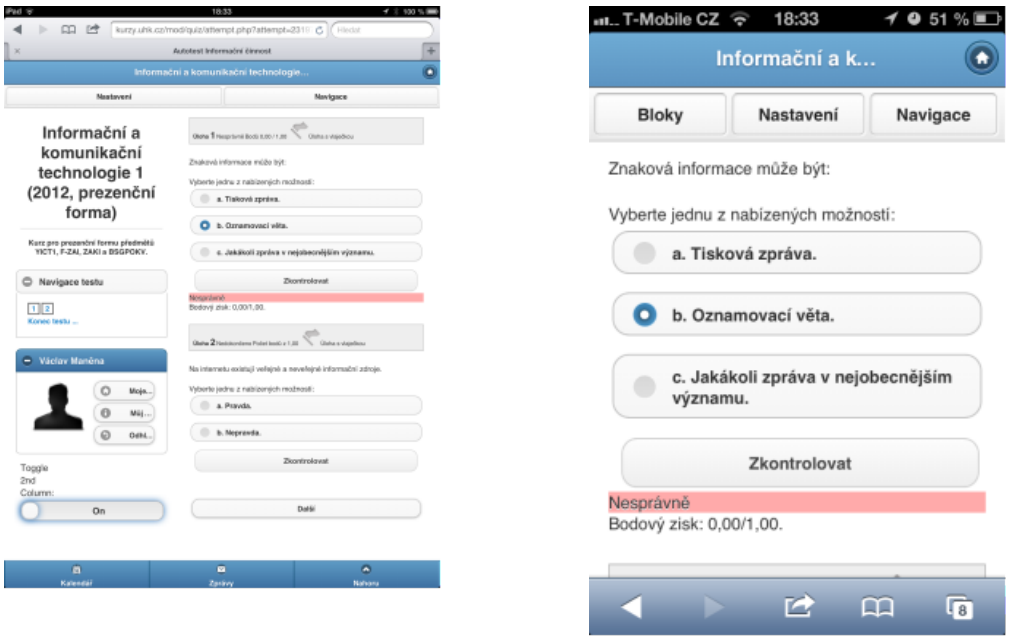


Fig. 5: Displaying a test in mobile devices of iPad 3 (left) and iPhone 4S (right) Displaying the side strip with a title and references intended for navigations in the course can be disabled by an user.

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MULTI-SCREENING AND ITS APPLICATION INTO LMS

In 2012 the Google Company published study „The New Multi-screen World: Understanding Cross-platform Consumer Behavior“ (Google, 2012). There were 1 611 respondents participating in the study and the Google Company had explored what way they behaved in the Internet and what devices they used for the access to the Internet In this respect there had occurred a term of multi-screening describing the typical behavior of current Internet users with the access to the Internet content from several various devices at the same time. There are two basic kinds of multi-screening: sequentional and simultaneous.

The sequential usage means that a user is switching among diverse devices during fulfillment of his/her task. A typical example from current life: We are looking at diverse ware in mobile equipment or we are looking for information about a culture event. We will perform purchasing the ware by means of our computer later. The simultaneous usage means that we use several devices for related or unrelated activities at the same time (see Fig. 6).

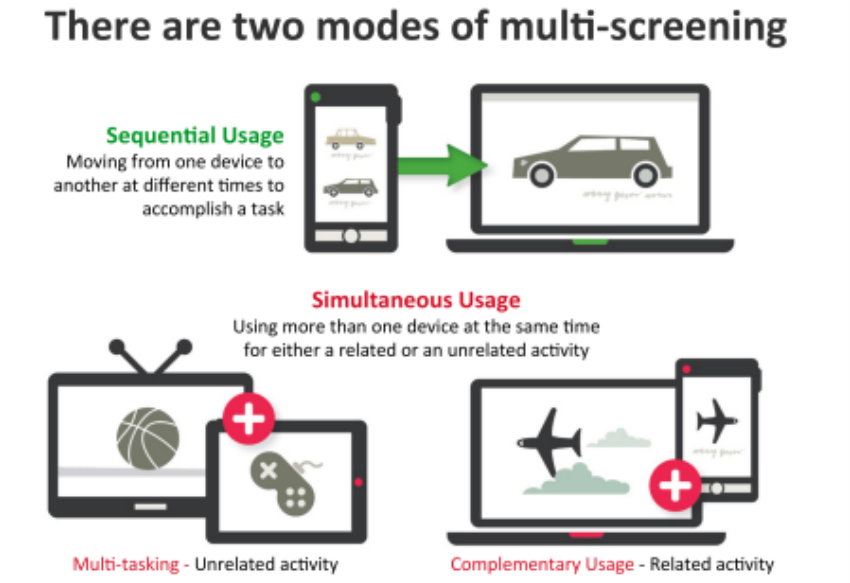


Fig. 6: Presentations of multi-screening modes (Google, 2012)

The multi-screening represents a very strong tendency which both simple web sites and advanced web applications are adapted to. One of the responses to this tendency represents using the so called responsible design in web sites and applications. If a site utilizes the responsible design, its content and appearance shall be adapted to the given equipment and the web browser´s window size. Because of that it is e.g. possible that in a case of page displaying in a small display of a mobile phone the elements on the site shall be automatically arranged below each other and instead of navigation references there will be displayed a pop-up menu which is more suitable for touch control.

Before starting the responsible design there was an option to display an optimized version of sites in tablets and mobile phones. In principle it is that a web site or application can find out from what equipment and with what browser the user is coming to. According to that a server will provide a special version of the site being suitable for an existing kind

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of the device and the browser. This principle has been presented in the foregoing text by means of displaying the LMS Moodle in the tablet and in the mobile phone (Fig. 4 and 5). This principle has been substituted progressively by the responsible design. The responsible designed site can adapt its layout according to browser window (Marcotte, 2010). Principles of operating the responsible design can be demonstrated in the following example of the LMS Moodle utilizing a special responsible theme (Fig. 7).

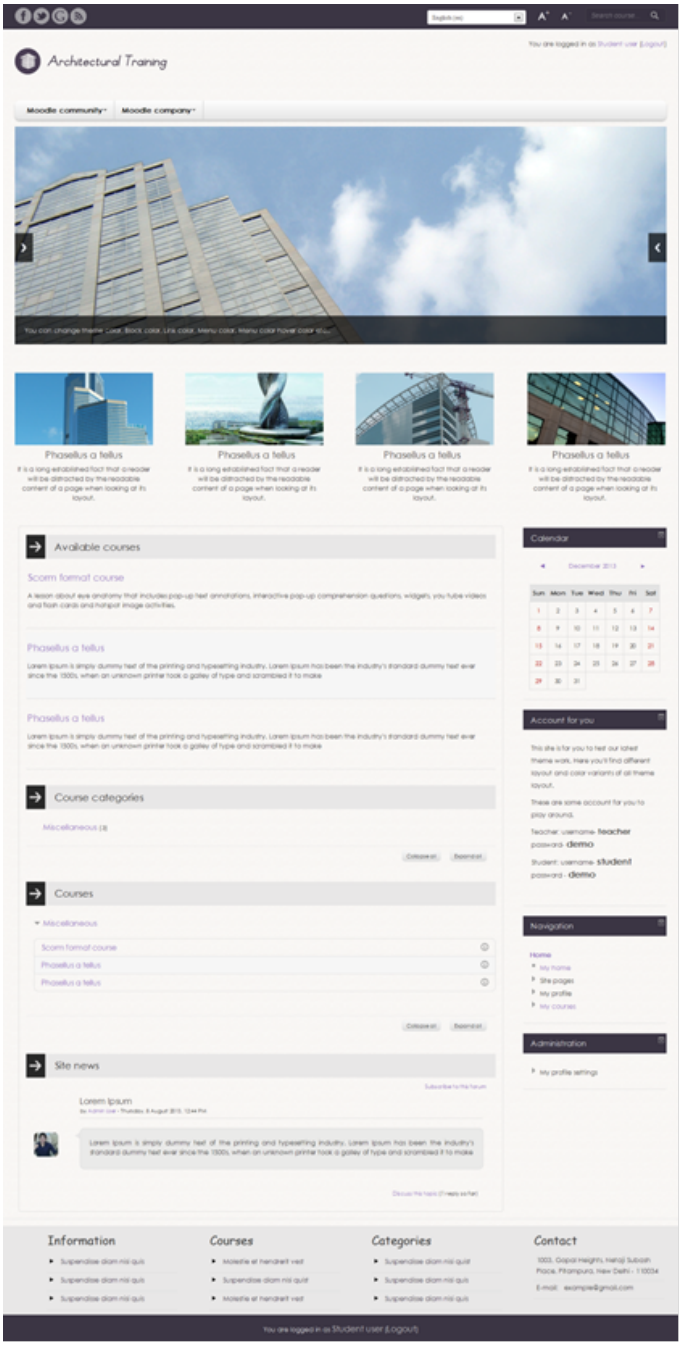


Fig. 7: The LMS Moodle with a responsible theme displayed in a common computer (Moodle Themes, 2013)

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If the same theme is displayed in a narrower screen of the tablet (the left side), some elements shall become narrower and a pop-up menu shall be displayed at the same time. The first sites shall be arranged below each other in the mobile phone (Fig. 8).

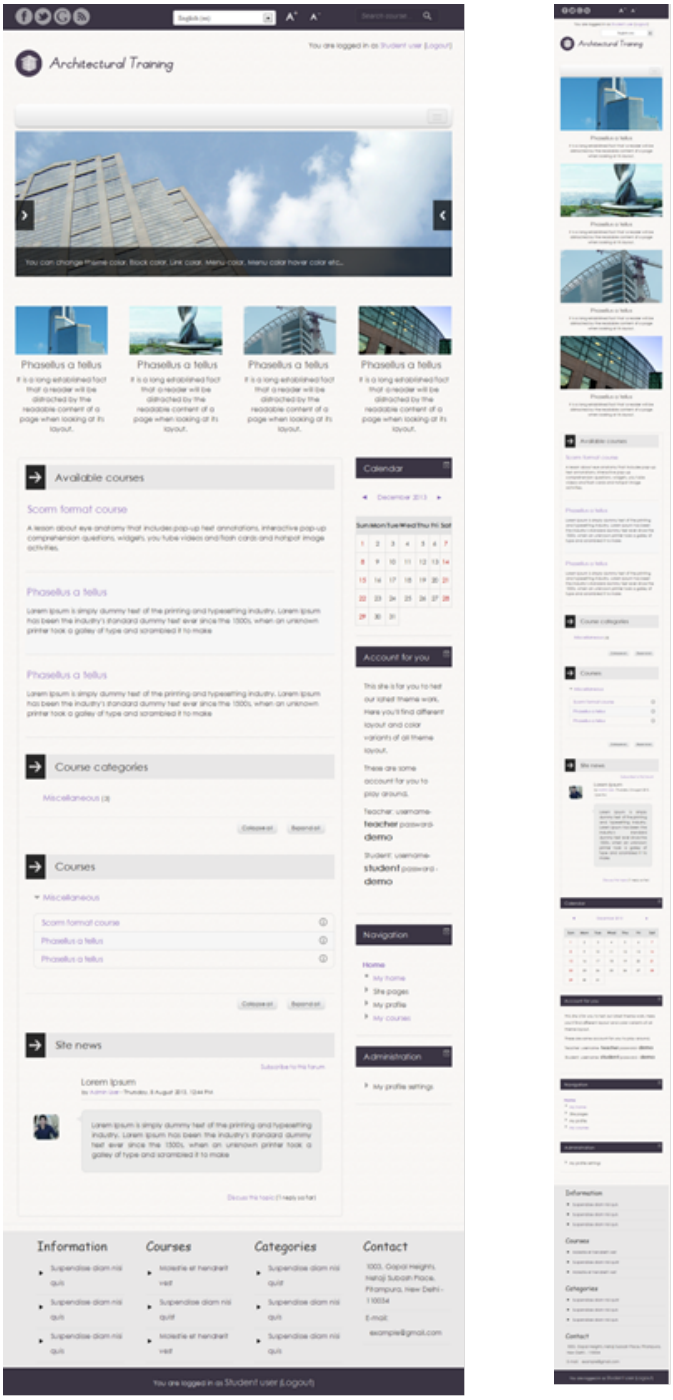


Fig. 8: Responsive theme displayed on tablet (left side) and mobile phone (Moodle Themes, 2013).

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CONCLUSION

Mobile technologies are beginning to play an important role in education. Users will increasingly require that the web applications must be usable on various types of mobile devices. Our research has shown that the number of users of mobile devices is increasing and their share is so significant that it can not be ignored. We also found that users use a lot of devices with different parameters. It is therefore necessary to use a technology that can ensure right display of content and usability on all these devices. A possible solution is to use the resposible design technology. Nowadays, the LMS Moodle is ready for use with responsible design.

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Using Virtual Environments for Vocational Education: The Avares Case

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Abstract

The main aim of the article is to present how virtual reality is used in AVARES for making education more attractive to young generations. AVARES (Enhance attractiveness of renewable energy training by virtual reality), is a project supported by the European Commission under the Leonardo da Vinci Transfer of Innovation grant scheme. It aims to develop a Virtual Reality Environment and innovative learning methodologies for vocational education and training. The project integrates a developed virtual world with a traditional Learning Management System (LMS), represented by Moodle, for more attractive learning in the challenging field of Renewable Energy Sources (RES). The hybrid educational platform developed in AVARES project combines traditional learning procedures offered to students via Moodle, acting as a Virtual Learning Environment (VLE), with learning procedures delivered to students in an 3D Virtual World. The Virtual World is developed in Open Simulator (OpenSim), an open source platform for creating multi user 3D Virtual Worlds. VLE focuses on the management of the learning material processes, whereas the Virtual World environment offers students the ability to interact and experiment with items and constructs in a similar way they would do in real world.

Key words

Virtual Reality. Virtual Learning Environment. AVARES project. Transfer of Innovation. Renewable Energy Sources. Vocational Education.

INTRODUCTION

The "Virtual World" term is used to describe digital spaces that can be explored from within, where users can navigate through, interact with objects, other users and softbots. Users can exchange information via text, audio, still images, animation and video (Kluge and Riley, 2008). Usually the user's presence is facilitated by an "avatar" - a digital 3D object that is used to represent the user. This representation is chosen by the user who may choose if his virtual identity has any real-world resemblance (Miah and Jones, 2011).

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The currently popular virtual worlds are three-dimensional (3D) computer rendered environments which can be accessed over a network, usually via Internet, populated by users in the form of avatars who interact with the simulated environment and other users. These virtual worlds have moved beyond gaming and chat environments are transformed into powerful communication and education tools.

In the report prepared by Mr. Christian Reimsbach-Kounatze (OECD, 2011) of the OECD Directorate for Science, Technology and Industry (STI), we can read that education and training seems to be the most promising application areas for virtual worlds. At the present time over 150 universities have a presence in the Second Life virtual world or other virtual worlds. There are a number of factors that have led to high rates of adoption by universities and other educational institutions (OECD 2011).

These include face-to-face and group interaction between students and educators around the world, access to resources and knowledge, voice communication, and examination of abstract and complex models through 3D visualisation or projections of visual information.

Virtual worlds also provide realistic and interactive role-playing simulations for training situations. Virtual worlds are becoming a major technology for teaching, learning, research and collaboration. Virtual worlds constitute a growing online space for collaborative play, learning, edutainment and work. Furthermore, the experience of many designers, researchers and users of virtual worlds suggests that there are three critical attributes of effectively designed virtual worlds (Bronack et al, 2008) (Bartle, 2004): (a) Thematic design of space, (b) Promotion of presence and (c) Awareness of the unique qualities of human behaviour in online social environments.

EDUCATIONAL POTENTIAL OF 3D VIRTUAL WORLDS

Recently, 3D virtual worlds have started to attract attention as platforms for learning (Xerox, 2009). They offer new learning delivery channels through which training organizations can provide experiential or simulated learning and group activities in a shared space. A virtual world can provide a perfect multi-dimensional environment and allow lot of tools for informal learning, coaching, brainstorming sessions in real time collaboration and also recording and capturing the ongoing activities.

Nowadays, the existing 3D virtual worlds provide immersive learning delivery platforms that can be adapted to different training scenarios ([3D Learning and Virtual Worlds]):

- discovery learning by clicking on objects with associated information,
- reinforcement learning by offering a knowledge repository, tools, etc associated with 3D objects,
- collaborative workspaces, such as 3D classrooms and informal sites for discussion, encouraging school-style study and research,
- traditional instructor-led learning through a distance delivery method,
- simulated learning by modelling a process or interaction that closely resembles the real world in terms of fidelity and outcomes.

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The 3D virtual environments possess several significant advantages over other training approaches (Ross McKerlich 2007):

- the experience can be much more engaging than a typical page-turning course
- the learner can learn by doing
- expensive video conferencing is not required for real-time online activity
- a user's learning experience can be designed to fit specific task needs with a flexibility and immediacy that is impossible in real life
- exploration and discovery are encouraged
- fantasy and imagination can be unleashed
- virtual 3D spaces often allow full recording of any activity, interaction or exchange, enabling past events to be re-experienced or re-used.

The ability to inhabit any type of body and to customize one's own look gives many people the opportunity to express themselves as they truly feel and not as society forces them to be.

AVARES PROJECT

Virtual Learning Environment (VLE)

An international consortium began working at the AVARES project (AVARES, 2014) in October 2012 and the project will be completed in September 2014. The project aims to create a 3D virtual learning environment and multimedia leaning materials for vocational education and training in the field of renewable energies. A hybrid education platform developed in the project combines traditional educational practices, provided via learning management system (LMS) Moodle (see Fig. 1) and a virtual world (3D RES Park).

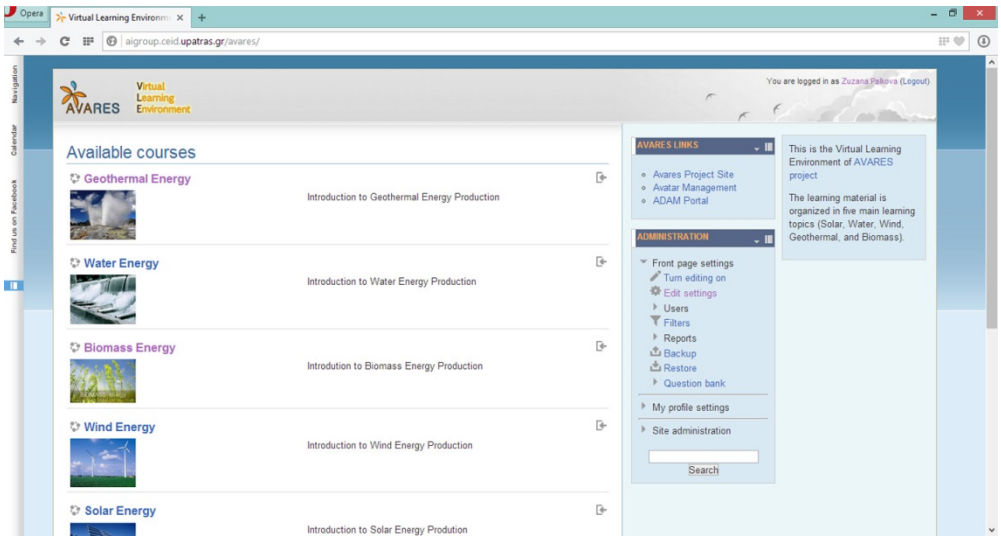


Figure 1: Virtual learning environment combines the advantages of LMS Moodle and virtual reality

LMS Moodle focuses on the learning process management and delivers to students a theoretical background for the RES field. Students can explore and learn about RES domain through 5 courses:

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- Solar Energy
- Water Energy
- Wind Energy
- Geothermal Energy
- Energy of Biomass

Students can register to the Virtual Learning Environment (VLE) platform and create personal accounts. After that, they can anytime access the platform with their credentials. The course material mainly consists of presentations that the students can download and study on their own pace. Learning materials also include textbooks, web-pages, animations and videos. In the Figure 2, a solar energy module in the Virtual Learning Environment is illustrated.

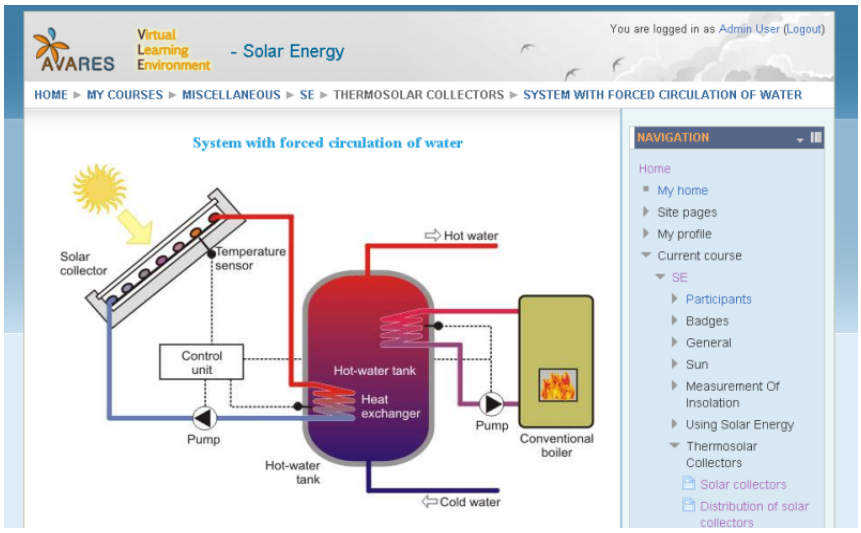


Figure 2: The Solar Energy module in the Virtual Learning Environment

3D Virtual RES Park

The 3D Virtual RES Park offers an environment that allows shifting the traditional educational process (book/textbook) to the new way of learning that is interactive and more visual (see Fig.3). Virtual reality offers an attractive and effective way of learning where students can learn through experimentation and interactions in the virtual world.

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Figure 3:The virtual world gives students the ability to communicate with other students or interact with the objects

The AVARES 3D RES Virtual Park consists of:

- **The 3D Auditorium** - trainers giving lectures in the 3D Auditorium (see Fig. 4) will be able to load specific presentations from the VLE or even upload their own slides.



Figure 4: 3D Virtual RES Park Auditorium

- **Sub-Areas dedicated to each course -** for each one of the five main learning topics (Solar, Water, Wind, Geothermal, and Biomass) there is a designated area inside the world with the corresponding training material along with interactive 3D models (see Fig. 5) that will help them comprehend the presented topics.

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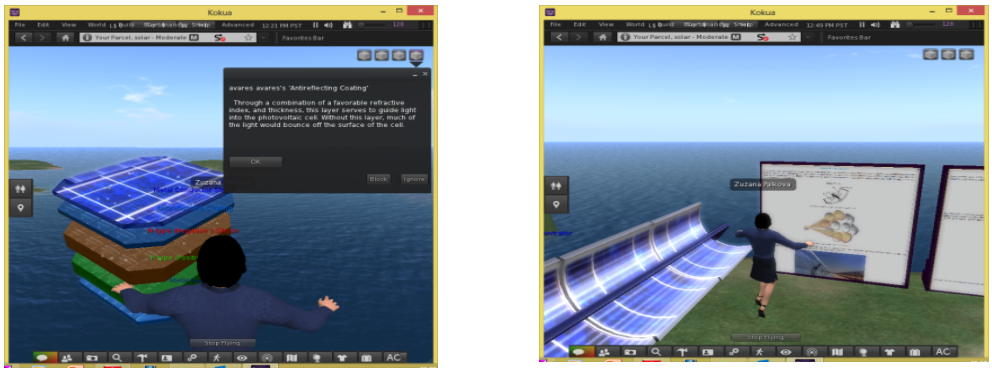


Figure 5: Interactive 3D models allow understanding the principles of their operation

- **Classrooms/Meeting Rooms** - these rooms can serve as meeting areas for project partners and as classrooms for small groups of students as well (see Fig. 6).

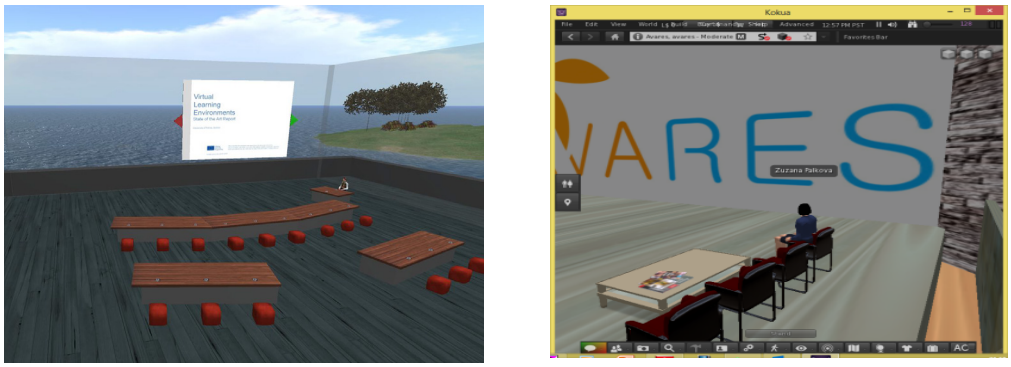


Figure 6: A classroom in the Virtual Word.

Connecting VLE and 3D Virtual RES Park

The learning materials stored in the VLE (Moodle) are available in the 3D RES Virtual Park as well. Specific activities and presentations can be displayed as posters or boards at various areas of the 3D Virtual RES Park. As depicted in Figure 5 , adjacent to 3D models representing RES systems users can read the corresponding learning material from VLE. Trainers/teachers can give their lectures in the 3D Auditorium where they are able to load learning materials from the VLE or even upload their own slides.

Sloodle (Sloodle, 2014) is a free and open source project which integrates the multi-user virtual environments of Second Life and/or OpenSim with the Moodle learning management system. Sloodle allows connecting a student account in Moodle with a corresponding avatar. Thanks to this connection, avatars are able to participate in the Moodle activities like tests or assignments. Chat between users inside the virtual world is also stored in Moodle.

CONCLUSION

In this paper, we present the hybrid learning platform developed in the frame of the project AVARES supported by European Commission running under the Leonardo da Vinci

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Transfer of Innovation grant scheme. The platform combines in an effective way two environments - the traditional learning environment Moodle and the 3D Virtual RES Park implemented in OpenSim. The main aim of the AVARES project is to develop the multimedia learning materials for vocational education and training in the field of renewable energies and emphasis is given to the application of modern ICT equipment and virtual reality.

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Internet Social Networks and Generation Y at Faculty of Economics and Administration, University of Pardubice

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Abstract

A social network is a connected group of people, who share each other's data in the virtual network. These services offer various possibilities of interaction - chats, news, emails or forums. We made a questionnaire survey for comparison of social networks utilization with students of the Faculty of Economics and Administration at the University of Pardubice. The survey was aimed on using specific types of web services that are most frequently visited worldwide and locally in Czech Republic. We made classification of some attributes into scales. These attributes were size of municipality, number of hours spent at PC per week, age etc. Evaluation of the survey was made to discover correlation between each attributes. Then we made cluster analysis to show the differences of using some chosen application for social networking within the students. We used Kononen´s Self Organizing Map, Two-Step Cluster algorithm and K-Means method and results are shown in the paper.

Keywords

Generation Y. Social network. Faculty of Economics and Administration University of Pardubice. Facebook. Communication. Questionnaire survey.

INTRODUCTION

For almost ten years experts have been talking about the onset of Generation Y, so called Internet generation. Each generation has its specifics by which it wants to differ from the previous generation. This process brings shift and progress in opinions for the society and also searching for new ways. Distinguishing particular generations which are expressive and specific in their behavior and expression can be defined chronologically. It is well characterized by (Rezlerová 2009) in chapter Who Are People of the Y Generation?: "*The first significant generation were so called Baby Boomers who were born after WWII between 1946 and 1964. They were succeeded, especially in the western countries, by Generation X – people born between 1965 and 1974 while some sources prolong this period till 1982, which causes overlap with the following generation. Young people, marked as Generation Y, born after 1976 (or 1974) can be further divided into two groups – those older than 25 and so nearer to Generation X and the younger ones.*"

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As any other generation also members Generation Y are formed by the period when they live. They grow up surrounded by modern technologies and have been using them automatically since their youth. World-wide expansion of the Internet and mobile networks was important for forming this generation, especially services like email, text and multimedia messages, multimedia content of the Internet or web social networks. These are people who currently devote a large portion of their time to their "second" life – social networks such as MySpace or Facebook (Noska, 2009). Although they gain many acquaintances and contacts which they can apply not only in personal but also professional life, these networks may isolate them. Compared to previous Generation X, they have fewer friends that they meet directly. It has both, advantages and disadvantages, but, above all, this is new, different.

GENERATION Y AND DIGITAL MEDIA

Generation Y profits from more options for life-long education and gaining of experience from various spheres without regards to language and country borders thanks to new technologies enabling open communication and distant education. This determines the characteristics and needs of the generation. It is development which should not be underestimated and we have to agree with (Rezlerová, 2010) that until 2025, Generation Y will form the majority of population in productive age and, therefore, their demands on the job market and also education system must be respected Interesting thing is uses of digital technologies by teachers in school (Cápay, Magdin, Tomanová, 2012) which is part of this problem.

Based on (Junco and Mastrodicasa, 2007), whose research utilizes assumptions of (Strauss and Howe, 1992), it has been confirmed that 97 % of Generation Y use a computer, 94% use a mobile phone and 56% other multimedia devices. Thanks to these technologies, Generation Y has means of communicating with their parents more often than their predecessors when studying away from their home town. This generation takes communication with surrounding for granted (instant messaging, PM). The source for obtaining information has also significantly changed compared to Generation X. For 34% the Internet is the primary source of information against previously used printed media, radio broadcast and television. The research involved 7705 university students in the USA.

In June 2009 The Nielsen Company published a study based on a similar research (Covey, 2010) which supplies the newest data about how Generation Y uses media. The study describes the differences between different age groups within Generation Y and their approach to media. The study implies that the representatives of Generation Y between 18 and 24 years old spent 14 hours and 19 minutes per month on the Internet in 2009. A bit older group (25-34 years old) spent 31 hours and 37 minutes per month. Almost half of young Americans use Internet social networks; Facebook (44%) and MySpace (45%).

Problem Formulation

The research of social networks utilization among the students of the University of Pardubice included two surveys which were created and distributed to the target group. This was the pilot part of the research. Based on identified facts, we were interested in this

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part of the research whether the selected specific sample of Generation Y at the Faculty of Public Administration and Economics uses the Internet social networks in the same extent as the respondents from the above listed researches. We were further interested whether the results will be influenced by e.g. sex, study programme or the fact that a student lives in the student dormitory.

Problem Solving

The research of the topic was divided into two phases of survey. The goal of the research carried out by survey was to determine how selected students use social networks on the Internet, how much time they spent there and how this affects their social connections in the real life. Another goal of the research was to show the composition of the students, whether there are significantly communicating individuals among the students.

The SNA utilizes two types of network structure description – central and sub-structural. Central network structure is necessary for understanding the density, topography and disparity in the social structure. On the other hand, the substructure description examines the relations within the network - it is searches for groups and individualities(Křupka, Kašparová, Jirava, 2010). Our research includes both, structural and sub-structural analysis. The goal of utilization of the relationship analysis is to:

- identify teams (clusters),
- identify individuals (leaders, connectors, peripheral players),
- identify isolation of clusters and individuals.

For description and creation of social structure it is firstly necessary to accomplish a suitable description of individuals so that relations between them can be traced. It is vital that every identity – person should be described by the same norm and the norm should be widely accepted.

The research constituted of two parts:

- first part is general research of using social networks, how much time users spend on individual services of social networks on the Internet,
- the second part is focused on how much time users spend with individual persons (classmates) in real life, how much within the virtual world.

CLUSTER ANALYSIS

Before proceeding to the cluster analysis itself, Kohonen's network (Kohonen, 2001) was constructed, the output of which was the design of primary number of clusters for further analysis. For clustering itself, methods of cluster analysis Two-Step and K-Means were used.

Kohonen's Self-Organizing Map

Kohonen's Self-Organizing Map is a type of neural network based on competitive learning strategy. The input layer serves for input samples distribution. The neurons in the competitive layer are representatives of input samples and are organized into topological

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structure. This type of neural network with unsupervised learning can be used for grouping elements to different clusters, if a method without supervision is used. The elements within one cluster are similar to each other and elements in different clusters are different from each other. (Alexa, 2010)

The number of elements in the clusters which were created by the Kohonen's map is shown in tab. 1 where Y and X are the coordinates of neurons in the competitive layer. The total number of neurons in the competitive layer is twelve but there are only three clusters with a significant number of elements (highlighted cells in the table). The number of significant clusters will be used in further analysis.

Tab. 1: number of objects in individual clusters.

Y, X	0	1	2	3
0	29	16	14	19
1	5	4	6	9
2	26	14	14	25

Source [own]

Two-Step Cluster Algorithm

Two algorithms were chosen for the cluster analysis – Two-Step and K-Means (MacQueen, 1967). Their results were compared and, although the results were comparable – Two-Step seems more appropriate for this concrete case.

The Two-Step algorithm stemmed from the results of the Kohonen's map, this means that there were three significant clusters. The results of the cluster analysis are displayed in the following tables. Table 2 shows the percentual ratio of respondents of the cluster using the particular web service and the frequency of using the web service. Due to the limitations of this paper only the highest values of the particular cluster were chosen. Tables (Tab. 3 and 4) show the representation of respondents according to other observed parameters. The highlighted cells are dominant for particular cluster and parameter.

Tab . 2: Results for individual web services.

		cluster 1	**cluster 2**	**cluster 3**
Facebook	0	2,35%	0,00%	3,7%
	1	30,59%	2,86%	29,63%
	2	2,35%	1,43%	0,00%
	3	1,18%	1,43%	0,00%
	4	4,71%	0,00%	0,00%
	5	25,88%	8,57%	3,7%
	6	32,94%	85,71%	62,96%
ICQ	0	1,18%	0,00%	0,00%
	1	16,47%	0,00%	7,41%
	2	12,94%	0,00%	3,70%

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	3	4,71%	2,86%	0,00%
	4	10,59%	5,71%	0,00%
	5	32,94%	8,57%	18,52%
	6	21,18%	82,86%	70,37%
Skype	0	3,53%	1,43%	3,7%
	1	56,47%	20,00%	66,67%
	2	12,94%	27,14%	25,93%
	3	3,53%	2,86%	0,00%
	4	4,71%	21,43%	0,00%
	5	17,65%	21,43%	3,70%
	6	1,18%	5,71%	0,00%
Spolužáci	0	2,35%	2,86%	0,00%
	1	7,06%	1,43%	3,70%
	2	18,82%	11,43%	3,70%
	3	18,82%	18,57%	0,00%
	4	32,94%	42,86%	0,00%
	5	20,00%	15,71%	81,48%
	6	0,00%	7,14%	11,11%

Source [own]

Tab. 3: Result for time spent at computer

Time	**cluster 1**	**cluster 2**	**cluster 3**
1	22,35%	11,43%	0,00%
2	41,18%	10,00%	22,22%
3	18,82%	24,29%	59,26%
4	10,59%	25,71%	0,00%
5	1,18%	10,00%	3,7%
6	1,18%	8,57%	11,11%
7	4,71%	10,00%	3,70%

Source [own]

Tab. 4: Result for the grade

Grade	**cluster 1**	**cluster 2**	**cluster 3**
1	0%	2,86%	3,70%
2	96,47%	87,14%	88,89%
3	3,53%	10%	7,41%

Source [own]

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Evaluation of Results of Cluster Analysis

For interpretation of the results of the cluster analysis, such algorithm was selected which was chosen as the most appropriate from the following decision tree algorithms: C 5.0, C&R Tree and QUEST. (Johansson, Niklasson and König, 2004, Morgan, 1193).

The target value was defined as sorting in of the element into particular cluster (cluster 1-3). Based on evaluation, the algorithm C 5.0 was selected as it interpreted the results of the cluster analysis in the best way. Algorithm C&R Tree reached 100% evaluation of 62 percentiles, so this algorithm has the best performance from the compared ones and was selected for a more detailed analysis of the created clusters.

The result of the cluster analysis is the model shown in Picture 2. It uncovers the weight of individual characteristics for sorting into clusters, which were generated by the Two-Step algorithm.

Another result of the decision tree is the following association rules which explain individual clusters, see Picture 1.

These rules will help to verbally explain three clusters created by the analysis of the survey at the University of Pardubice. The respondents were divided into three clusters.

```
ICQ <= 4 [ Mode: cluster-1 ]
 Stream.cz <= 4 [ Mode: cluster-1 ] => cluster-1
 Stream.cz > 4 [ Mode: cluster-2 ]
       Facebook <= 1 [ Mode: cluster-3 ] => cluster-3
       Facebook > 1 [ Mode: cluster-2 ] => cluster-2
ICQ > 4 [ Mode: cluster-2 ]
 ICQ <= 5 [ Mode: cluster-1 ]
       Spolužáci.cz <= 4 [ Mode: cluster-1 ] => cluster-1
       Spolužáci.cz > 4 [ Mode: cluster-3 ]
             Skype <= 3 [ Mode: cluster-3 ] => cluster-3
             Skype > 3 [ Mode: cluster-2 ] => cluster-2
 ICQ > 5 [ Mode: cluster-2 ]
       Facebook <= 2 [ Mode: cluster-1 ] => cluster-1
       Facebook > 2 [ Mode: cluster-2 ]
             Facebook <= 5 [ Mode: cluster-2 ]
                   Stream.cz <= 1 [ Mode: cluster-1 ] => cluster-
1
                   Stream.cz > 1 [ Mode: cluster-2 ] => cluster-2
             Facebook > 5 [ Mode: cluster-2 ] => cluster-2
```

Picture 1: Association rules Source [own]

It is distinctive for the first cluster (Cluster-1) that it is not dependent on the sex and study year; the respondents prefer ICQ for daily communication. They use Skype exceptionally. However, they like to consume multimedia content on YouTube several times a week. The members of this cluster are relatively latent to the Spoluzaci.cz network. These students spend between 10 and 20 hours of their free time per week at the computer. This cluster was most numerous, it involved 85 /46.70%) respondents. Generally, this cluster can be considered passive toward social networks.

Another cluster (Cluster-2) was the second largest, containing 70 students (38.46%). It is typical for these respondents that they are very active on Facebook (85%) which they use every day. They also utilize ICQ (82%) and Skype services for daily communication. The

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respondents in this cluster daily watch videos at YouTube. They typically spend 30-40 hours per week at their computer during free time activities. This cluster can be described as very active at the social networks.

The third cluster (Cluster-3), with 27 respondents (14.83%) the smallest, is form mostly by females. They typically communicate daily using ICQ, exceptionally use also Skype. They also spend time on Spoluzaci.cz several times week and watch videos at YouTube every day. The average time spent at the computer is approximately 35 hours per week.

CONCLUSION

According to the data published by the European Commission, 41.7 million European users use social networks, their number increased in 2009 by 35%. In 2012 the number is expected to exceed 100 million. Especially young people spend more and more time on the social networks. In contrast to standard letters or face-to-face communication, the information published on social networks is immediately accessible also to other users who can minute-by-minute live the life with the author no matter the place of stay. The expansion is also stimulated by price availability of the technologies enabling this kind of communication.

Based on the data observed in published researches carried out abroad and in the Czech Republic, we were interested in the first phase of the research at the University of Pardubice, which was focused on second grade full-time bachelor students at the Faculty of Public Administration and Economics, whether the selected sample of Generation Y uses social networks in a similar way to the respondents of the above listed researches. The concept of the research was formed by two phases of survey. The first one, partly described in this paper, is a general research of social network utilization, how much time respondents spend using different services of social networks on the Internet. The questions were divided into two subscales. The first subscale of questions was aimed at identification of importance of Internet or web services for communication; the other subscale was related to general identification of the respondent. The results imply that preferred services include Facebook, Spoluzaci.cz, Skype and ICQ. With increasing frequency of work on social networks, the popularity of two of them is increasing and that is Facebook and ICQ, which form more than 88% of all daily used services. At this stage of evaluation, it was also found out that the time spent on the Internet is not influenced by the domicile of the student and not even by the fact whether the student is accommodated in student dormitory. At this phase, the influence of study program was not evaluated due to unequal sample of males and females and the influence of sex.

The second phase of the survey, where we currently are at stage of processing collected data, will answer the questions how much time respondents spend with their peers in real life and how much time on social networks. The data will be processed in MS Excel, SPSS Clementine and software for processing and analysis of objects in social networks – ORA (Organizational Risk Analyzer). When processing the data, we had to cope with the problem that not all respondents of the first survey answered the second part and vice versa, which lead to decrease of the sample group. Despite this, we still do not consider appropriate to connect both phases into one questionnaire as it could lead to

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influence between both parts and it would also be too time consuming for the respondents. We believe the comparison between the estimation of respondents-students in the first phase and the reality they filled into the second survey will be interesting.

As this was a pilot research, the questionnaire survey will be repeated in the following academic years, most likely on a larger sample group. We will try to motivate the students to answer both questionnaires and to pay higher attention when filling them in.

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Constructivism at University: Pilot Study

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Abstract

The paper aims to present the research into application of constructivism to instruction at University of West Bohemia in Pilsen. In 2009–2011, a project entitled "Constructivism in University Education" was conducted in the Czech Republic, in which young academics at four higher education institutions (University of West Bohemia in Pilsen, University of Hradec Králové, University of South Bohemia in České Budějovice and Tomas Bata University in Zlín) were trained in using methods that support active learning and in applying the constructivist approach in higher education pedagogy. Three years later, we contacted the participants again to explore the extent, to which they use the information from the course in practice and to find their current position on the use of constructivism in instruction at higher education institutions. Outcomes of the preliminary survey of seventeen respondents from the University of West Bohemia in Pilsen are interpreted. Next year, data from all participants from all four partner institutions who completed the course will be added.

Keywords

Constructivism. Training programmes and courses. Faculty member. Higher education pedagogy. Teaching methods. On-line courses. Blended learning.

INTRODUCTION

Didactic constructivism in its moderate form without the aspects of absolutization, which attract justified criticism of the professional public, e.g. Olssen (2003), Rendl (2008), forms in our opinion a suitable basis for both face-to-face and distance learning at higher education institutions. With this view in mind, the project Constructivism in University Education was conducted at University of West Bohemia in Pilsen, University of Hradec Králové, University of South Bohemia in České Budějovice and Tomas Bata University in Zlín in 2009-2011, with co-funding from the European Social Fund and the state budget of the Czech Republic. The objective of the project was to introduce beginning academics to constructivist teaching principles and motivate them to use constructivism in their own teaching practice.

- In the face-to-face part of the educational course, the project participants were introduced to interactive methods in face-to-face instruction and encouraged to engage in problem solving, group activities, discussions, sharing their experience and reflection. The distance part of the educational programme had the form of a tutored on-line course.

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- We see the greatest benefit in the hands-on part of the project where the teachers consulted experienced lecturers in order to make didactic updates to one of their disciplines taught over a single semester, or to its part, and explored options for incorporating specific constructivist elements.
- Three years after the end of the course we want to assess the impact it had on the teaching practice of its participants, to find whether they keep using constructivist elements in their instruction and to explore their current attitude towards constructivism.

METHODS

We decided to conduct the pilot survey using a questionnaire. The questionnaire contained seven questions. They included closed-ended (structured) questions with multiple choices, as well as semi-closed-ended (non-structured) questions, in which explanations were required for the answers given to closed-ended questions. To facilitate interpretation of the answers in the questionnaire, we used additional questioning. The hypotheses constructed were verified using Fisher's exact test (Chráska, 2007).

Face-to-face discussions, evaluation questionnaires collected after completion of the course and subsequent interviews with graduates revealed certain differences between teachers of technical and non-technical disciplines. The survey therefore built on the comparison of the responses from teachers of technical disciplines and the non-technical ones.

In June 2013, we sent questionnaires to 32 graduates from the first and the second run of the course. Some of these graduates are no longer university teachers, several female lecturers are on parental leave and some questionnaires were not returned. In the end, we received answers from a total of 17 respondents. Eleven of those were teachers of technical disciplines at the Faculty of Mechanical Engineering and the Faculty of Electrical Engineering. The other six were teachers of other than technical disciplines. They included two lecturers from the Faculty of Philosophy and Arts, two lecturers from the Institute of Applied Language Studies and two from the Faculty of Health Care Studies. In the group of teachers of technical disciplines were included seven male teachers at the Faculty of Mechanical Engineering of University of West Bohemia (UWB) in Pilsen and three male teachers and one female teacher from the Faculty of Electrical Engineering (UWB). The group of teachers of non-technical disciplines comprised two female lecturers in foreign languages at the Institute of Applied Language Studies, two female lecturers in social sciences at the Faculty of Philosophy and Arts and two female lecturers in natural science disciplines at the Faculty of Health Care Studies of UWB.

The average age of the respondents at the time of questioning and at the time of graduating from the course was 30 and 27 years, respectively.

During July, the data from individual questionnaires was evaluated using statistical methods.

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RESULTS

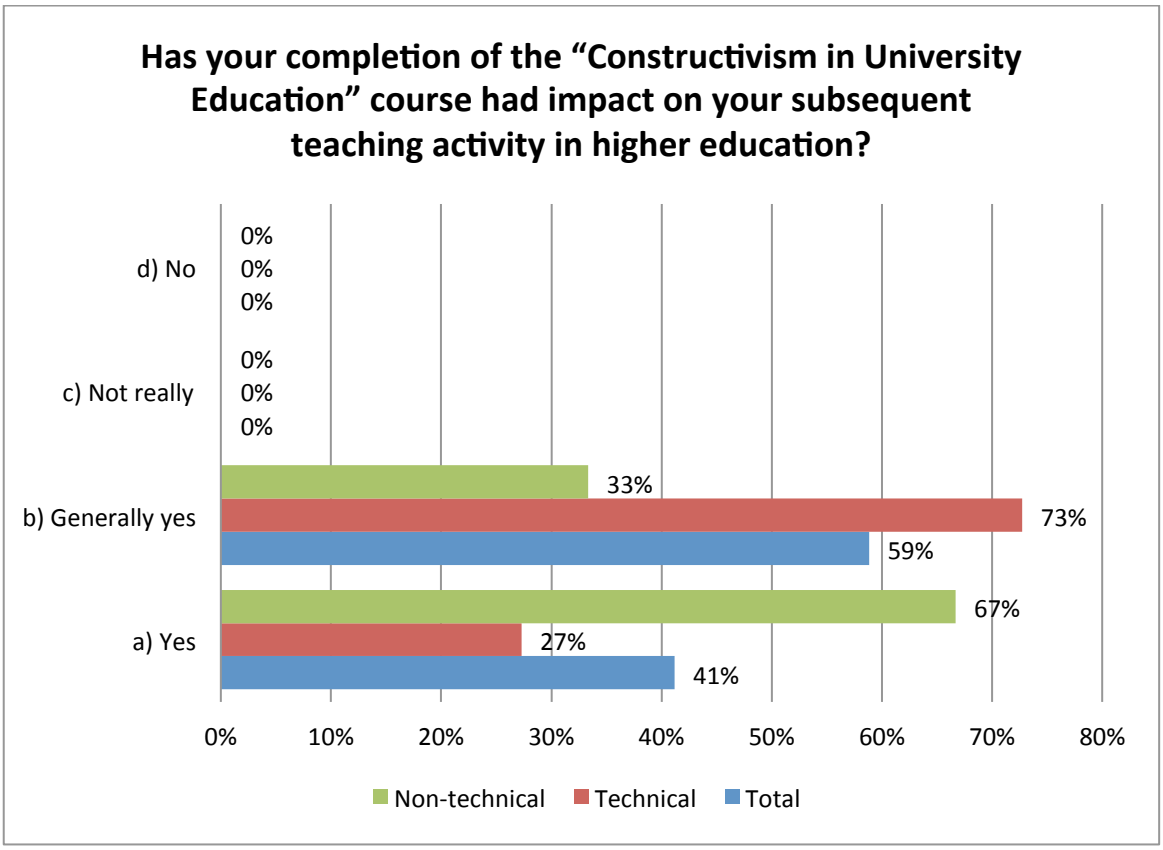
The present paper focuses exclusively on interpreting answers to two key questions.

Question 1: Has your completion of the "Constructivism in University Education" course had impact on your subsequent teaching activity in higher education?

As the group of teachers of non-technical disciplines included those who had completed teacher training studies or courses before, we assumed their completion of the present course would have a more profound effect on the teachers of technical disciplines. Consequently, the following alternative hypothesis HA and null hypothesis H0 were proposed:

H_0: The proportion of teachers who claim that their completion of the course has had a definite influence on their subsequent teaching practice is identical in both technical and non-technical disciplines.

H_A: The proportion of teachers who claim that their completion of the course has had a definite influence on their subsequent teaching practice is different in both technical and non-technical disciplines.



Graph 1

No respondent chose the "no" or "not really" options from the range of answers available. A total of 41 % respondents answered "yes" (27 % of those from technical disciplines and 67 % from the non-technical ones) and 59 % respondents chose "generally yes" (73 % of those from technical disciplines and 33 % from the non-technical ones).

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		Their completion of the course has had definite influence on their subsequent teaching practice				
		YES		**GENERALLY YES**		**Σ**
Teachers of technical disciplines	**YES**	3	a	b	8	11
	NO	4	c	d	2	6
	Σ	7		10		17

2×2 contingency table no. 1

The following Fisher's exact test formula was used for the calculation.

$$p = \frac{\binom{a+b}{a}\binom{c+d}{c}}{\binom{n}{a+c}}$$

At the significance level chosen, α = 0.05, the probability value was calculated (using the same expression as in the introduction): p = 0.162 > α. The margin of error of 16.2 % in rejecting the null hypothesis is too high, **which is why the hypothesis that "The proportion of teachers who claim that their completion of the course has had a definite influence on their subsequent teaching practice is different in both technical and non-technical disciplines." cannot be confirmed.**

The respondents have been invited to explain their answer.

The responses of teachers of technical disciplines who chose the option "generally yes" included the explanation that "the 'generally yes' response is due to the fact that the subject includes certain parts, to which the constructivist principles of instruction cannot be applied". The "generally yes" answer was also given by those respondents who have found and verified during the course that the procedures and methods they used were correct. Other reasons for the "generally yes" response were either more general or related to certain aspects of the instruction: I learned how to motivate students effectively and how to make the instruction more interactive and fun. I found interactivity to be the key to success.

I make an effort to make students more engaged in the instruction in order to make them think about the topic and to propose the next step themselves.

The respondents from among teachers of technical disciplines, who gave the "yes" answer, provided very detailed explanations.

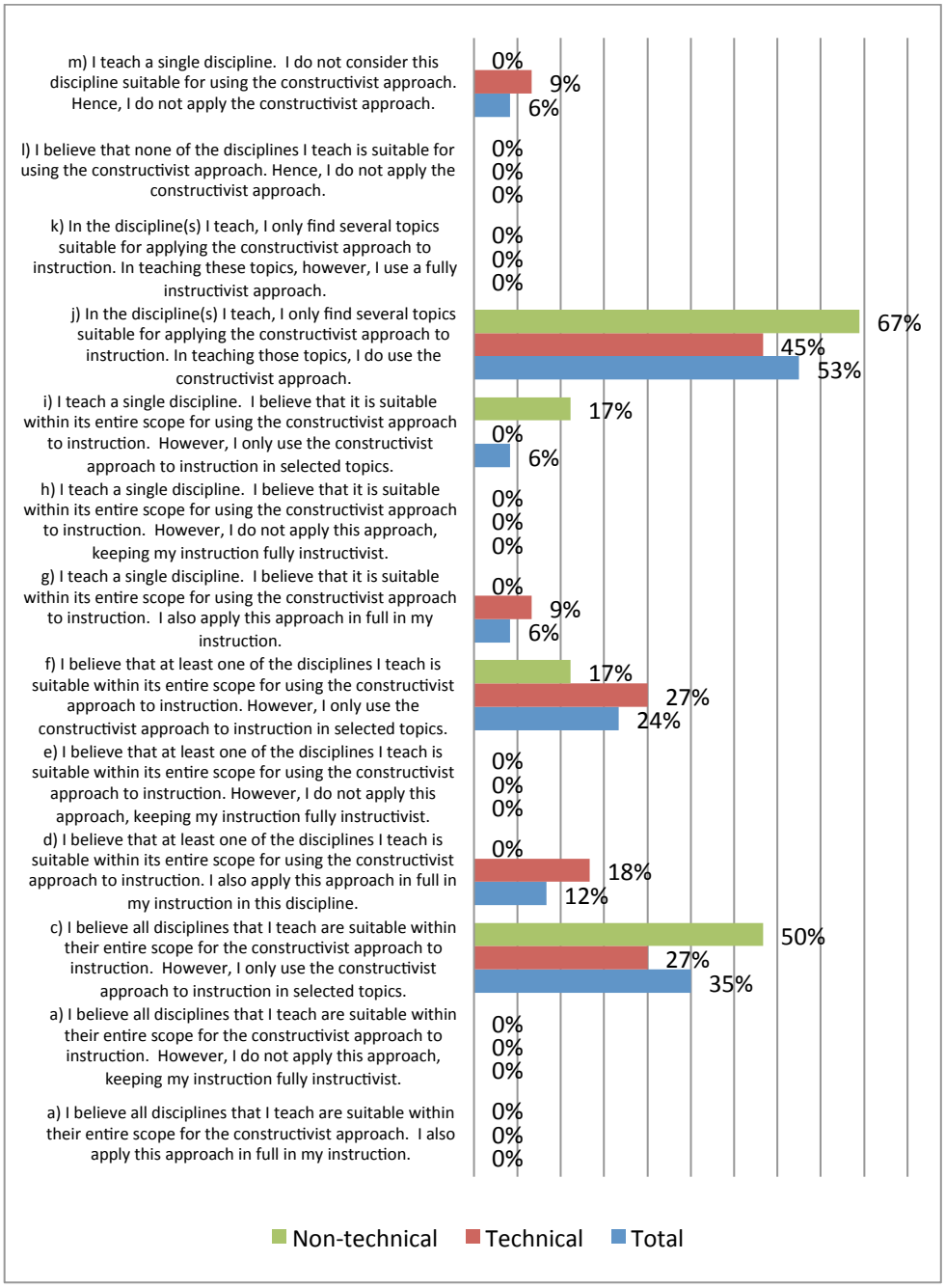
I improved my skills in dividing the instruction into time segments with diverse activities to keep students attentive throughout the seminar. I included in the instruction many hands-on exercises to develop the knowledge by experience. I learned to better communicate with various types of students.

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A very detailed explanation of the "yes" response was given by a teacher of non-technical disciplines. She mentioned the benefit of being inspired by other course participants and by the teaching methods and procedures they used.

In the group of teachers of non-technical disciplines, the explanations for the "generally yes" answer were influenced by the fact that some of these respondents had completed teacher training before. However, those who had not did acknowledge that the course contributed to changing their teaching methods.

Question 2: Choose the statements, which best fit your situation, from the following list.



Graph 2

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While interpreting the responses, we focused on the three most frequent statements.

In the discipline(s) I teach, I only find several topics suitable for applying the constructivist approach to instruction. In teaching those topics, I do use the constructivist approach.

After the course, the teachers of technical disciplines expressed the opinion that the potential for using constructivism in technical disciplines is limited. Hence, we have constructed the alternative hypothesis HA and the corresponding null hypothesis H0.

H_0: The proportion of teachers who report to be using the constructivist approach in teaching only some topics within their disciplines is the same in both technical and non-technical disciplines.

H_A: Teachers of technical disciplines report using the constructivist approach in teaching only selected topics more often than the teachers of the non-technical ones.

		In my disciplines I apply the constructivist approach to teaching only some topics				
		YES			**NO**	**Σ**
Teachers of technical disciplines	**YES**	5	a	b	6	11
	NO	4	c	d	2	6
	Σ	9			8	17

2×2 contingency table no. 2

At the chosen significance level $\alpha = 0.05$, the probability value was calculated (using the same expression as in the introduction): $p = 0.620 > \alpha$, which is why we accepted the null hypothesis and stated that **the proportion of teachers who report to be using constructivist approach in teaching only some topics within their disciplines is the same in both technical and non-technical disciplines.**

I believe all disciplines that I teach are suitable within their entire scope for the constructivist approach to instruction. However, I only use the constructivist approach to instruction in selected topics.

We have constructed the following hypotheses:

H_0: The proportion of teachers who consider all disciplines they teach as suitable within their entire scope for using the constructivist approach, and yet apply the approach to some topics only, is identical in technical and non-technical disciplines.

H_A: Teachers of technical disciplines report more often than teachers of non-technical disciplines that they consider all disciplines they teach as suitable within their entire scope for using the constructivist approach, and yet they apply the approach to some topics only.

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		I believe all disciplines I teach are suitable within their entire scope for using the constructivist approach, but I apply this approach to some topics only.				
		YES			**NO**	**Σ**
Teachers of technical disciplines	**YES**	3	a	b	8	11
	NO	3	c	d	3	6
	Σ	6			11	17

2×2 contingency table no. 3

At the chosen significance level $\alpha = 0.05$, the probability value was calculated (using the same expression as in the introduction): $p = 0.600 > \alpha$, which is why we accepted the null hypothesis and stated that **the proportion of teachers who consider all disciplines they teach as suitable within their entire scope for using the constructivist approach, and yet apply the approach to some topics only, is identical in technical and non-technical disciplines**.

I believe that at least one of the disciplines I teach is suitable within its entire scope for using the constructivist approach. However, I only use the constructivist approach to instruction in selected topics.

H_0: The proportion of teachers who consider at least one discipline they teach as suitable within its entire scope for using the constructivist approach, and yet apply the approach to some topics only, is identical in technical and non-technical disciplines.

H_A: Teachers of technical disciplines report more often than teachers of non-technical disciplines that they consider at least one discipline they teach as suitable within its entire scope for using the constructivist approach, and yet they apply the approach to some topics only.

		They consider at least one discipline they teach as suitable within its entire scope for using the constructivist approach, and yet they apply the approach to some topics only.				
		YES			**NO**	**Σ**
Teachers of technical disciplines	**YES**	3	a	b	8	11
	NO	1	c	d	5	6
	Σ	4			13	17

2×2 contingency table no. 4

At the chosen significance level $\alpha = 0.05$, the probability value was calculated (using the same expression as in the introduction): $p = 1 > \alpha$, which is why we accepted the null hypothesis and stated that **the proportion of teachers who consider at least one discipline they teach as suitable within its entire scope for using the constructivist**

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approach, and yet they apply the approach to some topics only, is identical in technical and non-technical disciplines.

The respondents agreed most frequently to the statement: *In the discipline(s) I teach, I only find several topics suitable for applying the constructivist approach to instruction*. *In teaching those topics, I do use the constructivist approach.* Overall, this response was given by 38 % respondents; 33 % of teachers of technical disciplines and 44 % of the non-technical ones.

The second most frequent response was: *I believe all disciplines that I teach are suitable within their entire scope for the constructivist approach*. *However, I only use the constructivist approach to instruction in selected topics.* Overall, this answer was given by 25 % of respondents; i.e. 20 % of the group of teachers of technical disciplines and 33 % of the group of non-technical disciplines.

A total of 17 % respondent chose the answer: *I believe that at least one of the disciplines I teach is suitable within its entire scope for using the constructivist approach*. *However, I only use the constructivist approach to instruction in selected topics.* 20 % of those were from the group of technical disciplines and 11 % from that of the non-technical ones.

The respondents have been invited to explain their answers.

I believe all disciplines that I teach are suitable within their entire scope for the constructivist approach to instruction. However, I only use the constructivist approach to instruction in selected topics.

One of the reasons given was that the teacher was unable to implement the constructivist instruction in the particular subject, although he/she considered the entire subject as suitable for this approach. Problems in applying the constructivist approach were reported for lectures. The teachers also expressed the opinion that the difficulty may lie in the teacher's view of the discipline rather than in the discipline per se. Where multiple teachers took part in the instruction of a particular discipline, the reported reason was that the other teachers could not be persuaded to agree with changes to the familiar form of instruction. Where teachers feel inadequately competent in a particular topic, they tend to use more instructivist approach. However, they expressed the belief that over time they would be able to adopt the constructivist approach, as with other topics. Other reasons included time pressure and a multitude of topics that had to be addressed.

In the discipline(s) I teach, I only find several topics suitable for applying the constructivist approach to instruction. In teaching those topics, I do use the constructivist approach.

The main reasons given by the respondents were the nature of the discipline(s) taught, the system of instruction set up by the guarantors of the subject and the general strength of the higher education teaching tradition.

I believe that at least one of the disciplines I teach is suitable within its entire scope for using the constructivist approach. However, I only use the constructivist approach to instruction with selected topics.

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In the seminars in the "Case Studies" subject I can employ various new methods of mine, as well as new exercises. As for the "Electrotechnical Materials and Environment", the subject comprises a prescribed schedule of seminars which we have to follow, as required by the subject guarantor.

It is particularly the "Management of Industrial Enterprises" subject where constructivism and discussions with students can be applied during the initial lessons focusing on theory. By contrast, the subject which, in my opinion, is the least open to constructivism is "Computer Skills 1" which focuses on describing how to operate software programs and on checking homework. In regard to constructivist elements, I see the greatest obstacle in their time-consuming nature, which is why I do not use them very frequently.

DISCUSSION

The explanations given by the respondents in the semi-closed-ended questions suggested that although some teachers considered all disciplines they taught as suitable within their entire scope for application of the constructivist approach, they only used it in selected topics. This had multiple causes:

- Time pressure and a multitude of topics which had to be addressed,
- Doubts about how to perform constructivist instruction within the entire scope, namely in lectures,
- Impossibility to persuade colleagues who took part in the instruction to adopt changes to the familiar way of instruction,
- Preference of the instructivist approach in topics with which the lecturer has had only short experience and had less confidence.

Other barriers to the use of constructivist approach to instruction seen by the respondents included the system of instruction set up by guarantors of the subjects, the overall strength of the tradition of higher education teaching and the nature of the discipline taught.

CONCLUSION

The preliminary survey revealed a positive finding: the answer "yes" to the question whether their completion of the "Constructivism in University Education" course has had impact on their subsequent teaching activity in higher education was given by 41 % of respondents and the answer "generally yes" was given by 59 % of respondents. The proportion of teachers who reported that their completion of the course has had a definite influence on their subsequent teaching practice was identical in both technical and non-technical disciplines. In 2014, this questionnaire verified in the present pilot survey will be used for questioning all 106 course participants at four partner institutions.

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Didactic Aspects of Technology of Support of the Multimedia Creation in the Engineering Education

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Abstract

Technical courses are taught with the support of the computer directly to the project encouraged the teaching of its concept. Very few activities in our textbooks and methodologies but surprisingly it allows. In doing so using their own teaching pupils or projects managed by the teacher brings many positive elements in the education and upbringing of the individual. In particular, the ability to plan their training activities, as well as be consistent, proceed with the task, despite the difficulties, learn to work in a team (collaborate, communicate , share work), plan their activities. If you are integrating information technology thus help shape the student who will have developed all these skills , we made for himself, probably more than we could have learned it by heart all content. If e-learning is characterized by electronic support the learning process, we introduce analogy for direct instruction supported by information technologies identified by the e-learning. If you use it in the computer network, we are talking about online teaching. Information technology in school issues bring new teaching organization.

Keywords

Engineering education. Multimedia creation. Support of technical modelling.

INTRODUCTION

The relationship between theory and its practical application in the education of constant challenge. Teachers see the meaning of their work to teach students how to apply the theory learned in different contexts, in virtually any situation induced to simulate aspects of the real world, focusing on their future work. Students benefit from the experience gained, are able to react to new situations and develop new concepts and re- use lessons learned to facilitate understanding of new problems. Students learn to solve new problems of a technical subject (e.g. physics, chemistry, etc.) and advanced technology using high-performance hardware. So they will be able to effectively apply its current products in research and development, while well understand the technical subject while to become professionals in the field of computer science, acquire the qualification specified in the top research centers and companies, and for future teachers with experience gained reflected in the quality of teaching in the performance their profession (Balogh, Turčáni, Burianová, 2010). Particularly in technical subjects, emphasis is placed on practical teaching and learning as a tool for implementing the "learning by

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doing" (learning activities). This approach, along with "experiential learning" are usually used to draw attention to different aspects of learning (Milková 2011).

Table 1 Changes paradigms of teaching under the influence of integration of information technology into teaching

OLD PARADIGM	**NEW PARADIGM- ICT support**
Teacher-centered instruction.	Student Student-centered learning
Single sense stimulation	Multi-sensory stimulation
Single path progression	Multi-path progression
Single media	Multimedia
Isolated work	Collaborative work

Modeler may vary in their work environment, a user interface, general principles of spatial modeling remain equivalent. Application software to meet the particular creative tools. Parametric models are formed through sketches and volume or area of structural elements. Their definitions should be clear without Redundant or contradictory information possible solutions usually there are more (Milková, 2012). The students are placed considerable demands in the areas of logical thinking and spatial imagination. In that involves a number of opportunities for the application of alternative methods of teaching, problem and project-based teaching, creative development and teamwork. Learning to solve problems (Hubalovsky, 2011) lies in the fact that the student acquires the ability to independently search procedures and solution strategies and decisions in alternative situations.

MULTIMEDIA SUPPORT TECHNICAL MODELLING

Applying multimedia supports allows the improvement of the teaching process. For example, graphical symbols representing links sketch entities or value of parametric dimensions are relatively small and usually cannot be together with other entities desktop visually increase. For a graphic description of the work and views of details is a precondition record images in high resolution. Apply on- line technology is due to significant data rates limited by the parameters of the network connection. High-speed networks enable continuous transmission of high-definition video streaming between the source and the end user. Another alternative is to transfer through the "video on demand". Digital technology allows the reproduction of audio-visual recording stored on an optical disc using a computer or TV and players, their application is therefore wide. The transmission media such as disk image (usually a data format ISO) between the client and the FTP server is also possible, which is beneficial for students such as distance learning (Voborník, 2008). Self -visual recording can be realized through video cameras and other necessary technical means. An alternative is to use a system for recording lectures and making available such as Sonic Foundry Mediasite. Such a system, however, is more suitable for recording lectures in which they are presented through computer static visual materials. For the record lectures using animations or movies or presentations that include demonstration of computer software (Hubalovsky, 2012). The preferred application of

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other technologies. Proper lighting people lecturer is required to record his image, but may affect the quality of simultaneous visual presentation.

Alternative technologies for creating multimedia applications

Adobe Captivate is a potential tool for creating interactive educational multimedia and simulation run and operate various software applications. While working in an environment modelers are stored picture of his desktop and events from the keyboard and mouse. In edit mode, you can record an image of the desktop to expand the voice-overs , text labels , bitmap images in a variety of data formats, audio-visual sequences in Microsoft AVI (audio video interleave) , a simple vector graphics, Microsoft PowerPoint presentations and possibly some interactive elements (buttons , links , etc.) . The resulting work can be saved as a self-running application (Windows executable), or Microsoft AVI file format supported by Macromedia Flash (SWF, FLA, FLV). It can be shared via the web interface or FTP (file transfer protocol) server. The advantages of this option are the minimum requirements for user knowledge in the fields of computer graphics and multimedia. Captivate is also compatible with learning management systems (LMS). Image capture desktop computer can be through other software tools (e.g. TechSmith SnagIt, Hyperionics Technology LLC Hyper-Cam etc.) to form a compressed visual sequences in the Microsoft AVI format without high demands on data free hard drive space.

DIDACTIC ASPECTS OF APPLICATION OF MULTIMEDIA SUPPORT IN MODELLING

Science systems thinking attempts to illustrate that events are separated by distance and time and that small catalytic events can cause large changes in all complex systems. System approach is method which increase to attention and simultaneously, also motivation; method supports objectives of research (Hubalovsky, Musilek 2013). Parametric modelers may use different environments and user interfaces, but the general principles of parametric modeling are similar. The relevant software application is mostly used as another creative tool. Models are created through sketching and through volume or spatial constructional elements. They must be clearly defined, without any redundant or contradictory information. There are always several solutions. Technician must be able to deal with difficult and demanding logical tasks and must be able to use spatial imagination. This offers many opportunities for the application of alternative teaching methods, problem and project teaching techniques and the development of creative teamwork. The art of learning to solve problems lies in the fact that the student-technician acquires the ability to independently seek solutions and strategies and to make decisions in alternative situations.

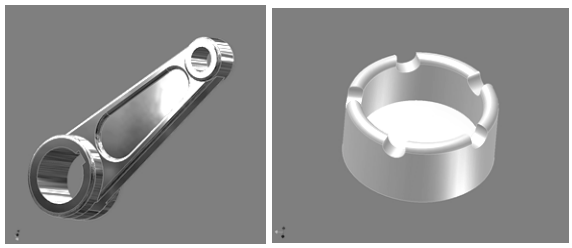


Fig.1 First step of system approach in modeling: free creation of the model

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In order to strengthen cross-curricular relations, the Secondary School of Applied Cybernetics in Hradec Kralove introduced project teaching classes. One of the projects realized by the school is called the Virtual tour of objects. The technology of virtual reality is based on various fields such as programming, computer graphics, mathematics, but also on various artistic fields.

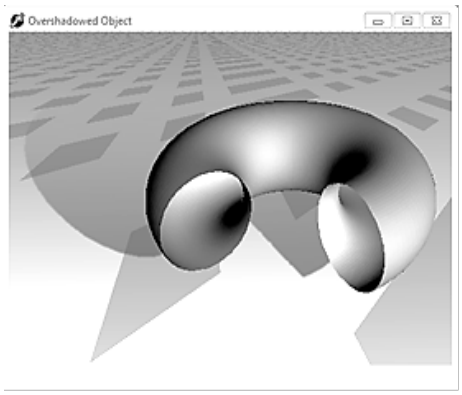


Fig.2 Next step of system approach: parametric modification of an object with realistic design and effect lighting

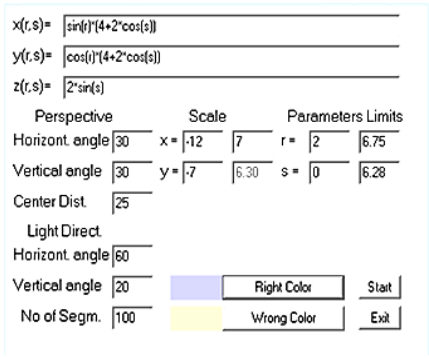


Fig.3 Programming table of parametric modification of an object with realistic design and effect lighting

Therefore, the above-mentioned project involves students focused on these fields of study. Students of the Computer Graphics class undergo classical art training and courses, which teach them the basics of computer graphic technology. Participants in the project are organized into two groups including future experts of various disciplines. Some are technically oriented (e.g. programmers) and others are artists. To achieve creative cooperation between these groups of students is not always an easy task.

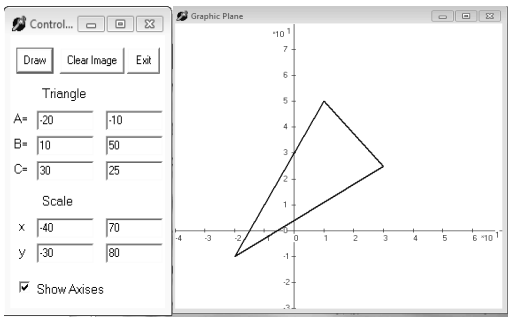


Fig.3 Own using of mathematical tools in creation of parametric mathematical models

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Own creating simply mathematical tools are the last step in the understanding of the principles of the creation of graphical objects. Own work on the basis of the game with the objects created motivation: How software creates graphical objects?

Product Lifecycle Management System in the role of the LMS learning

PLM - Product Lifecycle Management is a management philosophy of a management of a life cycle of any product. The process is carried out through systems based on the capabilities of data storage, sharing, security and definition of information flows. PLM system enables the integration of a wide range of data formats, including the option of viewing them. The ability to define the processes according to specific requirement creates the potential to promote teaching. In practice, PLM tools are deployed primarily in technical fields for management of development and production data. As a graduate of a technical field will start in practice, it is very likely that its activities will be closely associated with the use of instruments featured. In the present study, the product is a virtual prototype of the pupils' project. The case study is an example of distribution of educational materials, simulations, model CA data, but also the instructions of a teacher - a project coordinator who has the opportunity to monitor all activities in near real time and respond through the system, including the diagnosis of specific outcomes and their assessment. The data sets can be archived, viewed and analyzed retrospectively. The operator PLM system through a Web interface provides the access to the application for the use of independent of a school locality or workplace.

Entering a CAx / PLM project is based on actual needs, in accordance with a thematic plan of a subject or a course. This may be a short-term project aimed at acquiring skills for implementation of a particular procedure or set of procedures related to the sub-task. On the contrary, it may be a large project such as the nature of coursework or term paper. In all cases, the activities associated with the use of PLM in the role of the LMS are identical. The main objective is the distribution of educational materials in the form of an electronic text and image materials, videos and sample solutions. Nonlinearity of access to individual thematic units can join the project designed with educational materials related to various problematic solution. PLM can be characterized primarily as a database system, extended by the possibility of defining the processes of information flow and communication. The ability to define processes according to specific requirements can customize the application for control of data and management of information flows in solving of large and complex sub-tasks. For solving of students' problems, this characteristic is beneficial for the teacher - a project consultant, but also for the student - a solver of the project. The study shows the potential to support work on technical projects, specifically of engineering field. In this area, PLM applications are mostly used and performance and environment of this area are also mostly adapted. One such example is the ability to integrate most popular formats of data files, including a CAx data and ability to link databases with the appropriate applications. The ability to customize applications for specific PLM industry can also be used for support of education on projects such as economic or scientific disciplines. For working on engineering-oriented projects, the following features, based on experience and needs of engineering practice can be used:

- The use of a database of standard components implemented across all projects.
- The use of a database of its specific components and making them available for other projects.

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- Creation of technological processes using the database processes.
- Visualization of 3D data from different systems without the necessity to own a license of a CAx tool.
- Rating of projects through tools of the approval and change management.

The use of PLM applications puts higher requirements for qualification of teachers and a system administrator. You can argue why not to use some of the known e-learning applications, or Internet or intranet sites. There are following benefits of PLM tools for students:

- Introduction to the category of tools used in practice.
- The possibility of defining of processes of a check of ongoing and finished projects.
- Obtaining patterns for naming conventions associated with the organization of project data.

The use of PLM tools brings also certain challenges that may hinder its overall deployment to support teaching. Unlike CAx tools this category of applications is not of strategic importance in the education sector for suppliers, and thus there are currently no licenses for academic purposes. On the other hand, the costs are lower than in the case of graphical systems. But there is a possibility to multiple rent the application for solving of e.g. a semester or a year project. Acquisition of tools can be supported by funds from grants, or engineering companies in the region may participate in which graduates find their professional application. Other difficulty can be a qualification of teachers. Operating with this instrument is, however, significantly easier than for example working with CAD applications. Training to acquire sufficient skills to use is a matter of not more than one day for teachers and for students. PLM environment of the learning project is shown in Fig.4.

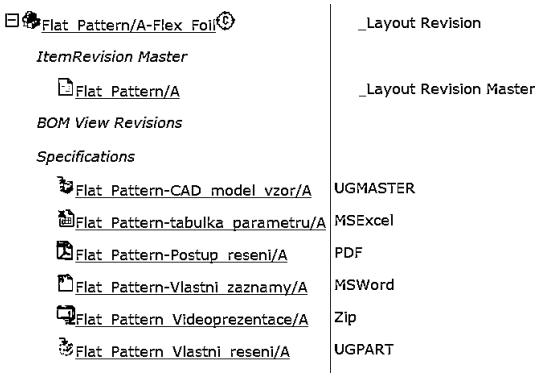


Fig.4: File of datasets specific to the learning PLM project.

Comprehensive application of the PLM philosophy for the support of project education, which combines the full-and part-time teaching is the subject of an investigation carried out at secondary industrial school and colleges.

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RESEARCH STUDY

The development of knowledge and skills of students is tested on two parallel groups of students. Students in the experimental group drew up designs using CAx tools with the support of PLM applications for data management and with the possibility of obtaining relevant information for projects. Teaching materials are integrated within PLM applications and their accessibility is nonlinearly controlled by a process defined in an application in PLM. Students of the control group worked only with the use of CAx applications, without the use of PLM systems. Deployment of PLM system has a proved beneficial in three aspects, important for achieving of the objectives of studies of students and also for their applicability in practice. Experiment results show the growth of motivation of students for study, particularly in connection with the generally perceived lack of relevant learning materials. Controlled access to text and video materials, with the current ability to preview undertaken and completed projects of virtual prototypes showed a significant increase of knowledge of issues in engineering of students. This was verified by tests of knowledge. Knowledge of PLM tool also significantly affects the adaptability of graduates after their move into professional practice. Evaluation of selected results of 162 respondents is shown in Fig. 5. In particular there are monitored parameters of connection of school and industrial environment.

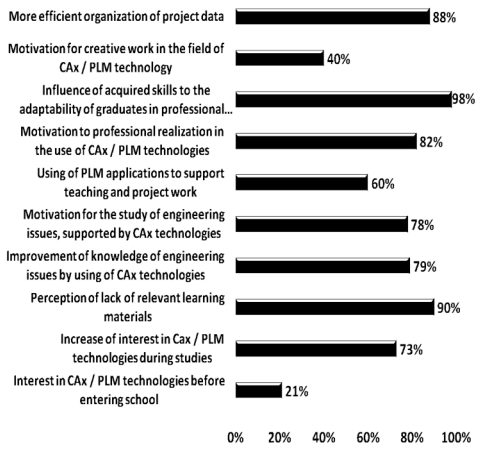


Fig.5: Selected results of positive attitudes of pupils to education, supported by the CAx / PLM technologies.

CONCLUSION

In the literature states that a person reportedly has quite creative skills of visual thinking, think not with words, but through visual images. Visual thinking is primarily used in abstract technical disciplines. The perception of visual information represents the largest share of the overall perception of all senses. Visual presentation draws attention, arouses interest and helps conceptualization. Interpretation coupled with practical demonstration is effective. Many concepts and ideas can be (Milková, 2012) understand visually rather than verbally as practical skills.

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Conceptual Issuses of the Digital Competence Development in the Framework of the Council of the European Union

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Abstract

In a view of rapid development of technologies that are entering each sphere of modern human beings, the digital competence is considered as one of the key competences required for successful employment and well-being. But in spite of the urgency conditioned by the fact, that almost all jobs in the future will require at least basic digital skills, many school pupils still lack access to the digital technology and content needed to acquire them, and a large number of adults lack digital skills altogether. The problem turns to be even worth because school administrators, curriculum developers and educators tend to be exposed to insufficient information regarding main streamlines and strategies of digitally–enhanced learning and training which would provide their students with appropriate content through correspondent tools and techniques. The current study delivers an overview and analysis of the recent legal statements and publications of the Council of the European Union concerning the digital competence, educational proprieties with the reference to the digital competence and appropriate skills, directions and strategies of their development in the European educational establishments. In the discussion of the results obtained it is admitted that ICT are generally seen as crucial gateway to better learning and more effective teaching, and indeed ICT should penetrate further in all levels of education. However, the real criterion should be the quality of resulting learning effects after all. The results of the research can be implemented in a process of elaborating research frameworks, training programs and curricula purposed to enhance students' digital competence and adaptability to the ever changing demands of the labour market and globalized society.

Keywords

Digital Competence. Education. The Council of the European Union. Technology.

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INTRODUCTION

Nowadays modern society is undergoing drastic processes of reformation and reorganization at all levels of its functioning. Developmental economic processes occurring in different countries, inconsistency of their economic levels and political disturbances are among the factors that lead to the growth of migration in the world and Europe itself.

As it was estimated, one person in five among the EU working-age population has low literacy and numeracy skills, a factor which seriously limits their employability (Conclusions on Efficient and Innovative Education and Training to Invest in Skills, 2014). Despite of a certain progress in unifying levels of education, transparency of learning purposes and outcomes much still remains to be done to reverse the impact of the crisis and to tackle underlying structural problems. (See the NMC Horizon Reports).

A great number of discrepancies can be observed when assessing students' competences and their capabilities to meet demands of the labour market, moreover when we deal with applicants with different cultural and educational background.

While training programs tend to become more simplified, and the assessment of learning outcomes is likely to lower the complexity of its procedures and criteria, the labour market put forward its own demands based on the needs of the rapidly developing industry and technologies (Levi, 2010). Therefore, the overall conclusion is that students' ICT competencies have even a greater impact on their position on the job market compared to their actual level of domain knowledge (See the Report by the EIT ICT Labs).

To achieve the growth potential of these technologies the workforce must be equipped with the adequate skills, especially since the emergence and rapid development of new technologies could lead to significant skill shortages and mismatches (Digital Competences In The Digital Agenda, 2012).

At the same time there are indications that many school pupils still lack access to the digital technology and content needed to acquire them, and a large number of adults lack digital skills altogether (Conclusions on Efficient and Innovative Education and Training to Invest in Skills, 2014). According to the recent calculations conducted by the European Commission over 50% of Europeans use the internet daily, while 30% have never used it at all. Disabled persons face particular difficulties in benefiting fully from new electronic content and services. As ever more daily tasks are carried out online, everyone needs enhanced digital skills to participate fully in society (Digital Agenda for Europe, 2014).

In a view of such circumstances the Council of the European Union claims that there is an urgent need to address the key challenges of youth unemployment and inadequate skills levels (Conclusions on Efficient and Innovative Education and Training to Invest in Skills, 2014). EU education and training systems are expected to play a fundamental role in ensuring that young people and low-skilled adults acquire skills and competences that match the needs of today's labour market (Conclusions on Efficient and Innovative Education and Training to Invest in Skills, 2014). Among them digital competence is of the prime importance, because as the forecasts suggest almost all jobs in the future will require at least basic digital skills (See the European Digital Agenda).

Regarding the topicality of the problem, and a necessity of elaborating a new paradigm of training with the emphasis on the competences required by the modern labour market, it is urgent to overview and analyse recent statements and publications of the Council of the

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European Union, in order to define conceptual issues of developing digital competence as a main instrument required for a person's successful functioning in a modern society.

The research concerns the digital competence, educational proprieties with the reference to the digital competence and appropriate skills, strategies of their development and directions of their implementation in the European educational establishments.

The statements analysed and laid out in the paper can be implemented in a process of elaborating research frameworks, training programs and curricula purposed to enhance students' digital competence and adaptability to the ever changing demands of the labour market and globalized society.

METHODS

The research was conducted by the methods of the literature review analysis, which included an overview of recent publications approved and promoted by the Council of the European Union as a legal basis for reformation of education and further development of training programmes in educational establishments of different levels.

RESULTS

What is digital competence?

As it is known in 2006 the European Parliament and the Council (2006) published a recommendation identifying eight Key Competences for Lifelong Learning among which Digital Competence was pointed as a fundamental basic skill. In 2010 the value of this recommendation was approved in the Europe 2020 Strategy (European Commission, 2010).

According to the definition provided by the European Parliament and the Council (2006), Digital Competence involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet." (European Parliament and the Council, 2006).

On the bases of the analysis of the recent frameworks of the digital competence studies, it is defined as the set of knowledge, skills, attitudes (thus including abilities, strategies, values and awareness) that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning, socialising, consuming, and empowerment (Ferrari, 2012).

Being digitally competent today implies the ability to understand media, to search for information and be critical about what is retrieved and to be able to communicate with others using a variety of digital tools and applications (Ferrari, 2012). All these abilities belong to different disciplines: media studies, information sciences, and communication theories.

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The need for Digital Competence covers much more that technical skills and can be presented in 7 areas (Figure 1).



Figure 1: Main areas of the digital competence (after Ferrari, 2012).

Current State of the Digital Competence Development in EU Countries

Evaluations conducted in 2011 allowed eliciting the following data and specifics of the digital competence development among different groups of European population (Digital Competences In The Digital Agenda, 2012):

- In 2011, 73% of EU 27 households had access to the internet, a 3 percentage point. Increase over 2010.
- A lack of skills is the second most important reason for not having access to the internet (after lack of interest) and it has increased in importance compared to 2008 by 9 percentage points. From a cross-country perspective, more than 1 out of 2 households without internet access in Cyprus, Estonia, Latvia, Portugal, Slovenia, and Slovakia reported a lack of skills as a reason for not having internet access at home.
- In terms of different levels of digital skills, on average 14% of Europeans have low level computer skills, 25% have medium level skills and 27% have high level skills. At the same time, 30% of Europeans have low level internet skills, 32% have medium level skills and 11% have high level skills. These figures have not changed significantly over the past 2 years, increasing by only 2 percentage points.
- Countries with a higher rate of regular and frequent computer or internet users tend to have a higher rate of medium and high-skilled people.

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- Only 1 out of 3 students in Europe are taught by teachers for whom participation in ICT training is compulsory.
- Only 53% of the labour force said is confident that their level of computer and/or internet skills are sufficient if they were to look for a job or change job within a year. The Nordic countries, the Netherlands and the UK have levels of confidence in skills at or above 70%..
- Age, gender, and education remain the key challenges. Older people as well as those with lower levels of education tend to have lower level digital skills and the same is true for women in comparison to men. As a result, 'skilling up' European citizens requires a set of specific strategies that will address age, educational and gender gaps.

It is stated that the level of the digital competence development is caused by the factors that can be presented in three groups: environmental factors, individual competence, and personal attitudes (Digital Competences In The Digital Agenda, 2012). An overview of the factors in each group is presented in the table (Table 1).

Table 1: A Conceptual Framework of the Digital Competence (Digital Competences In The Digital Agenda, 2012).

Environmental Factors	Access to ICT	Computer
		Internet
		Mobile devices
		Etc
Individual Competence	Operational Skills	Basic computer skills
		Basic internet skills
	Active application to aspects of life	Work / Professional
		Learning
		Communication
		Participation in society
		Leisure
		Collaborative networking
Personal Attitudes	Personal Attitudes	Critical/reflective use
		Responsible use
		Legal and ethical principles
		Confident use
		Creative use

Due to the recent data more people are going online than ever before (70%) and most are doing so every day (59%). Furthermore, disadvantaged people are catching up with the average population in terms of their use of the internet (54%) and the target for internet use by this group will also most likely be met (Internet Use and Skills, 2013).

Surveys conducted in schools of Europe made it possible to confirm that ICT provision and use in European schools is improving but several obstacles remain:

- Teachers still believe that insufficient ICT equipment is the biggest obstacle to ICT use in many countries.
- Whilst teachers are using ICT for preparing classes, ICT use in the classroom for learning is infrequent.

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- Teacher training in ICT is rarely compulsory and most teachers devote spare time to private study.
- Students and teachers have the highest use of ICT and ICT learning-based activities when schools combine policies on ICT integration in teaching and learning.
- Most schools still don't have an overarching policy of ICT implementation in learning and teaching. Therefore, teachers generally believe that there is a need for radical change to take place for ICT to be fully exploited in teaching and learning (Survey of schools: ICT in Education, 2013).

Targets and Actions to Develop Digital Competence

The digital agenda and innovation policy take on growing importance. We should review developments, with a view to completing the digital single market by 2015 as agreed. Further progress in the Union's innovation policy will also bring great benefits for the European industry (The way forward for the European Council up to 2014, 2012).

Analysis of the Conclusions on Efficient and Innovative Education and Training to Invest in Skills (2014) allows defining the following priorities in the area of the digital competence development.

Firstly, focus on:

- Facilitating as far as possible long-term investment in the modernisation of education and training and the development of skills at both national and European level, while placing greater emphasis on the efficiency and quality of educational investment.
- Equipping people in all age groups with better and more relevant skills, notably by strengthening lifelong learning and promoting equal opportunities for access to quality education and training, including for learners with disadvantaged backgrounds.
- Continuing - in cooperation with relevant stakeholders - to modernise and improve educational methods on the basis of the latest research, and making full use of the opportunities offered by digital learning, including - in accordance with national circumstances – by: a) supporting educational institutions in improving their capacity – and, where appropriate, investment in ICT infrastructure – so as to exploit the potential of new technologies and digital content, including massive open online courses; b) promoting more diversified learning experiences which blend face-to-face and digital learning methods; c) encouraging initial teacher education and continuing professional development to explore the use of digitally supported teaching methods.

Secondly, it invites the member states to:

- Continue efforts to improve the acquisition of key competences and to decrease the share of low-achievers at school.
- Promote the acquisition of basic skills, as well as the adoption of re-skilling and up-skilling measures through strengthened lifelong learning, with a focus on the low-skilled.

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- Explore how transparency and recognition instruments in formal education could also cater for new forms of learning, including the validation of skills acquired through quality web- based learning.
- Support education and training institutions in exploiting the potential of new technologies and digital content as a complement to traditional educational approaches and with a view to meeting the needs of different learners, including those with disadvantaged backgrounds.
- Support teachers and school leaders in acquiring a high level of digital skills and adopting innovative teaching practices, for example through flexible training, incentive schemes, and updated curricula for teacher education.

Thirdly, it invites member states and the commission to:

- Strengthen the contribution of education and training to the EU agenda for growth and jobs by making more efficient and effective use of investments in order to raise skills levels, improve learning outcomes and address skills shortages.
- Encourage partnerships at national and European level between creators of educational content with a view to increasing the supply of quality Open Educational Resources and other digital educational materials in different languages, whilst paying due regard to copyright and licensing issues.
- Further exploit the eTwinning platform and make use of the new Open Education Europa portal as a reference point for existing Open Educational Resources produced in the EU.
- Follow up on the November 2013 Council policy debate by organising a summit on the challenges posed by new technologies and Open Educational Resources, particularly as regards quality assurance and the assessment and certification of skills acquired through new modes of learning.

Fourthly, it invites the Commission to:

- Promote an open public debate in the context of the consultation on the European Area of Skills and Qualifications on the impact of new technologies and digital content in current practices and EU instruments and policies, including issues such as quality assurance, assessment and certification."

The European Commission has today adopted new priorities for the digital economy and society which are laid out in the Digital Agenda for Europe (2010). The Digital Agenda for Europe was adopted in 2010, as an integral part of the Europe 2020 strategy, to stimulate the digital economy and address societal challenges through ICT. The European Council and the European Parliament have since called for further strengthening of the European digital leadership and completion of the Digital Single Market by 2015 (European Council conclusions of 1/2 March 2012).

Nowadays the Digital Agenda for Europe (2014) defines the following actions to enhance the digital competence of the European population.

- Prioritizing digital literacy and competences for the European Social Fund
- Developing a framework to recognise ICT skills
- Prioritising digital literacy and skills in the 'New skills for jobs' flagship

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- Increasing participation of women in the ICT workforce
- Educating consumers on the new media
- Establishing EU-wide indicators of digital competences
- Evaluating accessibility in legislation
- Ensuring the accessibility of public sector websites
- Helping disabled people to access content
- Implementing digital literacy policies in Member States
- Implement provisions on disability in Member States
- Mainstreaming eLearning in national policies of Member States
- Establishing Grand Coalition for Digital Jobs and Skills

DISCUSSION

The results of the research allow confirming the fact of the further penetration of ICT into all the spheres of the human life.

Conceptual foundations of the digital competence as the notion, its definition and structure which consists of the subcategorized skills successfully develops on the basis of the statements of Recommendation of the European Parliament and of the Council on Key Competences for Lifelong Learning (2006).

The development of the notion of the digital competence and its components has found its continuation in numerous research projects (Ferrari, 2012). In spite of the certain inconsistency in the terminology which authors use for denoting the main object of their research, all of them are aimed at investigating the current status of the digital competence in different social groups, factors and mechanisms of its development.

Despite the fact of the considerable progress in the overall ICT implementation in all the spheres of the human life, definite discrepancies in the levels of the digital competence development can be still observed. First of all, these are students and grownups from educational establishments where ICT has not come into use as an indispensable tool for achieving learning and communication purposes. Apart from subjective factors that slow down the development of the digital competence, there are factors which root in the general policy of the institution and inconsistency of the strategies of implementing digital technologies for learning and teaching.

There is also an urge to provide an equal access to the digital technologies as well as the training to use them for people with disabilities and low-skilled adults in order to facilitate their adaptation to the society and provide possibilities for their personal realization.

Simultaneously it should be admitted that ICT are generally seen as crucial gateway to better learning and more effective teaching, and indeed ICT should penetrate further in all levels of education. However, the real criterion should be the quality of resulting learning effects after all.

There is ample attention for the digital technologies in societal sectors like care, education, industry, creativity etc. So far ICT has been promoted as a goal in itself. It is

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now the moment to recognize that the digitalization has its own methods, tools and policies (formalisation, abstraction and privacy issues). It is essential that we accept digital technologies and the digital competence as catalytic rather than autonomous. The Education sector needs to have the courage now to bring forward its own priorities and innovation directions.

CONCLUSION

To conclude the findings obtained on the basis of the analysis of the cornerstone papers and statements of the Council of the European Union concerning the digital competence and its development, the following conceptual issues should be emphasized.

1. Digital competence is represented by the set of knowledge, skills, attitudes that are required when using ICT and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively for work, leisure, learning, socialising, consuming, and empowerment.
2. The realization of the digital competence occurs in such areas as information management, collaboration, communication and sharing, creation of content and knowledge, ethics and responsibility, evaluation and problem-solving, technical operations.
3. The level of the digital competence development is caused by environmental factors (availability of computers and mobile devices, access to the internet, etc), individual competence (operational skills and their active application to aspects of life), and personal attitudes (critical and reflective use, responsibility, application of legal and ethical principles, confident and creative implementation).
4. Due to the recent data more people are going online than ever before (70%) and most are doing so every day (59%). Furthermore, disadvantaged people are catching up with the average population in terms of their use of the internet (54%) and the target for internet use by this group will also most likely be met. At the same time there are indications that school pupils still lack access to the digital technology and required content, and a large number of adults lack digital skills altogether. Disabled persons continue to face particular difficulties in benefiting fully from new electronic content and services. Most schools still don't have an overarching policy of ICT implementation in learning and teaching. Teachers generally believe that there is a need for radical change to take place for ICT to be fully exploited in teaching and learning.
5. Enhancement of the digital competence is planned to be achieved by a comprehensive system of actions which include: prioritizing digital literacy and competences for the European Social Fund; developing a framework to recognise ICT skills; prioritising digital literacy and skills in the 'New skills for jobs' flagship; increasing participation of women in the ICT workforce educating consumers on the new media; establishing EU-wide indicators of digital competences; evaluating accessibility in legislation; ensuring the accessibility of public sector websites; helping disabled people to access content; implementing digital literacy policies in Member States; implement provisions on disability in Member

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States; mainstreaming eLearning in national policies of Member States; establishing Grand Coalition for Digital Jobs and Skills.

6. The results of the research can be implemented in a process of elaborating research frameworks, training programs and curricula purposed to enhance students' digital competence and adaptability to the ever changing demands of the labour market and globalized society.

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Matlab as a Tool for Bézier Curves' and Surfaces' Evaluation

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Abstract

This article deals with Bézier curves' and surfaces' modeling as a part of e-learning course of computer graphics that was created for distance, "face to face" and blended learning at the Department of Informatics, Faculty of Natural Sciences, Constantine the Philosopher University in Nitra, Slovak republic. The subject Computer Graphics is the part of bachelor study program of discipline Applied Informatics and is determined for the students of master study programs in specialization Informatics too. The content of this subject includes 2D and 3D transformations, algorithms for drawing basic graphical elements in raster graphics, fractal theory, animation, color-processing, modeling and drawing 3D objects. In this paper we concentrate on the topic from this subject content focused on curves' and surface' modeling and we describe created application in MATLAB for evaluation of Bézier curves and surfaces in Computer Graphics teaching. This application is very useful for the students because it encourages their imagination and the spatial perception. In this way it helps them to better understanding the Bezier curves' and surfaces' shape changes depending on changing control points' positions.

Keywords

Computer graphics. MATLAB. Teaching. E-learning. Course. LMS Moodle. Bézier curve. Bézier surface patch.

INTRODUCTION

In Slovak and Czech education regions some universities are creating their own learning and management environment (Technical University of Liberec, Masaryk University in Brno), but most of the universities combine learning using one of the number of commercial or free LMS. They use products such as Claroline, Fle3, MS Class Server, ILIAS, WebCT, Enterprise Knowledge Platform, Eden, LearningSpace, eAmos, eDoceo, Uniforms, uLern, Aspen, Oracle iLearning, NETOPIL School and Moodle (Cápay, 2010). As the best "investment" to the future seems to be an LMS Moodle which is increasingly appearing also in secondary schools too. The reasons are its good price, continuously development and active community (Balogh and Turčáni, 2011).

At our university we use LMS Moodle as an central environment for five faculties and all departments. In last few years there were created many courses for supporting

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teaching and also for testing process, for example a course created at the Department of Informatics, Faculty of Natural Sciences (Cápay et al., 2011).

The article describes one of these courses, especially its topic dealing with curves' and surface patches' modeling, and MATLAB which was selected as an environment suitable for the visualization of curves and surfaces in Computer Graphics teaching.

SUBJECT COMPUTER GRAPHICS

Subject Computer Graphics is determined for the second class students of the bachelor study program, discipline Applied Informatics in a full-time and part-time study and for the first class students of master study programs in specialization Informatics in full-time study, too. This subject is taught at the Department of Informatics, Faculty of Natural Sciences, University of Constantine the Philosopher in Nitra as a compulsory subject.

Students of enumerated study branches have one lesson of lecture and two lessons of practice per week which is a typical weekly hour allowance for the subjects with final grade examination.

The Computer Graphics subject enables to understand that graphic program systems serve for graphical output creation; to understand fundamental methods used in computer graphics; to understand fundamental computer graphics algorithms and joins the theory with its the practice comprehension. Every student is required to be enrolled into the online course because it provides students the study of electronic study materials, tests, questions and tasks (Cápay and Tomanová, 2010).

The content of the subject is identical for all study forms and includes following themes (Cápay and Tomanová, 2010):

7. Introduction to computer graphics: history, fields of its using, fundamental terms and definitions, bitmap and vector graphics.
8. Color processing: color intensity, saturation, lightness, brightness, hue, color mixture, color models RGB, CMY, HSV, HLS.
9. 2D transformations: homogenous coordinates, translation, rotation, scaling, symmetry, skewing, composition of the transformations.
10. Line rasterization: analytical representation of line, DDA algorithm, Bresenham algorithm, antialiasing.
11. Circle rasterization: Cartesian and polar coordinates, Bresenham algorithm.
12. Line and text clipping: Cohen-Sutherland algorithm, algorithm of gradual partition.
13. Plane areas filling: area types, recursive and nonrecursive algorithms, scan algorithm.
14. Curve and surface patches modeling: approximation and interpolation curves, cubic Bézier curve, cubic Ferguson curve and cubic Coons curve, Bézier curve, B-spline, rational Bezier curve, NURBS, tensor-product surfaces, tensor-product Bézier surface patches.

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15. Introduction to fractal geometry: self-similarity, Hausdorff dimension, plane fractal generating, Brownian motion and midpoint method removing.
16. Animation: animation systems classification, calculation of motion interphases, motion trajectory.
17. Introduction to 3D graphics: 3D transformations, translation, rotation, scaling, symmetry, skewing, clipping in 3D.
18. 3D modeling and projection: parallel, axonometric and perspective projection, sweeping, constructive solid geometry tree, boundary representation and filled parts of space calculation.

Computer Graphics E-learning Course

The Computer Graphics e-learning course (fig. 1) was created in LMS Moodle. The course is divided into 12 lessons. Each of the lessons corresponds to one subject content theme and provides study materials in form of texts, pictures, presentations, animations and interactive teaching support which add much more clearness into the teaching process in comparison with common computer graphics textbooks provided to students (Cápay and Tomanová, 2010).



Figure 1: Lesson 8: Curves' and surface patches' modeling demonstration.

Teaching text in pdf format is a compulsory part of each lesson. Majority of these study materials in pdf is presented during the lecture. In several lessons there is a presentation from the lecture added, to help students understand some important terms using their graphic demonstration (Cápay and Tomanová, 2010).

Each lesson provides students the animations and interactive teaching aid created in Adobe Flash, MATLAB, GeoGebra etc. They contain animations and interactive animations according to what object or transformation property should be presented.

These applications are determined for all students to work with them. The full-time students work with these applications during their lessons because its using is included in Questions and Tasks solutions. The part-time students may use them during their individual self-study and preparing for the computer graphics exam.

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All these study materials are supplemented with Questions and Tasks (Balogh, Turčáni and Burianová, 2010), mentioned above, which are discussed with the full-time students during their lessons. They are in each lesson ordered logically from simple ones to more and more complicated. During their solving students gradually construct their own partial solutions. It leads to solving the partial problems and its complex represents the solution of original problem (Cápay and Tomanová, 2010).

MODELING OF CURVES AND SURFACES

Bézier curves, named after Pierre Bézier, are fundamental curves of the most commercial systems ranging from CAD/CAM to graphic design. Bézier curves are defined for any polynomial degree, we´ll first focus on their cubic case $n = 3$, cubic Bézier curve.

In general, we define cubic Bézier curve by

$$P(t) = P_0 B_0(t) + P_1 B_1(t) + P_2 B_2(t) + P_3 B_3(t) = \sum_{i=0}^{3} P_i B_i(t), \tag{1}$$

where the 2D or 3D points b_i are the Bézier control points which form the Bézier polygon of the curve (Farin and Hansford, 2000). Commonly, the special polynomial expressions in (1) are called the cubic Bernstein polynomials (2)

$$\begin{aligned} B_0(t) &= (1 - t)^3, \\ B_1(t) &= 3t\,(1 - t)^2, \\ B_2(t) &= 3t^2(1 - t), \\ B_3(t) &= t^3. \end{aligned} \tag{2}$$

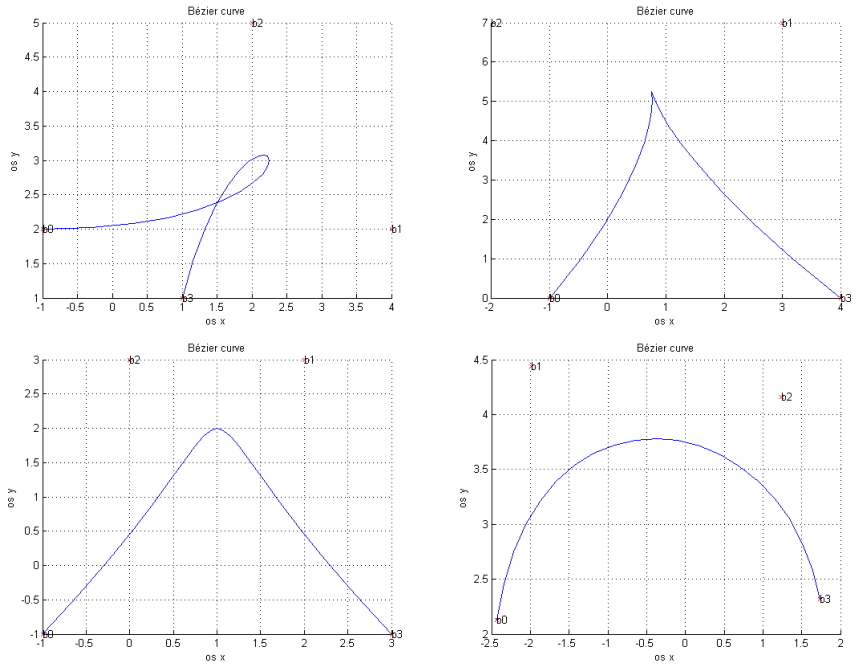


Figure 2: Several cubic Bézier curves rendered in MATLAB.

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The example of several cubic Bézier curves created in Matlab are in figure 2. For values of *t* outside $\langle 0, 1 \rangle$, the curve will typically not stay within the control points' convex hull (Farin and Hansford, 2000). See figures 3 and 4 for an illustration. This is called extrapolation (fig. 4).

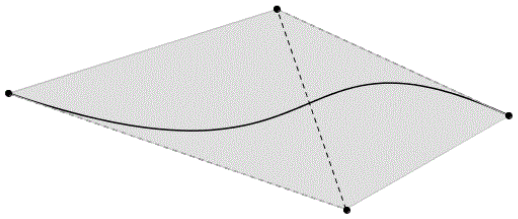


Figure 3: The convex hull property – Bézier curve lies in convex hull of its control points. (Tomanová, 2014)

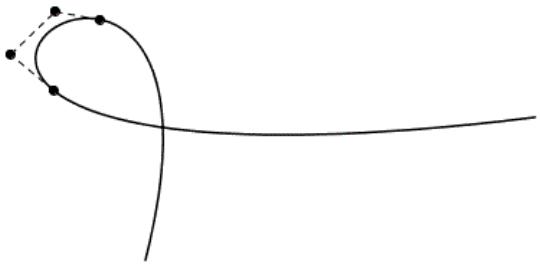


Figure 4: The convex hull property – curve doesn't lie in convex hull of its control points (Tomanová, 2014)

Some authors prefer to write Bézier curves and polynomial curves in matrix form. Using matrices we can rewrite cubic Bézier curve like this (3)

$$P(t) = \begin{pmatrix} t^3 & t^2 & t & 1 \end{pmatrix} . \begin{pmatrix} -1 & 3 & -3 & 1 \\ 3 & -6 & 3 & 0 \\ -3 & 3 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{pmatrix} . \begin{pmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \end{pmatrix} . \tag{3}$$

Rewriten using the monomial coefficients a_i this becomes

$$P(t) = \begin{pmatrix} t^3 & t^2 & t & 1 \end{pmatrix} . \begin{pmatrix} a_0 \\ a_1 \\ a_2 \\ a_3 \end{pmatrix} \tag{4}$$

monomial form of cubic Bézier curve (Farin and Hansford, 2000) where a_i are monomial coefficients which are defined as (5)

$$\begin{pmatrix} a_0 & a_1 & a_2 & a_3 \end{pmatrix} = \begin{pmatrix} -1 & 3 & -3 & 1 \\ 3 & -6 & 3 & 0 \\ -3 & 3 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{pmatrix} . \begin{pmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \end{pmatrix} . \tag{5}$$

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We have used the monomial form of Bézier curve (4) for curve evaluation in application described in the last chapter of this article.

A Bézier curve of degree *n* (Farin, 2002) is defined by (6)

$$P(t) = P_0 B_0(t) + P_1 B_1(t) + \ldots + P_n B_n(t) = \sum_{i=0}^{n} P_i B_i^n(t) \tag{6}$$

where the $B_i^n(t)$ are Bernstein polynomials (7)

$$B_i^n(t) = \binom{n}{i} . t^i (1-t)^{n-i}. \tag{7}$$

Tensor-product surfaces can be constructed from any two types of univariate blending functions. If the univariate blending functions are Bernstein polynomials, the surface is a Bézier surface patch. Let´s consider 3D points b_{ij}, i, j = 0, ..., 3. These control points define bicubic Bézier surface patch because m = n = 3 and are organized as follows (8)

$$\begin{pmatrix} b_{03} & b_{13} & b_{23} & b_{33} \\ b_{02} & b_{12} & b_{22} & b_{32} \\ b_{01} & b_{11} & b_{21} & b_{31} \\ b_{00} & b_{10} & b_{20} & b_{30} \end{pmatrix}. \tag{8}$$

The corresponding blending functions are (9)

$$\begin{pmatrix} (1-s)^3 t^3 & 3s(1-s)^2 t^3 & 3s^2(1-s)t^3 & s^3 t^3 \\ (1-s)^3 3t^2(1-t) & 3s.(1-s)^2 3t^2(1-t) & 3s^2(1-s).3t^2(1-t) & s^3 3t^2(1-t) \\ (1-s)^3 3t.(1-t)^2 & 3s.(1-s)^2 3t.(1-t)^2 & 3s^2(1-s).3t.(1-t)^2 & s^3 3t.(1-t)^2 \\ (1-s)^3 3t.(1-t)^2 & 3s.(1-s)^2(1-t)^3 & 3s^2(1-s).(1-t)^3 & s^3(1-t)^3 \end{pmatrix}. \tag{9}$$

Each row and column of control points (8) define one curve. The curve defined by control points b_{ij}, j = 0, ..., n as the i^{th} s-control curve and the curve defined by control points b_{ij}, i = 0, ..., m as the j^{th} t-control curve. Then there are m + 1 s-control curves and n + 1 t-control curve (Sederberg, 2012).

Generally, the only control points that lie on a Bézier surface patch are the corners

$$P(0, 0) = b_{00};\ P(1, 0) = b_{m0};\ P(0, 1) = b_{0n};\ P(1, 1) = b_{mn} \tag{9}$$

The corresponding blending functions for Bézier surface patch defined by control points b_{ij}, i = 0, ..., m, j = 0, ..., n are more complicated (their computation includes computation of Bernstein polynomial of degree m and n) and are used for modeling Bézier surface patch in the application.

MATLAB INTEGRATED ENVIRONMENT

MATLAB is an integrated environment for scientific computing, modeling, algorithm design, simulation, analysis and data presentation, parallel computing, measurement and signal processing, design control and communication systems. In recent years MATLAB has become the worldwide standard in technical calculations and simulations in science, research, industry and also in education. Thousands of world universities use MATLAB to

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research and improve the quality of teaching in technical computing and data analysis. Students use the knowledge gained after graduation because MATLAB is nowadays an indispensable tool in many industrial and economic sectors.

MATLAB is much more simpler programming language than Fortran and C and provides huge potential for productivity and creativity. Its the most valuable attribute is its extremely fast computational core with optimal algorithms that are checked many years by the experts of this branch worked on the top workplaces around the world. Last but not least, it is also a great advantage that MATLAB is implemented on several major platforms such as Windows, Linux, Solaris and Mac (MATLAB, 2014).

Graphics in MATLAB allows to display standard results of the calculations. There is possible to use several types of graphs: the two-dimensional functions of one variable, the three-dimensional functions of two variables, pie charts, histograms and so on. The programmer can change look almost of all graphic objects not only during its designing but after its rendering too. When using three-dimensional graphs it can be set shading (location of incident light), graphs can be animated and objects might be displayed transparently etc. Most of these effects can be achieved by several commands applying. There have been used fast rendering technologies, OpenGL or Z - buffer, there, but only in the case of being supported by user´s computer.

Images created in MATLAB graphical windows are not static. Each rendered object has an identifier which means that you can change its properties and thus the appearance of the object too. Appearance of the objects can be changed using the tools from the toolbar of the graphic window. The graphics system of MATLAB, called Handle Graphics, allows you to upload control buttons to images and so create the manageable graphical user interface (MATLAB, 2014).

MATLAB as a tool for curves and surfaces evaluation

Because of rendering of Bézier curves and Bézier surfaces we have programmed GUI application using MATLAB (fig. 5). The reason for this system selection is that it provides an interactive environment for numerical computations, visualization and programming (Koprda, 2013).

In the part *Input elements* user can choose to render Bézier curve or Bézier surface. Based on the selection mentioned above the number 4 or 16 is put into the box N which represents the minimum number of control points. To write the coordinates of control points to the matrix it is necessary to click to the button Get point coordinates and the input window appears. Pressing button Compute and draw the curve, respectively surface is drawn at the right side of the application window.

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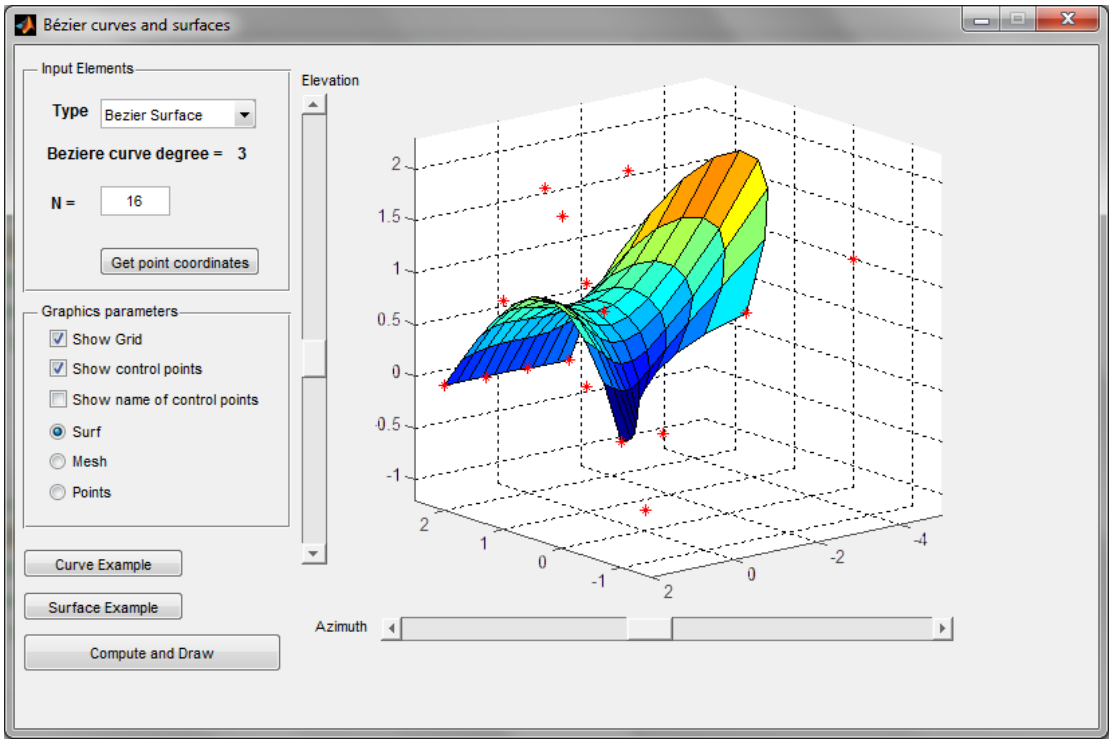


Figure 5: Bézier surface rendered in the created application.

Because of simply computing with matrices to calculate Bézier curve in MATLAB we have used relations (6) and (7). For rendering Bézier surfaces it has been used matrix of control points (8) and blending functions (9).

The user can use checkboxes in the panel *Graphical parameters* to show or hide grids, control points and the names of control points. Radio buttons placed in the same group allows setting of three different modes of rendering surfaces.

On the sides of the chart are for better visualization placed scrollbars which serve to change azimuth and elevation. The horizontal scrollbar change the azimuth angle (deviation from the y-axis) and by vertical scrollbar we can change the elevation angle (deviation from the x-axis - view of the observer).

Two function keys, not mentioned yet, located in bottom left corner, Curve example and Surface example, as it is understandable from its names, serve to rendering of Bézier curves and surfaces without user input.

Students works with this application during their lessons focused on curve and surface modeling, solve Questions and Tasks with support of this application, possibly their create their own application in selected graphic environment.

CONCLUSION

We have been using the Computer Graphics online course since 2006 (8 academic years, about 100 students per semester). During these years, the course was improved until today's version. By using of this course we have gained better view of the students' activities realized in this course during their studying and self-studying.

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Created and presented application is very important for students learning because it helps them to see how 3D curves really look like and how they behave when their control points are moved. The students can really see how curves and patches can be modified and what are the results of position change of the control points. The students may observe these changes interactively, and even they can create their own applications in selected graphic interactive environment. There are the reasons which cause that students like working with this application and it helps them in studying of this Computer Graphics topic.

Created application is relatively new, it is a part of this topic for a short time and the case study that we have realized confirmed the weak difference between the results of students educated in a traditional way without this teaching aid and of the students educated using the application because of a small research sample, we suppose. So we don`t consider this case study results to be significant enough and it is the reason that we are planning to apply testing on larger sample in next term when subject Computer Graphics will be taught and more students will be registered we hope.

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Algorithm as a Tool of Artists

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Abstract

This paper sets out its main objective to show the reader a relatively lesser known areas such as the use of informatics in the visual arts. First we will focus on description of the historical development of the visual arts, which led to the currently used terminology and classification of this field, and consequently no longer focus only on the sub-region, which is a computer-generated art. We show motives that led to their creation, mention their main founder and the artistic results. We describe several ways how interesting outcomes can be created fairly, artistically, easily and quickly with the help of Maple. We show by the implementation of developed algorithms in Maple how one of the basic IT courses is closely related, which undoubtedly is a computer graphics, with the ability to create new artistic outputs the shift in computer-generated art. We must learn to consider the aesthetics of the work in addition to using cold mathematics and software but. The resulting work can then address the viewer as well as painting, sculpture or photography. This post is aimed at teachers of computer science for inspiration for teaching, but can also reach students who are interested in combining science and art culture. However, references to mentioned visual displays can be used by teachers of visual arts.

Keywords

Algorists. Algorithm. Algorithmic art. Computer Art. Computer-generated art. Digital Art. Maple. New Media. Pipeline.

INTRODUCTION

Motivation is very important in the educative process. Motivation may be coursed by instructions, by the sequence of actions, by the vision of the application of the curriculum in practice, by interesting equipment and interesting topic or teaching. In this paper, we focus on the theme that connects computer science, mathematics and art. Such interdisciplinary connection is interesting in terms of all three disciplines, because we can discover new connections and possibilities. Students in secondary schools and universities may find that not only computer graphics is about editing files, but they can create their own artworks based on mathematical knowledge through computers. Students are also encouraged to develop aesthetic perception of the computer display. For example, Sonia Landy Sheridan, member of algorists, was influenced by images of same scientific nature like cardioid, chromosomes or diffraction.

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This post is intended to familiarize candidates with the concepts of digital art, computer art and the development of interaction between artists and computer. Another part of the paper focuses on the creation of algorists and in this respect will be given to illustrate some of the source code and outputs formed in Maple.

NEW MEDIA

New media art indicate bonding technology innovation with new forms of artistic expression. New media include a photograph, film, radio, television, satellite, video and other technologies that greatly influenced and transformed the traditional forms of art. New technology is inspired by the artistic practice of movement of the first half of the last century such as Constructivism, Futurism and Dadaism, enabled the development of kinetic art, sound poetry, new typography, while also shaped the form of post-war electronic scene. Since the sixties, we're talking about computer art too, originally focused on experiments with algorithmically generated image and sound, later characteristic cybernetic concepts of art work as an open system. (Artlist, 2006-2014)

Since the nineties, new media art identifies primarily with the creative use of digital and network technologies. Internet (net art), various software and applications for cooperation or for real time effects, advanced technology, virtual and mixed reality, computer games and other digital products of culture, or even database, visualization, wireless and mobile technology, robotics and even emerging biotechnology and nanotechnology enter into an artistic practice. (Artlist, 2006-2014)

Digital art is term under new media. Digital art is term for artistic works or practices created or used by digital technology. Digital technology transformed traditional painting, drawing, sculpture and music art. This medium allows for multiple kinds of manipulation and a seamless combination of art forms, which can lead to a blurring of the distinctions between different media. The potential for manipulation is always heightened to such a degree that the reality of ‘what is’ at any given point is constantly open to question. (Paul, 2008) The techniques of digital art are used extensively by the mainstream media in advertisements, and by film-makers to produce visual effects. Desktop publishing has had a huge impact on the publishing world, although that is more related to graphic design. (Popper, 1997)

Digital art is not the same as computer art, because digital art is a more general term. Computer art is such an art in which computers play a role in the output. Computer art is the production or display, image, audio, video, videogame, website, algorithm or gallery installation.

The following diagram shows the development of different directions of new art and current new art on Figure 1.

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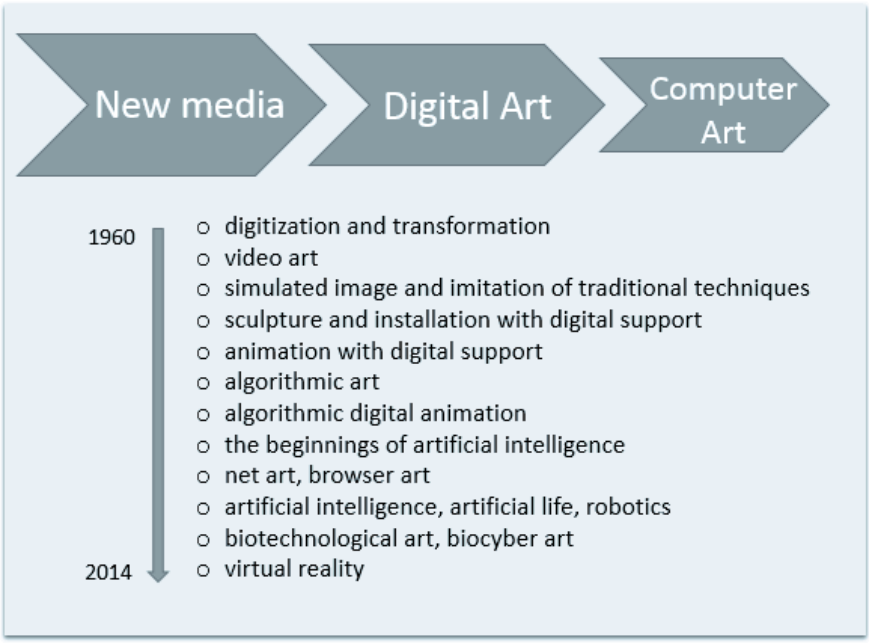


Figure 1: Schema of New Media evolution

ALGORITHMIC ART AND ALGORIST

Algorithmic art is also known as computer-generated art. Some of the earliest known examples of computer-generated algorithmic art were created by *Georg Nees* and *Frieder Nake* in the early 1960s. These artworks were executed by a plotter controlled by a computer. Creation of algorithmic art must include a process based on *an algorithm devised by the artist*. An algorithm is simply a detailed recipe for the design and possibly execution of an artwork, which may include a computer code, functions, expressions, or other input which ultimately determines the form the art will take. This input may be *mathematical*, *computational*, *or generative*. Some external factor is usually introduced. This can either be *a random number generator* of some sort, or an external body of data. Some artists also work with organically based gestural input which is then modified by an algorithm. Term used for digital artists who create algorithmic art is '*algorists*'. (Sheridan, 1983)

Algorithmic art may be found throughout history, from prehistoric basket weaving to geometric and conceptual art in the 20th Century. The advent of computers provide us with form-generating leverage and algorist artists of the late 20th Century pioneered procedures that have come to permeate the visual and sound arts in the 21st Century. Those artists who first experimented with coded artistic procedures with computers included *Hiroshi Kawano, Herbert Franke, Manfred Mohr, Vera Molnar, Edward Zajec and Roman Verostko*. (Verostko, 2013) Another important artist is *Jean-Pierre Hébert*, who in 1995 wrote an algorist manifesto, which is the natural form of the algorithm, see Figure 2.

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```
if (creation && object of art && algorithm && one's own algorithm) {
include * an algorist *
} elseif (!creation || !object of art || !algorithm || !one's own algorithm) {
exclude * not an algorist *
}
```

Figure 2: Jean-Pierre Hébert, Algorist manifesto

Yet algorithmic art should not be confused with the practice of mathematics. The process of writing the score for a drawing requires poetic engagement similar to that required for composing the score for music. Clearly programming and mathematics do not create art. Programming is a tool that serves the vision and passion of the artist who create the procedure. (Verostko, 2013) There is a selection of some of the artists and their artworks follow now. With algorists the exhibition and conference called SIGGRAPH is significantly associated. SIGGRAPH is an acronym for special interest group on computer graphics and it is one of the most popular organizations of the expanding computer graphics. (Taylor, 2013)

For example *Herbert Franke's* artwork *Oszillogramm* (1961-1962) is created by a simple analogue computer. In principle, the result is the super-position of two electronic oscillation components. The real picture is in motion, for viewing an old cathode tube oscilloscope. The photo is a slide made from the screen. The next artwork *Desert* (1997) was made with Mathematica and the graphic software Bryce. It was Franke's beginning with mathematical experimentation. His first period of producing was about generative photography, then he began to use computers and mechanical plotters. Since then, he found more and more interesting possibilities for producing new types of pictures, in 2D and 3D, and also in motion, or interactive, or in connection with music. (SIGGRAPH, 1998)

Roman Verostko maintains an experimental studio where he has developed original algorithmic procedures for creating his art. His earliest use of electronics consisted of synchronized audiovisual programs. Verostko had modified his software with interactive routines to drive paint brushes mounted on a pen plotter's drawing arm. For example, set of plotter drawings *Pearl Park Scriptures*, was produced in honour of Alan Turing. For example, Figure 3 shows *Pearl Park Scriptures – P* (2004). (Taylor, 2013, Verostko, 2013)

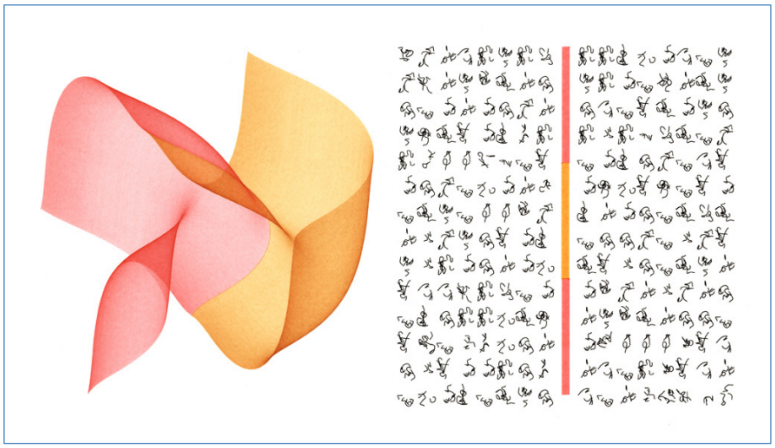


Figure 3: Roman Verostko, Pearl Park Scriptures (Verostko, 2013)

Jean-Pierre Hébert began working with conceptual algorithmic art in 1974. He co-founded algorists with Roman Verostko. Technically, Hébert's work rests on simple coding

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informed by geometry, mathematics, physics, and great attention to rendering details. Some of his concepts stem from Zen Buddhism and a spiritual approach to life. We can mention the set of artworks *Twenty-four views of the metagon* and *Ryoanji* series.

Jazz musician, *Manfred Mohr*, initially focused on gestural abstraction. He began the exclusive use of black and white as a means of visual expression. Then his art transformed form abstract expressionism to computer-generated algorithmic geometry. The influence of mathematics and music gives his work a core essence of rhythm and repetition. In 1972 Mohr turned to sequential drawings of the fixed computer-generated films. He renewed his work on the 4D hypercube in 1987. He designed and built small PCs and software *Spacecolor*, *Subsets* and *Artificiata II.* (Taylor, 2013)

SOME NEW MAPLE PROCEDURES IN THE FIELD OF ALGHORITMIC ART

System Maple has been developing during the past 30 years by group of scientists called "Symbolic Computation Group" at the University of Waterloo, but currently Maplesoft™ is a subsidiary of Cybernet Systems Co. Ltd. in Japan, the leading provider of high-performance software tools for engineering, science, and mathematics.

Maple allows to perform various types of symbolic and numerical calculations. All computations can be replenished by some texts and hyperlinks (these closed blocks are named as "worksheets"). Maple enables exporting worksheet to LaTeX, HTML, RTF and MathML, which is an extension of HTML for the presentation of mathematical texts on the web. The worksheeds can be converted in the programming languages C, Fortran and Java (Bernardin, 2011, Maplesoft, 2011).

We focus on the preparation of several algorithms from the computer art and show how it can be that easy in the Maple program with students in this chapter.

We will pursue these algorithms in order to examples how you can easily apply the teaching of computer geometry in the computer art. We have put together here in sketched several procedures in Maple, which may be a further specification of programming used to create professional works from the computer art.

We define functions **roll** and **eps** on the base of command **rand(M..N),** which generate a random integer in the range from M to N:

```
roll:=rand(0..30); eps:=rand(0..10):
```

Random colored squares algorithm

We define the command **square**, which create square with centre in point [*sx*, *sy*], length of the side *a* and with color *b*:

```
square:=proc (a, sx, sy, b)
          POLYGONS([[sx+a,sy-a],[sx+a,sy+a],
                    [sx-a,sy+a],[sx-a, sy-a]],COLOR(HUE, b))
        end proc:
```

We draw 10 000 squares with the colors randomly generated by the function i*roll()+j*roll())/6000 by this way

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```
    PLOT(seq(seq(square(1,2*i,2*j,(i*roll()+j*roll())/6000), i=0..99),
j=0..99), STYLE(PATCHNOGRID), AXESSTYLE(NONE));
```

We obtain this picture

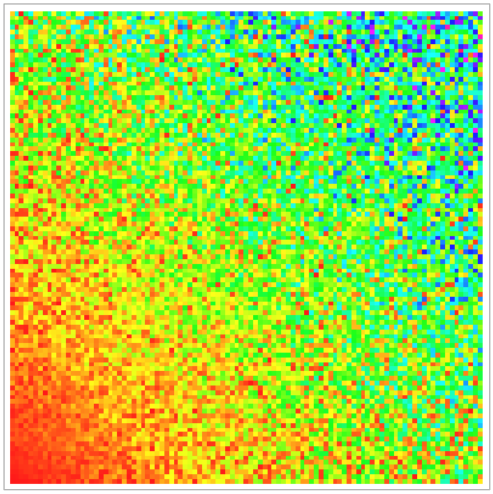


Figure 4: Picture created by Random colored squares algorithm

Random b-spline curves algorithm

We use the Maple's routine **BSpline**, which computes a piecewise function representing the b-spline of order **k** in the variable **x** for randomly generated points and we display eight b-spline curves in one picture

```
c := BSplineCurve([seq([roll(), roll()], x = 0 .. 50)], t):
v := seq( plot(c, t=0..100, axes=none,
          color=COLOR(HUE, roll()/100),thickness=floor(eps()/2)),
      i=1..8):
display(v);
```

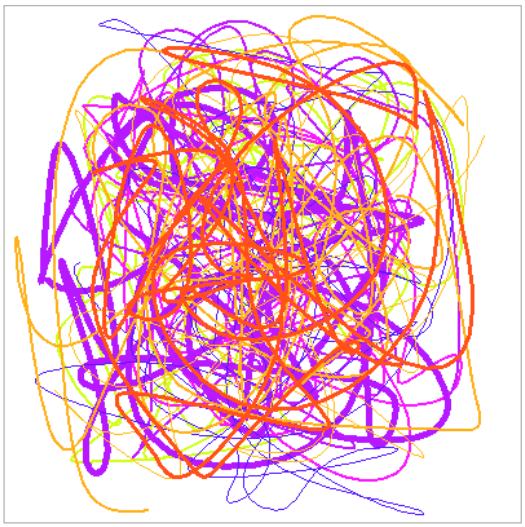


Figure 5: Picture created using Random b-spline curves algorithm

Random areas algorithm

We define the matrix *M*, which has a hundred rows and a hundred columns, and which represents the screen that is divided into ten thousand squares. Next, we define the

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procedure **Region**, which construct a random area on the basis of individual squares and then it assigns them also randomly generated color. Figure 6, which we can see below, contains one hundred randomly generated surfaces obtained using procedure region

```
M:=Array(0..99, 0..99);
Region:=proc(M)
  local barva, centrX, centrY, Dm, Hm, Lm, Pm, i, j;
  barva:=roll()/100;
  centrX:=roll(); centrY:=roll();
  Dm:= max(centrY-eps(),0);
  Hm:= min(centrY+eps(),100);
  for j from Dm to Hm do
    Lm:= max(centrX-eps(),0);
    Pm:= min(centrX+eps(),100);
    for i from Lm to Pm do
       M[i, j]:= barva:
    end do;
  end do;
end proc:
seq(Region(M), i=1..100):
PLOT(seq(seq(square(1,2*i,2*j, M[i,j]), i=0..99), j=0..99),
STYLE(PATCHNOGRID), AXESSTYLE(NONE));
```

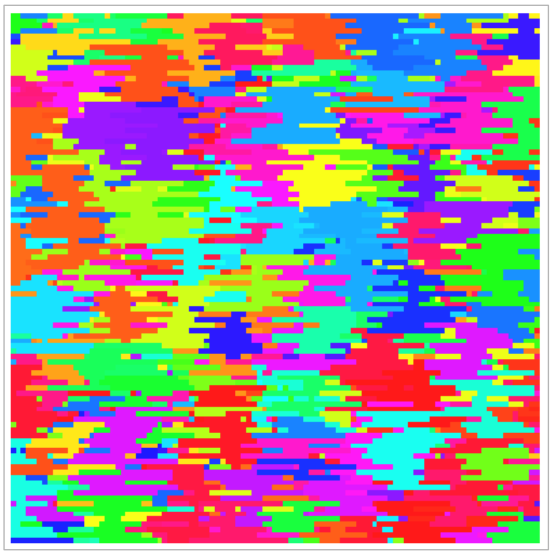


Figure 6: Picture created using Random area algorithm

Pipeline algorithm

Now our goal is to build **Pipeline** procedure that displays the pipe of circular cross section, the centers of these circles lie on any specified curve. For this purpose, we define a rotation matrix **RotM** which determines the rotation axis relative to any designated point (a, b, c) and a unit vector (u, v, w) (Murray, 2013). Then we construct using procedures **RotPoint** and **RotCirc** points defining each circle packing procedure and **GenMat** will record all points of the packing circles into a single matrix, which then draw the **Pipeline** procedure. See Figure 7 where is displaying seven randomly selected curves with randomly selected colors too.

```
RotM:= proc(a,b,c,u,v,w,t)

    Matrix([
```


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```
         [cos(t)*(v^2+w^2)+u^2, u*v*(1-cos(t))-w*sin(t), u*w*(1-
cos(t))+v*sin(t), (a*(v^2+w^2)-u*(b*v+c*w))*(1-cos(t))+(b*w-
c*v)*sin(t)],
     [u*v*(1-cos(t))+w*sin(t), v^2+(u^2+w^2)*cos(t), v*w*(1-cos(t))-
u*sin(t), (b*(u^2+w^2)-v*(a*u+c*w))*(1-cos(t))+(c*u-a*w)*sin(t)],
     [u*w*(1-cos(t))-v*sin(t), v*w*(1-cos(t))+u*sin(t),
w^2+(u^2+v^2)*cos(t), (c*(u^2+v^2)-w*(a*u+b*v))*(1-cos(t))+(a*v-
b*u)*sin(t)],
     [0,0,0,1]])
     end proc:
sol:=proc(A, B, cc1)
      solve({
      cc3 = A[3]+sqrt(1-(cc1-A[1])^2-(cc2-A[2])^2),
       (B[1]-A[1])*cc1+(B[2]-A[2])*cc2+(B[3]-A[3])*cc3-((B[1]-
       A[1])*A[1]+(B[2]-A[2])*A[2]+(B[3]-A[3])*A[3])=0})
     end proc:

RotPoint:=proc(A,B)
           local OB, c1, c2, c3, n, u, v, w, vys;
           c1:=A[1];
           vys:=evalf( sol(A,B,c1) );
           c2:=eval(cc2, vys); c3:=eval(cc3, vys);
           [c1,c2,c3,1]
         end proc:
del3:=proc(A) [A[1], A[2], A[3]] end proc:

RotCirc:=proc(A,B)
          local OB, C, n, u, v, w;
           C:=RotPoint(A,B);
           n:=sqrt((B[1]-A[1])^2+(B[2]-A[2])^2+(B[3]-A[3])^2);
           u:=(B[1]-A[1])/n;
           v:=(B[2]-A[2])/n;
           w:=(B[3]-A[3])/n;

             [seq( del3(evalf(RotM(A[1],A[2],A[3], u, v, w,
             2*Pi*i/20)).Vector(C)), i=0..20)];
          end proc:
GenMat:= proc(vB)
               local i, MB;
                  MB:=[seq( RotCirc(vB[i],vB[i+1]),
                  i=1..Dimensions(Matrix(vB))[1]-1 )];
               end proc:
Pipeline:= proc(vB, b)
             local i, j, MB, dim, Pl;
               MB:=GenMat(vB); dim:=Dimensions(Matrix(MB));
               Pl := seq( seq(
               POLYGONS([ MB[i,j], MB[i,j+1],
                     MB[i+1,j+1], MB[i+1,j] ]),
                          i=1..dim[1]-1),
                     j=1..dim[2]-1);
               PLOT3D(Pl, STYLE(PATCHNOGRID), COLOR(HUE, b))
              end proc:
```


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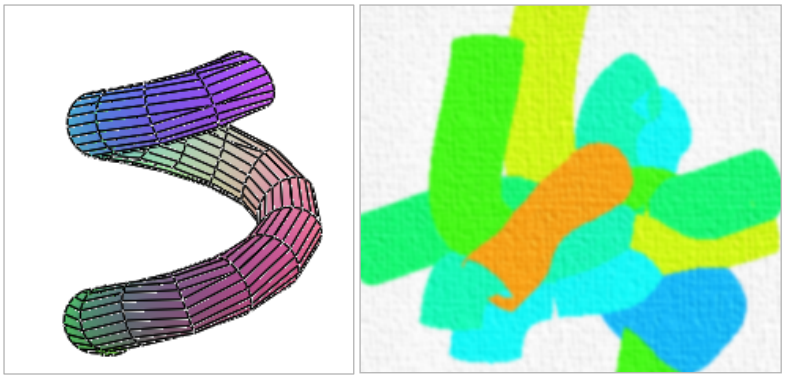


Figure 7: Pictures created by using Pipeline algorithm

CONCLUSION

In this paper, we present the main aspects of the historical development of computer art and especially the algorithmic art. Wide range of arts - New media - is a typical linking computer technology, scientific knowledge and artistic intentions. Each of the algorists approach to the use of algorithms in the art differently. We have outlined some possibilities of preparing some algorithms from the computer generated art in Maple. However algorithms cannot be used indiscriminately. After all, we have to sense of what we want to achieve in our artwork. This topic can reach students and teachers. We believe that the computer art belongs to the curriculum of teacher of art but the reality is that there isn't usually sufficient space for this subject.

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Universal Testing Environment as an External Tool of Moodle

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Abstract

The Universal Testing Environment is a sophisticated electronic cloud online test system, containing features that make it exceptional compared to other test systems. Moodle is a very widespread open-source LMS tool that has a many modules that can be used to implement a full-fledged eLearning teaching. This article will describe how these two systems were connected and tests in the Universal testing environment so they can be run directly from the Moodle course. This connection was realized through an External tool module, which is part of Moodle. Thanks to the Bridge design pattern then it was not necessary intervention into the code of any of both systems. This "bridge" translate LTI (Learning Tools Interoperability) protocol, which communicates Moodle, to the URL in format required by application interface (API) of Universal testing environment. This functionality is currently used at the University of Hradec Králové and the high school Podorlické vzdělávací centrum in Dobruška.

Keywords

Test. Universal Testing Environment. Moodle. External tool. LTI. Application interface. Cloud.

INTRODUCTION

The both linking systems in more details, especially the less known of them will be firstly presented. Its comparison with other test system can be found in Voborník (2011b).

Universal Testing Environment

Universal Testing Environment (hereinafter referred UTE) is an electronic online testing system designed for the creation, operation and administration of the tests. User part of the application (testing and administration interface) is created as the *Rich Internet Application* (RIA) at the *Silverlight*[2] technology. The system originated as a dissertation of the same name (Voborník, 2012b). (Voborník, 2012c). Similar solution for remote contact learning method can be found e.g. in (Hubálovský, 2012; 2013; Milková, 2012).

[2] Silverlight is a software plugin for development lavishly furnished internet applications that run within a web browser. It is developed by Microsoft, executed using the plugin which is a smaller version of the .NET framework and written in various languages supported by .NET (e.g. C#). (Lammarsch, et al., 2008)

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UTE approaches original way on the issue of electronic testing, both in terms of used technology an in terms of solution of sub-problems. RIA achieves convenience of desktop applications as well as it keeps the advantages of could computing. Any web browser and installed plugin Silverlight 5 is sufficient for using UTE, nothing else needs to be installed on the client computers and the server of organization. (Voborník, 2012c)

The tests consist of individual questions in UTE similar as in the other test systems. However here each question is treated as a separate component. In order the authors were able to fully utilize their creative potential and they needn't limit themselves to a set of predefined types of questions, own language named **QML**[3] was created. This allows to integrate into the questions arbitrary graphics, animation, active and randomly generated objects. Each question is so the independent the graphical and functional unit, which could cover completely thematic area of the curriculum if the random elements are appropriate used. (Voborník, 2011d)

Each question can be any **graphic** processed. This can be not only by embedded raster images, but QML directly supports vector rendering of standard graphical elements as line, rectangle, ellipse, polygon, path, etc. (see Figure 1). The code for the definition of standards was inspired SVG[4] and XAML[5]. (Voborník, 2011b)

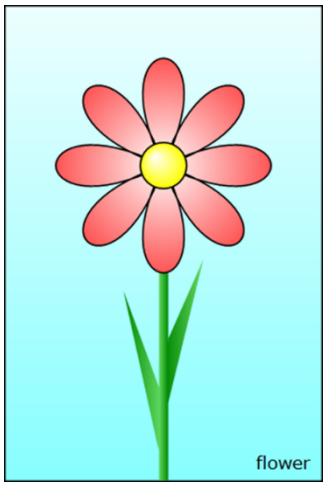


Figure 1: Sample of vector graphics by QML

Transformations are also supported. They allow to objects or groups of object located on the positional elements (containers) change the scale or rotation. **Animations** can be understand as one of the advantages which the test can never have on the paper. Therefore QML supports it too. Currently it is possible to animate to scale, rotation, movement, transparency and colour. (Voborník, 2011d)

In addition to static (or animated) graphical objects QML also support the **active elements**. They provide interactivity to the tested users, i.e. the possibility to intervene into the question and do something as them answers. There are several types of active elements, and each of them has different properties:

- **Switch** - it have several versions of its appearance (content) which is cycled changed by mouse clicking. The challenge is to choose the right variant. Among other things it can to replace the checkboxes or radio buttons.
- **Sorting** – this element contains a set of items (text or graphic) which are shuffled in the question and the tested user has the task to organize them into the correct order by using drag&drop[6] method.

[3] QML – Questions Markup Language, based on XML (Voborník, 2011b)
[4] SVG – Scalable Vector Graphics (Eisenberg, et al., 2002)
[5] XAML – Extensible Application Markup Language (Macvittie, 2006)
[6] drag&drop is a method in which the objects are moved on the desktop by the mouse so that the cursor are placed above the object, the object are "grabbed" by pressing the mouse button, then the object are dragged to the desired position, where it is "released" so that the pressed mouse button are released (Voborník, 2012b)

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- **Text input** – the edit box into which the tested user has the task to type the correct text answer.
- **Combo box** – it is an openable box with many options from which the tested user has to the task to choose the right variant.
- **Items and targets** – the items can be moved over the entire question's area by using drag&drop method. The task is to place them into the correct targets (see Figure 3a), i.e. areas into which items "bog down" by defined rules (Figure 2).

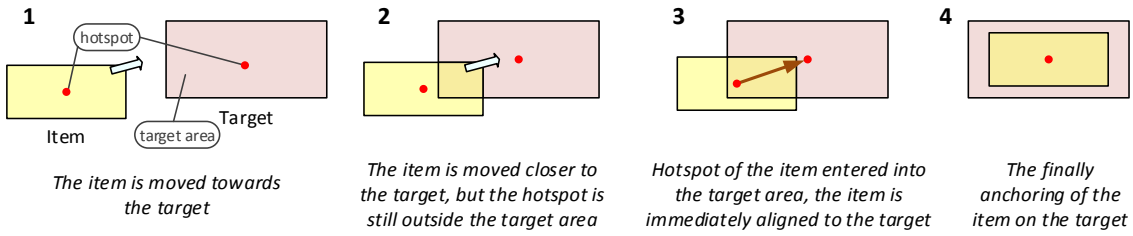


Figure 2: Illustration of anchor item to the nearby target (Voborník, 2012b)

The **random elements** are most extraordinary at UTE. They allow in a question generate random numeric values and also texts (see Figure 3b). Both can then be further combined in internal calculations, and commands for branching, cycles, etc. Thanks to the questions can be used repeatedly without risk that the tested user automatically interpret the solution without the knowledge of curriculum included in question. (Voborník, 2012c)

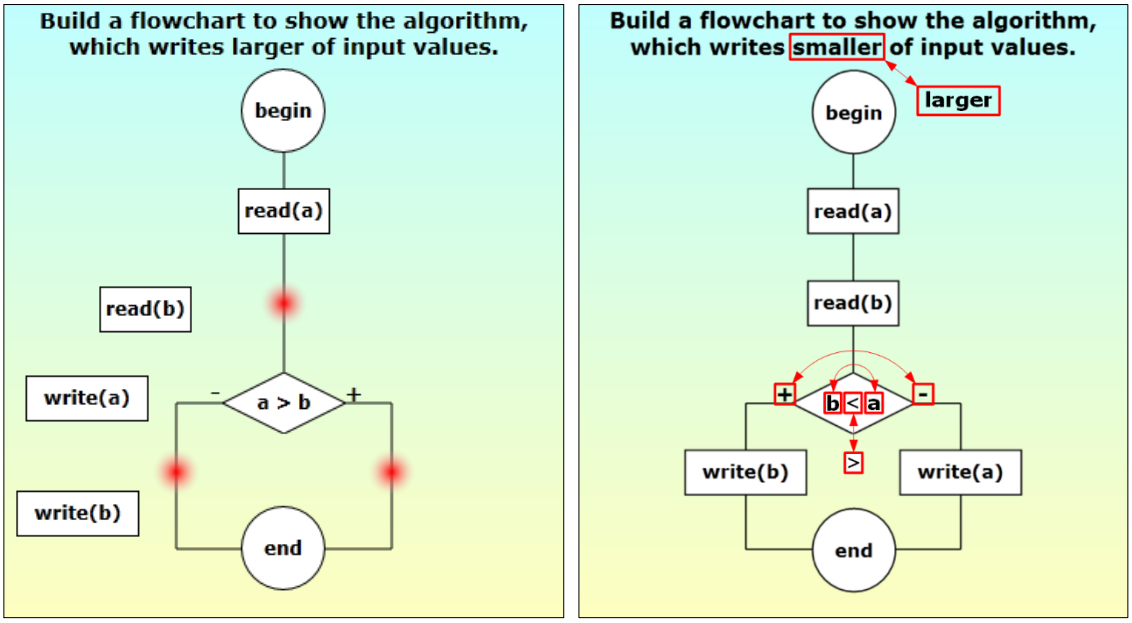


Figure 3: Sample of the question with the items and the targets in a default state (left) and resolved state (right), where is highlighted the parts that are randomly changed in the task and how (Voborník, 2011c, 2011d)

Automatic assessment is also sophisticated. For each part of each active element can be set to any **fuzzy score scales** for evaluation. The scope and scale can be chosen arbitrarily for each question. The system itself calculates the maximum possible score while the questions are generated, and the obtained score divides by this maximum, thus resulting score is converted back into a single range <0, 1>. Similarly works well overall

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evaluation of the test, where the result is the weighted average of the results of individual questions. (Voborník, 2011d)

For the evaluation of written text answers is also available possibility to determine the **degree of similarity** of the answer with the pattern. For this purpose, UTE has implemented 18 algorithms, which according to various aspects can express similarity between two texts as a percentage. Recognition of score in the question does not need to be subject only to absolute exact wording of the answers, but a certain tolerance may be allowed (e.g. typos or other form of the word). It is also possible to gain score value directly derived from the percentage of similarity between the two texts.

In addition to the evaluation of the test that accurately determines the percentage result, UTP can also provide detailed **analysis of the test**. Here is at all active elements indicated whether they were resolved correctly, partly correctly or completely wrong. For each variant, then can be also add additional information to further explain the obtained evaluation (see Figure 4).

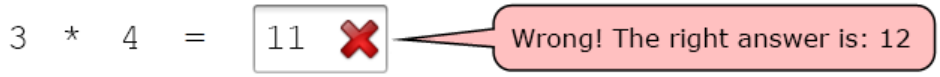


Figure 4: Example of automatically generated feedback

QML allows you to create graphically stunning and functional extensive questions, however taxes for this versatility is sometimes unnecessarily lengthy code. In order the same code in a recurring type of question was not necessary to write (copy) ever again, the ability to define an arbitrary transformation **template** (XSLT) was added. This from a brief entry in a few trivial XML elements generates a comprehensive and fully functional question in QML with all appurtenances (see Figure 5). (Voborník, 2011d)

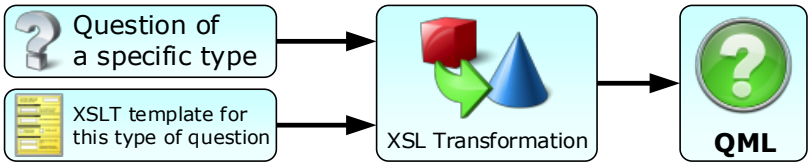


Figure 5: Scheme of the transformation simplified XML code of the question into the QML using the XSLT (Voborník, 2012c)

Questions of the specific tests before each launch may not only **mix**, but also randomly questions are **selected** from a larger database divided to the multilevel hierarchical structure. In this case, can be activated function for the **smart choice** of the questions. This function tries to maximize learning and testing effect of the test when it is launched repeatedly by the same user. This is achieved by an algorithm based on evolutionary principle which takes into account the previous results of the test in each of the possible questions. This principle was described in (Voborník, 2012a).

There is also a **protection against copying** from the internet or other applications. If the browser window or the current browser tab switched during test, the test is covered by a red panel and countdown of the automatic termination is launched. It can be stopped only by clicking on the *Continue* button. Time for this countdown and the number of tolerated switch can be set for the each test separately. (Voborník, 2011b)

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UTE can be used independently, or it can be interfaced with other systems via the **application interface** (API). UTE can be integrated into any web application, including modular or open-source LMS[7] and through the component *WebBrowser*, in to desktop applications too. The condition is that the systems used the UTE, must comply with the communication interface.

Moodle

Moodle (Modular Object-Oriented Dynamic Learning Environment) is a very popular learning management system, provides a highly configurable web-based interface that includes a wide range of activities which are, in general, sufficient for a standard course. (Corbera, et al., 2008)

Moodle includes module for creating, launching and assessment tests already in the basic installation (Voborník, 2014). These tests, although they are very good, they lack several important features that are commonplace in UTE (see previous section). The great advantage would therefore be, if it were possible to link these two systems and the Moodle courses could include the UTE tests.

Because the Moodle is open-source, so there were more possibility of linking. One of possibilities was edit the Moodle code directly, also could be to create a custom module, or add interface SCORM standard to the UTE, or use an existing module the **External tool**. The last option has proved to be most effective, both in terms of workload adjustments, as well as from user's view. External tools can be easy added to the course by any teacher without special privileges or assistance by administrator.

External tools in Moodle

External tool is therefore activity module in Moodle LMS. This can be added to any topic in any course same as other activity modules.

This module allows using an external third party tools which need not be included in the Moodle or its module. Just only the appropriate application interface that communicates based LTI[8] protocol (see Figure 6) and can thus be used as other integrated Moodle activities. (Voborník, 2014)

[7] LMS – Learning Management System, also in Šedivý and Hubálovský (2012)
[8] LTI – Learning Tools Interoperability

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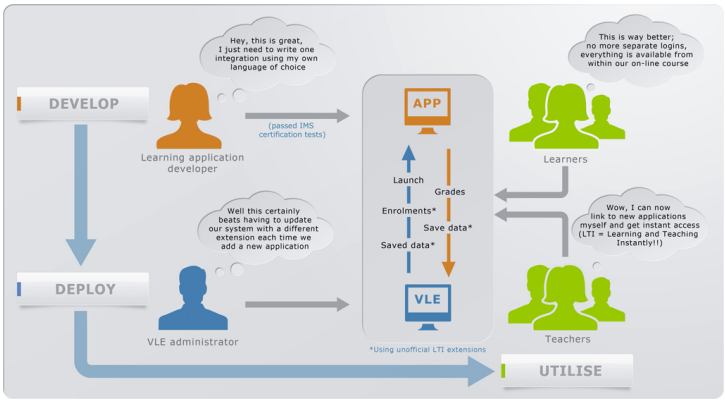


Figure 6: Scheme of the LTI protocol[9]

The basis of this communication is the URL address on which user is redirected by clicking on the name of the activity in the topics. It send by POST method to the external tool a hidden data of the user, such as the ID, login or e-mail address. It also includes authentication information such as a unique key (salt) for the communications, consumer key for identification of the application (Moodle) and checksum (hash) of whole message including the secret consumer password to validate the entire requirement.

Based on these data, the external on-line application can access some its operations, which the student executes and then by a similar way may send a "signed" data (e.g. grade) back into the Moodle. (Voborník, 2014)

IMPLEMENTACE LTI PROTOKOLU V UTP

Moodle sends data to the external tool such as a list of parameters and their values by the POST method, i.e. invisibly to the user. For this communication is of particular interest (inter alia) the following parameters:

- oauth_nonce – a unique random code for the requirement (salt)
- oauth_consumer_key – organization identifier (login)
- user_id – ID of the user that is registered in the Moodle
- lis_person_name_full – full name of the user in the Moodle
- lis_person_contact_email_primary – e-mail address of the user in the Moodle
- lis_outcome_service_url – URL address to which can be send back any data to the Moodle
- launch_presentation_return_url – return URL
- oauth_signature – signature (hash) of the whole message for request authentication; the hash is counted with secret password that is not included in the message

Moodle also allows to the setup of an external tool to add additional custom parameters that are sent to the application with the prefix "custom_" (e.g.

[9] http://www.imsglobal.org/toolsinteroperability2.cfm

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"custom_test=prg1"). These parameters allow preparation UTE support of several different mutually combinable type of use:

- **User login**
  - *Full-featured log in* – the user has already created and verified account in the UTE, he is a member of the organization under which this approach is established and he allowed self-login through API for this organization. It is important that the email address of the accounts in both systems (UTE and Moodle) was the same, because the user is identified and logged in by this address.
  - *Fictitious user* – users do not need to be registered in the UTE, for access is established a fictional user account under which are logging in and tested all students. In this case, the user is not be found by the email address, but according to the identifier specified in the additional parameter. In this case the email address is stored for each record of the testing in an optional parameter as application identifier. According to it, they are also filtered list of already finished tests for these fictitious users, so everyone sees only his own.
- **Launch application**
  - *Only logged in* – the user is only automatically logged into the system (and into the organization) and an overview of available or previously carried out tests are displayed to him. Here he can run a specific test (if it is currently available), or he can show the analysis of previously realized tests. After the test he is switched back to this overview.
  - *Launch test* – the user is logged into the UTE and the specific test is launched immediately. This test is intended by the identifier in the custom parameter for an external tool. After its completion, respectively after seeing its evaluation and analysis (if enabled), the user is logged out and redirected back into the Moodle.

All these variants of login in the UTE has supported earlier, but only through specific application interface (Voborník, 2012b, p.72). LTI protocol used in Moodle, however contains a different format for communication (e.g. POST method instead of GET, different parameter names, different calculation of authentication hash, etc.). Still, the best variant was to use of the existing API system also for LTI protocol.

For this purpose, was added special intermediate step to the UTE, respectively application webpage that accepts an incoming message LTI (POST), decodes the data and verify its validity. From these data its draw and sign a URL containing the necessary parameters (GET) for an already functioning application interface and it redirects the user on this URL (see scheme on Figure 7). Everything takes place in a fraction of a second, and the testing interface or the specific test is launched to the user, without he can note this step. Everything is maximum security with a disposable valid checksums (hash).

Parameter *oauth_nonce*, containing in each request another string of unique random characters, is used as the *salt* of each request. This key UTE save in the database and checks its uniqueness. This makes each generated URL usable only once (Voborník, 2011a and 2011e). Its validity is also limited to a few seconds, which makes its abuse almost impossible.

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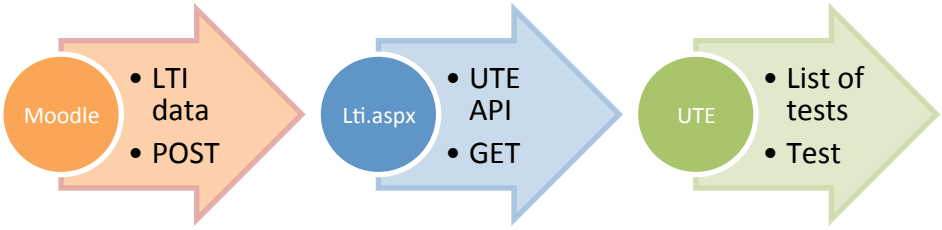


Figure 7: Diagram of sending data from Moodle to UTE

Thanks of creation an auxiliary site for translation of the LTI to the UTE API was not need to interfere with existing code of any of the two systems. Their communication is yet fully secured and allows all of the available variability. This approach of solutions basically applies the *Bridge* design pattern, described in (Bishop, 2007).

Linking UTE with Moodle via an external tool is very easy. Just in the administration of UTE set the test parameters and its availability by the classical way, and enabled access to test by secure API protocol. On Moodle side in the selected course is added external tool and a few parameters is set to (URL for launch, the organization identifier, password, and the parameters for run the UTE).

If there is no need to execute only the specific tests for specific course topics, just one external tool for the entire course is needed. Its only logs a student into UTE and shows him a list of tests, from which he can directly launch any of the currently available tests. In addition, here students can also see to the final analysis of the tests that they had written previously (if enabled).

USE IN PRACTICE

Support LTI protocol to UTE was added in April 2013 and it began to full use immediately. This occurred on the high school named "Střední Škola – Podorlické vzdělávací centrum, Dobruška" (SŠPVC) and on the University of Hradec Králové (UHK).

Střední škola – Podorlické vzdělávací centrum, Dobruška

UTE is used to separately on the SŠPVC before it. There all students were registered their user accounts, where they had a records of all previously passed tests. It was therefore desirable to have their history of tests remained continue available for them. So they can analyses their older tests from previous years to learn for graduation exam for example.

In this case, the approach with a full user login to UTE was provided only. Users, after logging into the Moodle and click on the appropriate action (external tool), has to directly displayed the list of tests in the UTE. From these test they will themselves chose and launch that with which should they work currently.

SŠPVC since February 2012 also uses Office 365 for school where all the staff and students have set up email box with address in a consistent format under the domain of school (surname.firstname@sspvc.cz). This address, which is everybody mandatory registered in the Moodle, is uniquely identifier for each in a form that everyone can easily read. Thanks this was made it possible for the following new classes (1st year in the school

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year 2013/2014) skip registration in UTE and for access to use only one fictitious user which is differentiate only by email addresses.

University of Hradec Králové

The UTE on the **UHK** was until then used only for unregistered auto tests. The UTE was not used for a rated testing, primarily because was need to register of each user to the system. Given that UHK as a possible support for learning uses the Moodle (http://kurzy.uhk.cz), the implementation of the LTI protocol to the UTE this problem was solved.

UHK is using a similar format of email addresses (firstname.surname@uhk.cz) a long time ago, so it could be access through a fictitious user put into operation immediately. Tests in the UTE accessed through the Moodle have become part of the test of the subjects in Applied informatics 1 and Programming 1-3 (see Figure 8) and also plans to deploy them in other subjects.

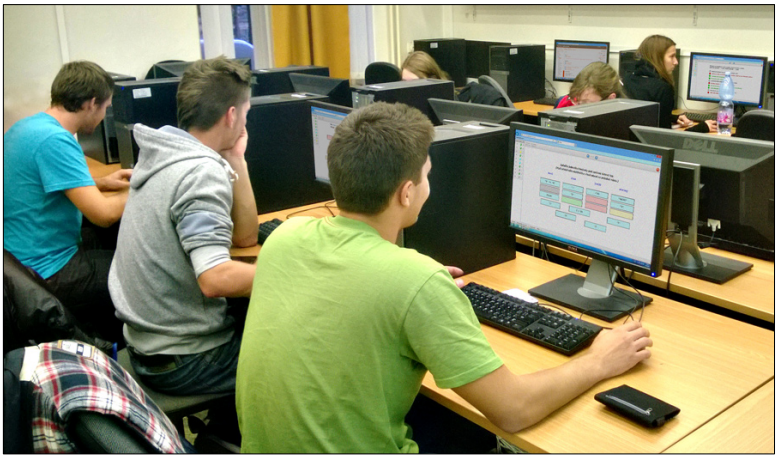


Figure 8: The exam of the subject Programming 3 via UTE

CONCLUSION

Universal testing environment provides a many features that no other electronic test system have. Moodle is a very widespread open-source LMS tool that has a many modules that can be used to implement a full-fledged eLearning teaching. These two independent systems succeeded in linking for cooperate. Extensive Moodle functionality can be extended by the use of tests developed and run in UTE using all its benefits.

Adding the tests prepared in the UTE into the Moodle is due to an external tool module so easy that it can handle any course creator himself without having to install anything else into the Moodle. Implementation of support to this functionality was realized without having to change existing code of the Moodle or the UTE. It was enough to just add a simple compiler of LTI protocol to the UTE API.

Only one-way communication is supported in the current version, i.e. from the Moodle to the UTE. In the future, it should be also added support for reverse flow of information, i.e. the possibility that the UTE sent data from such evaluation of the completed tests back to the Moodle.

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UTE may be used equally with any other LMS that supports the LTI. Through UTE was carried 7,642 tests until 1st February 2014.

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Section:

Learning/Teaching Methodologies, Assessment and Learning Environments

Application of Petri Net for Evaluation Modeling of Student in the LMS

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Abstract

From the teacher´s needs point of view, the basic requirements in the LMS (Learning Management System) are presenting the curriculum, education management, communication with students, their motivation to study, observation of their progress and assessment of their work. The paper describes a universal model of an electronic course (e-course) in LMS created by the structure of Petri nets. The universal model is created in a way so that it reflects the student´s and the teacher´s needs, it is not too complicated, but modular and complex, and it is comprehensible and transparent. Then the paper provides the creation and the description the scoring an evaluation system of a student who passes the parts of the e-learning course. A module was designed into the created universal model – student scoring and assessment. While modeling this module all aspects and possibilities were taken into account which may appear during the assessment. The advantage of modeling in Petri nets is the simplicity of modeling and the consequential simulation of the given model. By the use of a universal model with relevant moduls created in Petri nets, it is possible to create practical electronic courses which will take into account all the aspects of a functional model. The created e-courses by the designed universal model can be then cheked up (evaluated) by the use of various statistical methods.

Keywords

Learning Management System (LMS). Modeling. Petri nets. Evaluation. Universal model

INTRODUCTION

Nowadays we live in a world of personal computers which are not restricted only to specialized workplaces. Almost everyone has now an access to them. Because of the rapid development of the Internet, the information technology has become more and more popular. It has found a way to education by online courses.

With the growth and evolution of the internet, online systems have increased. The education was not left behind and e-learning tools and platforms started to appear allowing managing educational process or even getting qualifications online (Campos-Rebelo et al., 2012). With the development of Computer Based Training and Web Based Training, the distance learning provides the novel learning way different from traditional education and has become one of the important styles of modern education (Lin et al.,

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2004) (Benedek et al., 2010). Learning Management System (LMS) is a kind of web-based system that aims at supporting educational activities in distance or presence modalities. Currently various LMS platforms have been developed and made available, and also have been largely used in both distance learning and traditional classes (Rocha et al., 2013).

The paper focuses on the evaluation modeling of the student passing the LMS. The scoring and assessment model of the student crossing the e-course was created into the universal model constructed in Petri nets (Balogh et al., 2013) (Balogh and Koprda, 2012) (Balogh et al., 2012).

UNIVERSAL MODEL FOR LEARNING MANAGEMENT SYSTEM

System modeling is an activity which on the bases of acquired knowledge enables thinking about the real world and thus consciously influences it. The notion of a system usually represents an abstraction of reality while the focus is on those facts which are relevant for this research. The modeled system has a certain structure, it is composed of elements (entities of the system) among which relations exist. In a dynamic system, the relations and the system set of elements may change.(Klimeš and Balogh, 2012).

In the sense of research technology, the core of the modeling is a substitution of the examined system by his model (a modeled system). The aim is to gain information about the original examined system by experimentation with the model.(Křivý and Kindler, 2001).

Thus is system defined as a really or abstractly existing object to be examined, while during his existence it may develop and cooperate with other systems which form his surroundings.(Backlund, 2000).

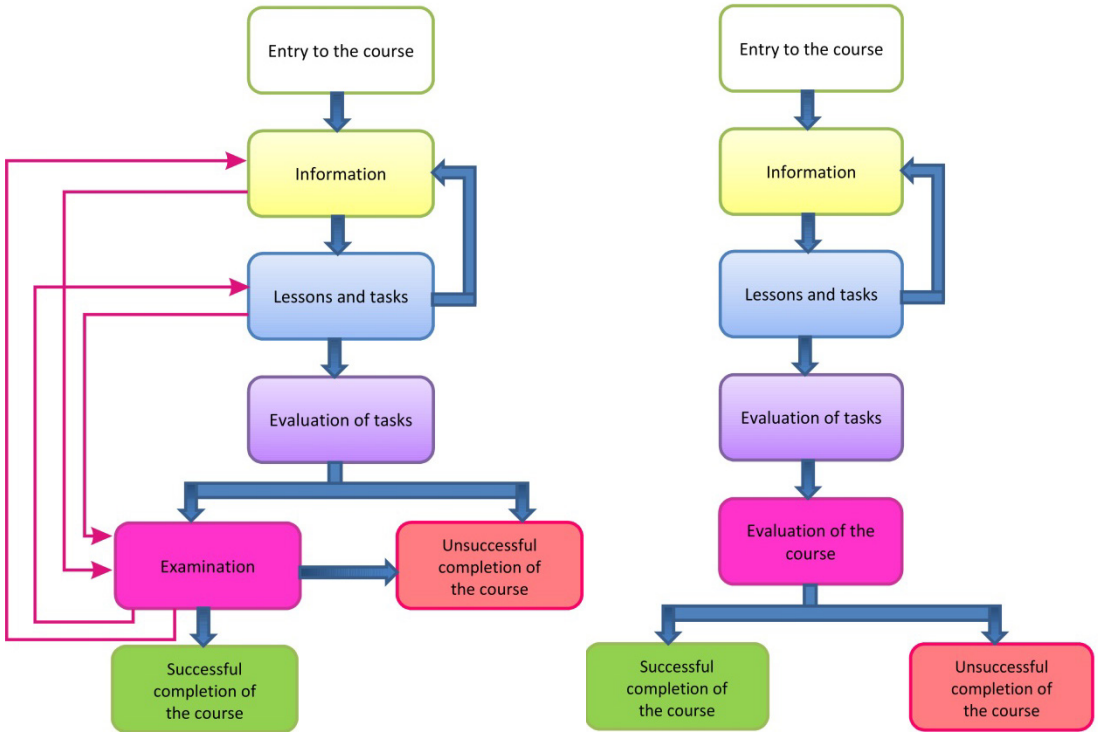
As long as system modelling is concerned,it is represented in a different environment (e.g. in a language or form understandable for the computer) where it is crucial to think about the internal characteristics such as reciprocal interaction between the system and its environment.(Křivý and Kindler, 2001) (Stastny and Skorpil, 2007) (Magdin and Koprda, 2013).

When modeling the correct LMS system, it is useful to know as much information as possible. This means get to know its behaviour in certain situations, requirements for control, physical or other restrictions of the given system. Then it has to be clearly determined what the system has to perform and which are the primal actions to avoid collisions. The aim of the requirements is to have the best universal model which describes the dynamics of the given system.(Ertel and Drozd, 2007).

With similar universal models similar e-learning courses would be created. The creation and construction of the universal model has already been described in some papers (Balogh et al., 2013, Balogh and Koprda, 2012).

Petri nets were used to create the universal model of the student passing the LMS. Process models can be also created using UML diagrams (Rabova, 2012). The structure diagram of the universal model is shown in Figure 1. To better understand the modeling and simulation concept it is essential to acquire the basic notions.(Peringer, 2008, Hubalovsky and Sedivy, 2011).

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a.) b.)

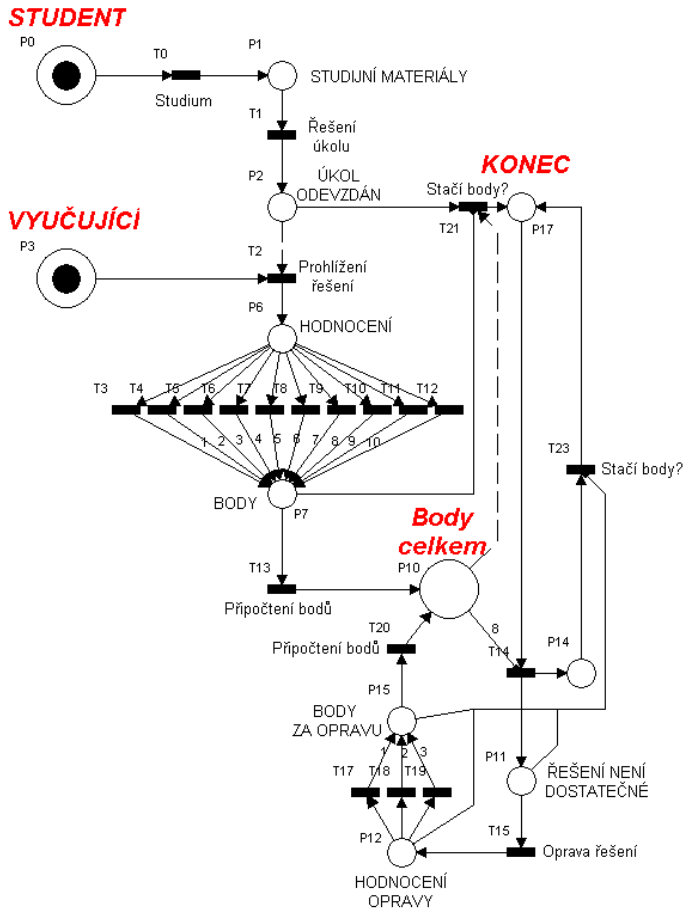
Figure 1: The structure diagram of the universal model a.) exam, b.) ongoing evaluation

Scoring and automatic assessment model of a task

The scoring model of a written task is a calculable function. Its input is the beginning of the work of a given task (student´s study of materials and the teacher´s waiting time for task submission). The output (the value) is the number of points gained by the student for solving the given task (Nagyová, 2009).

Figure 2 shows the scoring Petri nets of a written task. The maximum of points gained are 10 points with the requirement of gaining at least 8. At the moment of submiting the task (place P2) the T2 transition is implemented and the teacher may do the assessment of the task. Then he chooses a relevant number of points – are simulated by the choice of one from the transition T3 to T12. Thus in the place P7, 1 to 10 tokens appear, which consequently ascribe to the total number of points (place P10). As long as the student has not gained at least 8 points (the inhibitory arc conducting from the place P10 to transition T14 is testing it) he has to correct his solution (transition T15). The teacher decides how many points from 1 to 3 the student gains for his correction (again, choice from the transition T17 to T19). The points are ascribed to the total number of points (place P10). If the students number of point is still not sufficient (required 8 points), the situation is repeated – the students corrects his task and the teacher ascribes relevant points (Nagyová, 2009).

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STUDENT – STUDENT, VYUČUJÍCÍ – TEACHER, Body celkem – Total Scoring, KONEC - END

Figure 2: Scoring model of one written task (Nagyová, 2009)

This model is a precise image about task scoring and according to this model it is possible to create a similar construction of scoring model which can be composed to the already created universal model.

EVALUATION MODEL OF A STUDENT IN LMS

If the student wants to pass the exam, he needs to fulfill two major requirements. First, he has to do all the tasks, submit them. Then he has to gain a sufficient number of points from them (in this case, 75% of points). There are four tasks in the model with the total number of points of 40. From this number, the 75% minimal limit is calculated which are 30 points. The availableness of the student to the exam is based on the two facts. By the inhibitory arcs, it is verified whether the lessons have already been opened (whether a token exists in the places P800, P820, P830, P840, P850) and whether all the tasks have been submitted (whether exists a teacher token in the places P822, P832, P842, P852). All these inhibitory arcs connect with one transition (T870) at the same time (Figure 3). The inhibitory arcs work conversely than the normal ones, and enable the transition to realize when the places connected to it does not contain any token. This means that if all the given places above are empty, the tasks are already submitted. Inspection is needed here

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to avoid "unsuccessful end of course" before submitting all the tasks. When submitted, in the place P870 a token appears which provides availableness of the place P514 from each lesson (from the end of information sector and each lesson through the transitions T160, T260, T360, T460, T560). It is the place of task assessment. If the point gain is sufficient inhibitory arc of P700 activates the transition T561, thus gets to the place P664 meaning unsuccessful end of course (Figure 4). The inhibitory arc has a value of 30, taking the place P700 as empty until it reaches the number of 30 tokens (points).

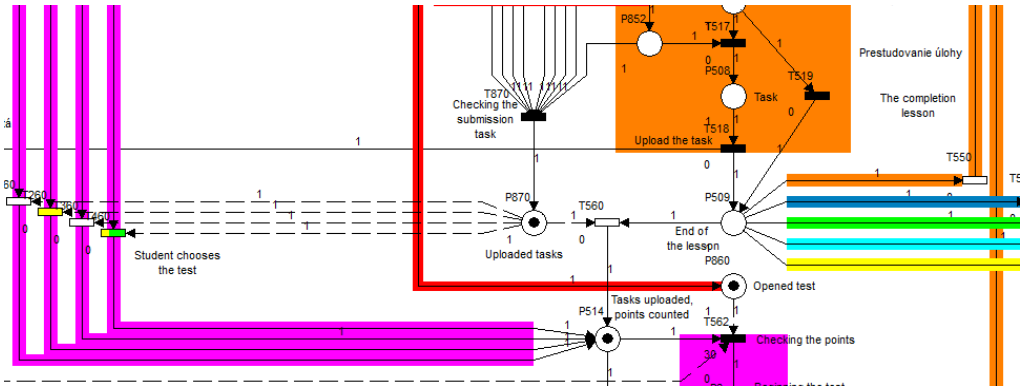


Figure 3: Before exam

If the limit of 30 points has been reached, moving ahead to the exam through transition T562 is available. The transition checks up the place P700 (Figure 4) by testing arc with the weight of 30, whether the 30 points exist there, and whether the teacher declassified the exam (whether the place P860 has a token). A testing arc was used instead of a normal one to keep the points gained from the tasks in the place P700. According to the place, it is possible to check up the correct system work anytime, even during the simulation. In the requirements, the form of the exam has not to be defined (whether it is an online testing, a written exam or a classic form of examination). The designed universal model contains an exam with a scoring from 2 to 20 points. The scoring was solved the same way as the task assessment. The token is waiting in the place P601 until the examination and the assessment end and the token in the place P602 starts the scoring of the exam by burning one of the 10 transitions from T662 to T680. In the place P604 points gained from the exam occurred. Originally, we got from P601 to P602, so no token has been left there. The new solution was made to not to unite the student activity simulation part (visible for the student) with the mathematic and the logical part (what is happening in the background, what is the LMS and the teacher doing). Thus their natural and original performance/behaviour has been maintained.

According to our laws a student has the right to have three attempts of examination. This means that such a net have had to be created in which it is possible to save the results of all attempts. The model counts the student´s attempt passing the exam, saves the gained points, shows the results, how the course ends. The student may study the desiderative lessons, materials, prepare himself for the next attempt, and again, be examined. The token in the place P603 shows, how many times the student has already been examined.

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The testing arcs are connected with three transitions where each arc has a different weight (1, 2, 3 – numbers of attempt). The testing arcs provide that the token does not disappear from the place, and the place may count the attempts. When the place P603 gets the first token, the one-weight testing arc activates the transition T621 and gets the tokens into places P621 and P631. A token got to the place P621 and consequently it opened a possibility of saving the results of the first attempt from the place P604. Result savings makes the transitions T611, T612 and T613. They need to know which one of them has to save the results and they have to fulfil the requirements:

- they need to have points from the place P604,
- they need to have a token from the place P62X, where X is a number of the current experiment (with the use of testing arc),
- they need to have an empty place for the next experiment (with the use of inhibitory arc).

If the next place is not empty, it means that an other experiment has been implemented and the next transition has to save the points. It is a crucial condition which, in fact, protects the results of the previus experiment.

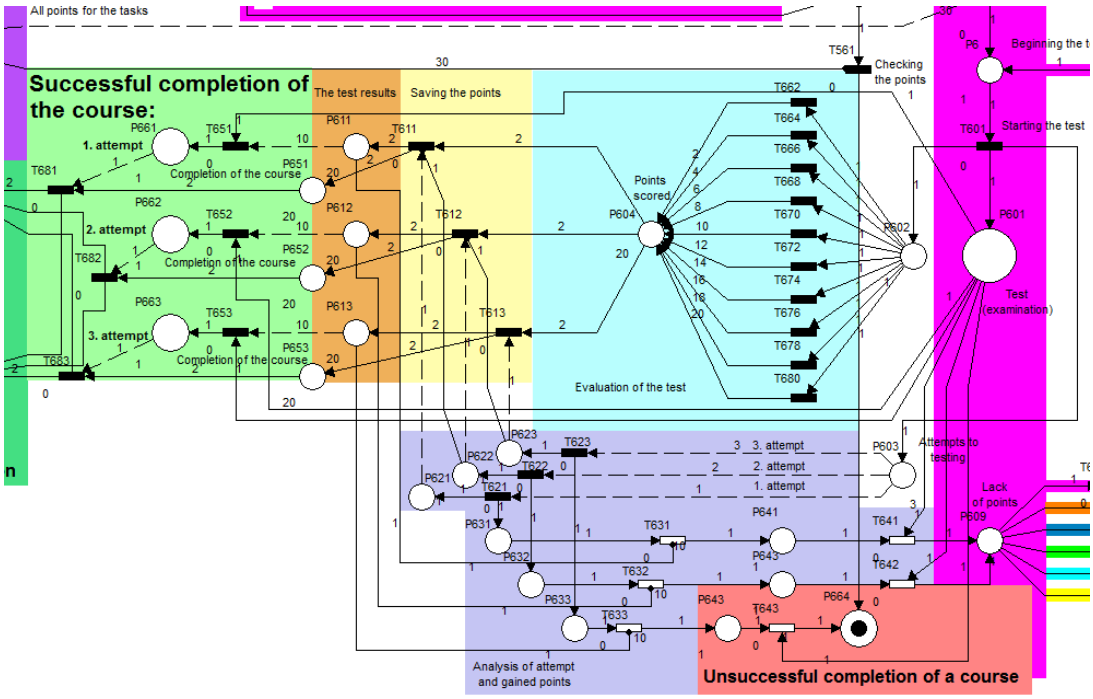


Figure 4: Exam progress model

If the transition T611 has been implemented, the number of points is presented in the place P611. Then if the half of the total number of points has been reached in an exam, the testing arc with the weight of 10 and the student´s token from P601 activates the transition T661. Thus the place P661 is reached, what is the first place of a successful end of the course. If on the exam the points do not reach the number of ten and in the place P611 there are less tokens than 10, the inhibitory arc activates the transition T631, and the token gets into the place P641. The transition T641 is connected to the place P601. The

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token in the place P601 represents the student´s action. It moves according to whether the student passed the exam (through the transitions T651, T652, T653 it gets to the state of successful end of the course) or he got a token from the place P641 (or P642), which means that he did not pass the exam and he may return to his materials and study again (T641, T642). Or in the case that the student did not pass the exam the third time, he finished the course unsuccessfully (T643).

Through the transition T641 (T642) he gets to the place P609, he can choose from the lessons by the transitions T6X0 where the X represents the number of a sector, or return to the exam. If the student´s token returns to the exam sector, the transition T601 sends a token to the abacus P603 which activates the transition T622 with the testing arc with the weight of 2. Then it sends tokens to the places P622 and P632 and thus activates the point savings of the second experiment (T612). If the student reaches a sufficient number of points, he has the possibility to return to the lessons and materials. If the student does not pass the exam the second time, he may return to the same ways and try it the third time. After saving the points of the third attempt to the place P613, the only way is to end the course successfully, or through the transition T633 get to the place P644 where he ends the course unsuccessfully.

The testing arcs from the places P621, P622 and P623 have an interesting function. In these places, there is no need of tokens just to save points from the exam to the right place. The tokens are not necessary because they are the activation condition of transitions T611, T612 and T613 as it was in the condition of the teacher to open the lessons in the places P8X1. It is necessary to block the operation of testing arcs and the transition T62X because if after his unsuccessful examination the student returns to the lessons, the token from the place e.g. P63 would be removed. The testing arc from P603 would sent another token to this place through the transition T62X which would also get to the lessons and it would be repeated again and again until the whole model would fill up with tokens. As long as there are tokens in the places P62X, the transitions T62X do not let any token to the places P63X even if it is empty.

Grading

When modeling the student´s transition through the system, there is a visible part of the already presented exam model with an added function of assessment. The function has its own principles, as an input, just a solution of a successful exam is needed. The possible scoring evaluation has to be set according to the fact, how many points it is possible to gain on the exam.

In Figure 5 there is a particular example. After passing the exam, the student gained 16 points. The token of 16 points could appear in each grade, but it does just only in that one where both input limits have been fulfilled. For example, in the case of the grade D according to the testing arc of 12, the transition may implement, but the inhibitor has found more than 14 tokens in the place P681 which means that the transition has not implemented. In the case of a B, both requirements have been fulfilled and thus the token appeared in the correct place (P692).

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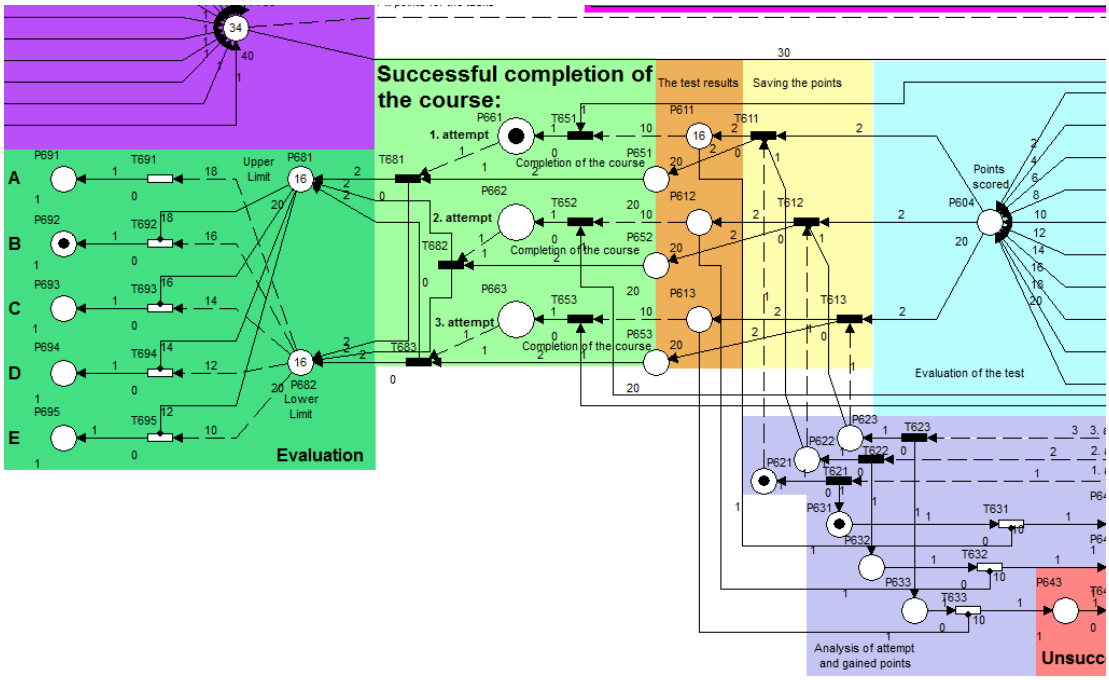


Figure 5: Grading according to performance during the whole semester

In Figure 6 there is the model of grading according to semestral performance. The function´s basis is the same, but it was necessary to add points gained from the tasks. Then the place P700 had to be duplicated which means that the content had to be copied into places P721 and P722. The purpose was to keep the role of this place and meanwhile to figure in its content to the points gained on the exam.

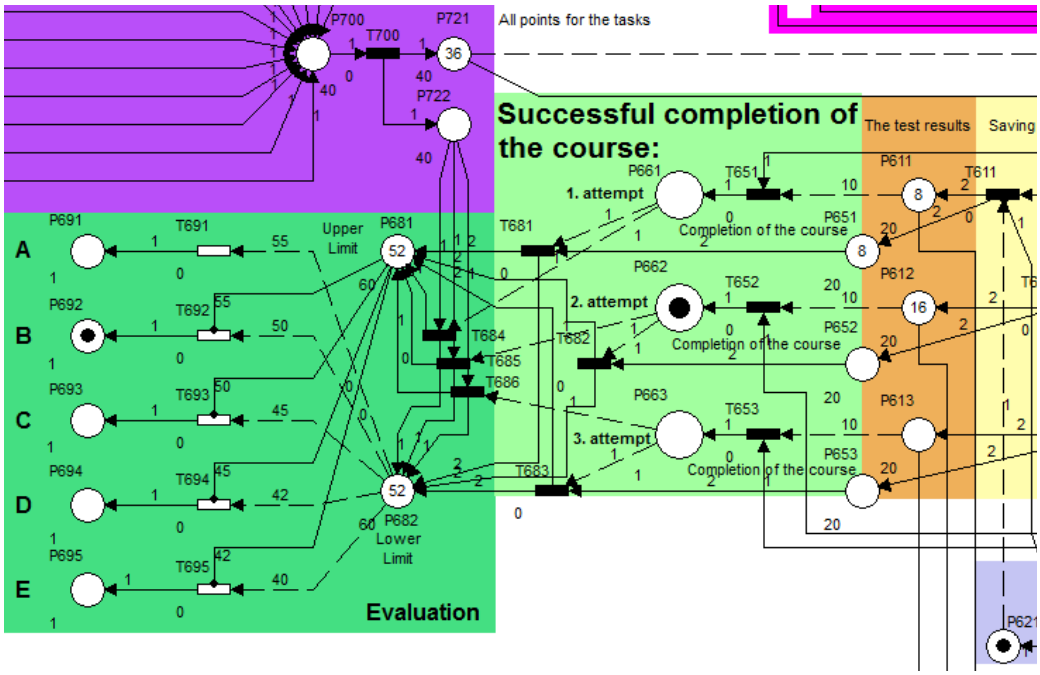


Figure 6: The model of grading according to semestral performance

Attention had to be paid when adding points gained in the tasks to the total number of points. It was crucial for the student to pass the exam first and then add the points

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gained in tasks by the use of transitions T684, T685, T686. In this version of the model the number of gained points is much more. That is the reason, why different point numbers are added to each place.

Deterministic transitions have to be used for correct function of grading in transitions T69X in order to start the grading only when the points gained have already been counted.

DISCUSSION

eLearning needs to evolve, and this evolution must take the student into consideration. Usually, in online learning processes, the student is conditioned by temporal issues, LMS technical constraints or an inefficient use of learning platforms features. If students are not placed at the centre of the eLearning processes, and if emerging technological and sociological trends are forgotten, any eLearning activity will fail. To avoid this situation it will be necessary to open the presented LMS conception. LMSs should allow the integration of other tools and must be centred on the user (García-Peñalvo et al., 2011)

To deploy a correct eLearning system for the users, it is essential to create a detailed model which covers all the particularities of the given system. The aim was to create a modular universal model of student communication control in LMS system by the use of Petri nets. It is possible to create other moduls by which the interaction between user and teacher can be improved.The benefit of modelling of educational processes using Petri nets is their formal description, which is complemented by a visual graphic depiction. This allows a precise and exact specification of the process, which facilitates elimination of ambiguity, vagueness and contradictions. Petri nets, besides the visual graphic expression, have also square defined mathematical fundaments, which can be suitably used in various software tools for the specification and analysis of computer-solved company processes.

In the paper, the model of student scoring and evaluation by the use of Petri nets is described. It was necessary to model the scoring evaluation of each task, test, final work, and exam. Since the scoring model depends on the type of the given task, a solution had to be found which is flexible and easily modifiable according to arbitrary requirements. In this case, also human factors play a big role : how the teacher images the course, how strict he is, whether he counts all the points gained through the semester, or he grades just the final exam, etc. When considering subject ending with an exam, it cannot be forgotten that the students has the rights for two correction terms. It means that together he has 3 attempts to pass the exam successfully. It may happen that after passing the exam, the student is not satisfied wih his grade and he wants to correct it. But what happens if he gets a worse grade on his second attempt? Is it possible for him to keep the older and then better one? All these events, cases, and details are not possible to summarize into one model without losing overview. In this case, alternative versions (moduls) may be done. By the use of a universal model with relevant moduls created in Petri nets, it is possible to create practical electronic courses which will take into account all the aspects of a functional model. The created e-courses by the designed universal model can be then cheked up (evaluated) by the use of various statistical methods (Klocokova and Munk, 2011, Skalka et al., 2012).

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CONCLUSION

The paper describes the transition modeling of the student through an e-course in LMS by the use of Petri nets. At the beginning, a universal model of student transition through e-course has been created into which an other modul was designed – student scoring and grading (evaluation). When modeling the modul, all aspects and possibilities were take into consideration, that may happen during the assessment. The benefit of modeling with Petri nets is the simplicity of modeling and a the consequential simulation of a given model. Another benefit of educational process modelling using Petri nets is its formal description, which is complemented by a visual graphic depiction. This allows for a precise and exact specification of the process, which facilitates elimination of ambiguity, vagueness and contradictions. Petri nets, besides the visual graphic expression, have also square defined mathematical fundaments, which can suitably be used in various software tools for the specification and analysis of computer-solved company processes. On the anstract model, simulation experiments may be implemented which are gradually evaluated. On the basis of achieved results, the student´s transition through e-course can be simulated and consequently evaluate his activities. To control the educational process, the aim of the system is to lead the communication according to the student´s knowledge and skills and thus change the quantity and the demandingness of the materials provided for the student.

When creating the materials, authors starts to deall with only the technical improvements in the area of Web-based education, but also accentuate the implementation of pedagogical and psychological concepts into planning the electronic forms of education, such as learning, recurrence curve and curve of forgetfulness. Although, an ideal system which would be close for every student is utopian for sure. But it is possible to approach the perfect personalization of teaching by means of correctly designed models by the use of Petri nets.

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Simulating Projectile Motion in Visual C# and Lazarus at Gymnasium

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Abstract

The paper brings the results of an experiment in which Lazarus and C# applications that simulate free fall and projectile motion in a vacuum were developed with two groups of undergraduates of Teaching Informatics and four groups of four-year gymnasium students (age 15-19). The aim was to explore the potential of the environments for learning programming and STEM disciplines together. Questionnaire was given to the students. The results are discussed.

Keywords

Programming. Modelling. Simulation. Physics. Mechanics. Ballistics.

INTRODUCTION

Governments make big effort to promote STEM (Science, Technology, Engineering and Mathematics) education in schools to encourage young people to go study STEM disciplines. However, the success is well below the expectation, which results in a huge demand for STEM specialists in the world. Reis et al. (2009) enumerate several challenges and obstacles that STEM education has been facing: theoretical-methodological inadequacy; teacher pre- and inservice preparation; quality didactic books and technology equipment; fallacious pedagogical theories according to which students can learn spontaneously without practical experience yet with overlay-abstracted contact with theory; difficulties to work in an interdisciplinary approach; rapid changes in the world of knowledge. The consequence is that secondary students find STEM disciplines difficult and boring. A way how to make STEM disciplines more attractive to the students is to enable them to experience the joy of exploring, discovering and creating a meaningful product, a software application that simulates a real system and helps to solve a real problem (see e.g. Hubálovský, 2010; Hubálovský and Milková, 2010). To create the application, the students have to make inquiry into the system, find the algorithm and implement it in an environment. That is learning STEM and programming together in the sense of "learning by doing" (Papert, 1986) and synthesising computing and sciences (Towards 2020 Science", n. d.). This way of teaching informatics at school supports interdisciplinarity and helps to develop the way of thinking used in STEM disciplines (see e.g. Hubálovský, 2012; Krajčovičová and Cápay, 2012). Finishing successfully developing the application gives

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young people the feeling of being a creator and success, which is a weighty motivating factor (see e.g. Cápay 2013; Cápay and Magdina, 2013; Trojovská and Trojovský, 2012).

Benacka and Reichel (2013) presented the results of an experiment with using Delphi for modelling at gymnasium. Free fall and projectile motion in a vacuum were simulated with 43 students. The topic is closely connected with computers as Harvard Mark I, the first automatic operating machine was used by the US Navy for ballistic computations ("Inventors of the Modern Computer", n. d.). A questionnaire was given to the students. The responses showed that the students found computer modelling an interesting way of learning programming and STEM disciplines together.

In this paper, the results of an experiment are presented in which Lazarus and Visual C# 2010 Express applications were developed with two groups of undergraduates of Teaching Informatics and four groups of four-year gymnasium students, age 15-19, 62 altogether. Free fall and projectile motions in a vacuum were simulated. The reason for choosing the two environments was that: (1) Lazarus is a Rapid Application Development tool that is largely used at schools in Slovakia (see Blaho, 2012); it uses the Object Pascal language, an up-to-date version of Pascal that was developed especially for teaching programming; it is free at www.lazarus.freepascal.org; (2) Visual C# was chosen by a group of 16 students (see below) as the second programming language to be studied along with Lazarus within the optional subject Programming; MS Visual Studio Express is free at http://www.visualstudio.com; (3) Both environments comprise components Chart and Timer that are essential for simulating. A questionnaire survey was carried out. The main aim was to ascertain whether the students found the lessons interesting, but also whether they understood the topic, learned new skills and whether the topic was motivating enough to continue with fall and projectile motion in the air as examples of more realistic physical motion. The results are discussed.

THEORY

The equations can be derived without using calculus just by superposing the motion in the x and y direction (Halliday, Resnick & Walker, 2011, p. 29, 64 - 70). That way is the topic taught in Slovak gymnasium in the optional subject Physics Seminar except for free fall that is taught in the first year in compulsory Physics.

Free fall: Let a body start falling free at time t =0 s from altitude h (Fig. 1 left) from rest. The coordinates, speed and time of impact are given by the equations

$$x = 0\,,\ y = h - \frac{1}{2}gt^2\,,\ v = -gt\ ,\ t_{\mathrm{imp}} = \sqrt{\frac{2h}{g}}\,. \tag{2}$$

Horizontal throw: Let a projectile be fired horizontally at time t =0 s from altitude h at speed v0 (Fig. 1 right). The coordinates, speed and impact time are

$$x = v_0 t\,,\ y = h - \frac{1}{2}gt^2\,,\ v = \sqrt{v_0^2 + g^2t^2}\ ,\ t_{\mathrm{imp}} = \sqrt{\frac{2h}{g}}\ . \tag{3}$$

Vertical throw: Let a projectile be fired vertically up from the ground at time t =0 s at speed v0 (Fig. 2 left). The coordinates, speed and time of impact are

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$$x = 0,\ y = v_0 t - \frac{1}{2} g t^2,\ v = v_0 - gt,\ t_{\text{imp}} = \frac{2v_0}{g}. \quad (4)$$

Oblique throw: Let a projectile be fired from the ground at time t =0 s at speed v_0 and elevation angle α (Fig. 2 right). The coordinates, speed and time of impact are

$$x = v_0 t \cos\alpha,\ y = v_0 t \sin\alpha - \frac{1}{2} g t^2,\ v = \sqrt{v_0^2 - 2v_0 gt \sin\alpha + g^2 t^2},\ t_{\text{imp}} = \frac{2v_0 \sin\alpha}{g}. \quad (5)$$

General throw: Let a projectile be fired at time t =0 s from altitude h at speed v_0 and elevation angle α (Figs. 3-5). The coordinates, speed and time of impact are

$$x = v_0 t \cos\alpha,\ y = h + v_0 t \sin\alpha - \frac{1}{2} g t^2,\ v = \sqrt{v_0^2 - 2v_0 gt \sin\alpha + g^2 t^2}, \quad (6)$$

$$t_{\text{imp}} = \frac{v_0 \sin\alpha}{g} + \sqrt{\left(\frac{v_0 \sin\alpha}{g}\right)^2 + \frac{2h}{g}}.$$

The general throw reduces to free fall if $v_0 = 0$ and $h \neq 0$, vertical throw if $v_0 \neq 0$, $\alpha = 90°$ and $h = 0$, horizontal throw if $v_0 \neq 0$, $\alpha = 0°$ and $h \neq 0$, and oblique throw if $v_0 \neq 0$, $0° < \alpha < 90°$ and $h = 0$.

LAZARUS APPLICATIONS

The applications that simulate free fall and oblique throw are in Figure 1.

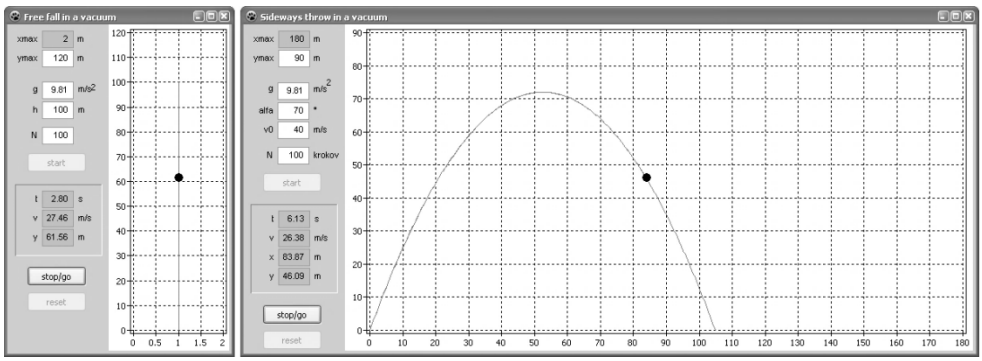


Figure 1: Free fall (left) and oblique throw (right) in Lazarus

The application that simulates general throw is in Figure 2. The Button components are named btStart, btStop, btReset. The Edits are edXmax, edYmax, edG, edAlfa, edV0, edH, edN, edT, edV, edX, edY. The white ones are for the inputs. The grey ones are for the outputs and set to "read only". There is component Chart1 with Chart1Lineseries1 for the trajectory and Chart1Lineseries2 for the ball. Runtime component Timer1 is set to disabled. The interval is set to 50 milliseconds. The following global variables are used: g, h, alfa, timp, x, y, t, v0, v and dt of type real, and N and i of type integer. Procedure FormCreate with local real variables Xmax and Ymax is executed just after running the application. The inputs are read. Chart Xmax is computed by the command Xmax:=2*Ymax to get the units of the axes equal, and outputted. The axes maxima are adjusted. Angle

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alpha is converted to radians. Impact time timp is calculated. Time step dt for drawing the trajectory is calculated as dt:=timp/400. The trajectory is cleared away by the command Chart1Lineseries1.Clear. Time is set to 0 and the (new) trajectory is drawn over 401 points by the loop for i:=0 to 400 do begin … end in which the x and y coordinates are computed and added to the graph by the command Chart1Lineseries1.AddXY(x,y), and the time is increased by dt. The ball is erased by the command Chart1Lineseries2.Clear, put in the initial position by the command Chart1Lineseries2.AddXY(0,h), and the outputs are set to "t"=0, "v"=v0, "x"=0 and "y"=h. The time step for simulating the motion is computed as dt:=timp/N. Clicking btStart starts procedure btStartClick in which btStart and btReset are disables, the inputs are locked, counter i is set to 0, t to 0, x to 0 and y to h, and the projectile is started to move by the command Timer1.Enabled:=True. The motion is simulated in procedure Timer1Timer (see below). Time t is increased by dt and counter i by 1. The ball is cleared away, the (new) x and y coordinates are computed, and the ball is drawn. The speed is calculated and outputted along with the time and coordinates rounded to 2 decimals. The motion is stopped if i=N, that is, if impact time timp is reached.

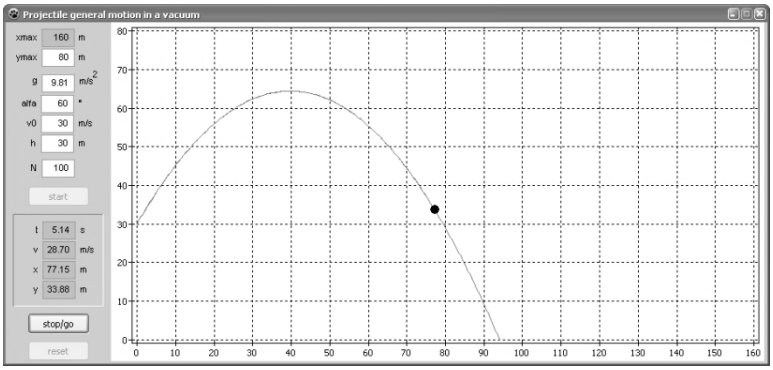


Figure 2: General throw in Lazarus

```
procedure TForm1.Timer1Timer(Sender: TObject);
begin
 t:=t+dt;
 Inc(i);
 Chart1Lineseries2.Clear;
 x:=v0*t*cos(alfa);
 y:=v0*t*sin(alfa)-0.5*g*t*t+h;
 Chart1Lineseries2.AddXY(x,y);
 v:=Sqrt(Sqr(v0*cos(alfa))+Sqr(v0*sin(alfa)-g*t));
 edT.Text:=FloatToStrF(t,ffFixed,4,2);
 edV.Text:=FloatToStrF(v,ffFixed,4,2);
 edX.Text:=FloatToStrF(x,ffFixed,4,2);
 edY.Text:=FloatToStrF(y,ffFixed,4,2);

 if i=N
 then begin
       Timer1.Enabled:=False;
       btReset.Enabled:=True;
       btStop.Enabled:=False;
      end;
end;
```

Clicking btStop stops or continues moving by the command Timer1.Enabled:=not Timer1.Enabled. If the motion is finished, btStop is disabled and btReset is enabled. Button btReset puts the ball in the initial position, adjusts the outputs, unlocks the inputs, enables

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btStart and disables btReset. If edit edYmax is active and key ENTER is pressed, then the following procedure runs procedure FormCreate. The procedure is assigned to all inputs on event KeyDown so the trajectory reacts interactively:

```
procedure TForm1.edYmaxKeyDown(Sender: TObject; var Key: Word;
  Shift: TShiftState);
begin
  if Key=13 then FormCreate(Sender);
end;
```

VISUAL C# APPLICATION

The Visual C# application that simulates general throw is in Figure 3.

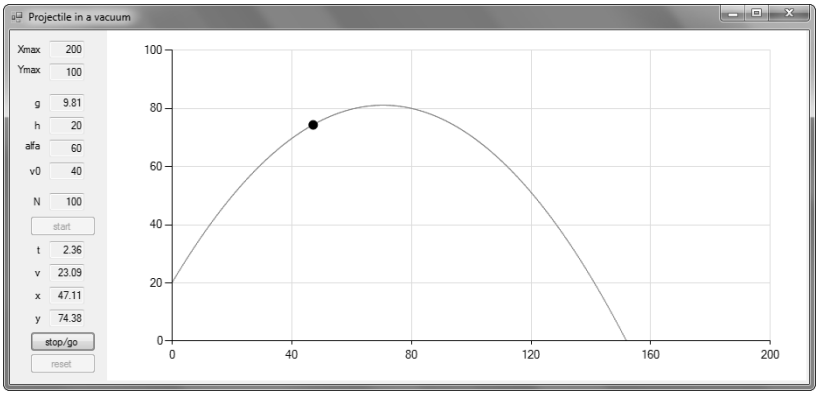


Figure 3: General throw in Visual C#

The algorithm is the same as in the Lazarus application. Component Chart1 comprises Series[0] of type FastLine for the trajectory and Series[1] of type FastPoint for the ball. The C# code that corresponds to the Lazarus code in the previous section is:

```
private void timer1_Tick(object sender, EventArgs e)
{
    t = t + dt;
    i++;
    chart1.Series[1].Points.Clear();
    x = v0*t*Math.Cos(alfa);
    y = v0*t*Math.Sin(alfa)-0.5*g*t*t+h;
    chart1.Series[1].Points.AddXY(x,y);
    vx = v0 * Math.Cos(alfa);
    vy = v0 * Math.Sin(alfa) - g * t;
    v = Math.Sqrt(vx * vx + vy * vy);
    textBox8.Text = t.ToString("0.##");
    textBox9.Text = v.ToString("0.##");
    textBox10.Text = x.ToString("0.##");
    textBox11.Text = y.ToString("0.##");

    if (i == N)
    {
        timer1.Enabled = false;
        button2.Enabled =true;
        button3.Enabled = false;
    }
}
```


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```
private void textBox1_KeyDown(object sender, KeyEventArgs e)
{
    if (e.KeyCode == Keys.Enter) Form1_Load(sender, e);
}
```

SURVEY

The applications were developed with two groups of university and four groups of four-year gymnasium students. The groups are listed in Table 1.

Groups PS1 and PS2 were 10 and 20 first year undergraduates of Teaching Informatics. They developed the Lazarus applications in optional subject Programming Seminar. Group PS1 developed the applications for free fall and oblique throw in two 90 minute lessons. Group PS2 developed the applications for general throw in a 90 minute lesson.

Group NI1 were 10 last year students (age 18-19) of Gymnázium Párovská 1 Nitra. They developed the Lazarus applications for general throw in a 90 minute Informatics lesson. The subject is an optional A level follow-up to compulsory subject Informatics taught in the previous years. Group NI2 were 5 last year students of Gymnázium Párovská 1 Nitra. They developed the Lazarus applications for general throw in a 90 minute lesson in optional subject Programming, which is another A level follow-up to compulsory subject Informatics. Group CC were 3 last year students of Gymnázium Nové Zámky, members of the computer modelling club that works at the school. They developed the Lazarus application for general throw in a 90 minute club session. Group SU were 14 last year students of Gymnázium Šurany. They developed the C# application for general throw in a 90 minute lesson of optional subject Programming in C# that they chose along the optional subject Programming in Delphi.

The groups were given the following four questions with answers to choose:

A) The lessons were (1: very; 2: quite; 3: little; 4: not) interesting;

B) I understood (1: everything; 2: majority; 3: little; 4: nothing);

C) I learned (1: very much; 2: quite much; 3: little; 4: nothing) new in programming.

D) I would like to develop the model of projectile motion in the air (1: yes; 2: no).

The average of the answers is in Table 1. The absolute frequency of the answers of the gymnasium students are in Table 2. There were five answers of 3 and no answers of 4.

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Table 1: Groups and average answers

Group	Age	Number	A	B	C	D
PS1	19-20	10	1.5	1.8	1.7	1.0
PS2	19-20	20	1.5	1.6	1.7	1.1
NI1	18-19	10	1.1	1.5	1.5	1.0
NI2	18-19	5	1.0	1.6	1.6	1.0
CC	18-19	3	1.0	1.3	1.3	1.0
SU	18-19	14	1.6	2.0	1.8	1.1
Weighted average			1.4	1.7	1.7	1.0

Table 2: Absolute frequency of the answers of the gymnasium students

Question	A				B				C				D	
Group	1	2	3	4	1	2	3	4	1	2	3	4	1	2
NI1	9	1	0	0	5	5	0	0	5	5	0	0	10	0
NI2	5	0	0	0	2	3	0	0	2	3	0	0	5	0
CC	3	0	0	0	2	1	0	0	2	1	0	0	3	0
SU	6	8	0	0	3	8	3	0	5	7	2	0	13	1

The relative frequency of the answers of the gymnasium students are in Figure 4.

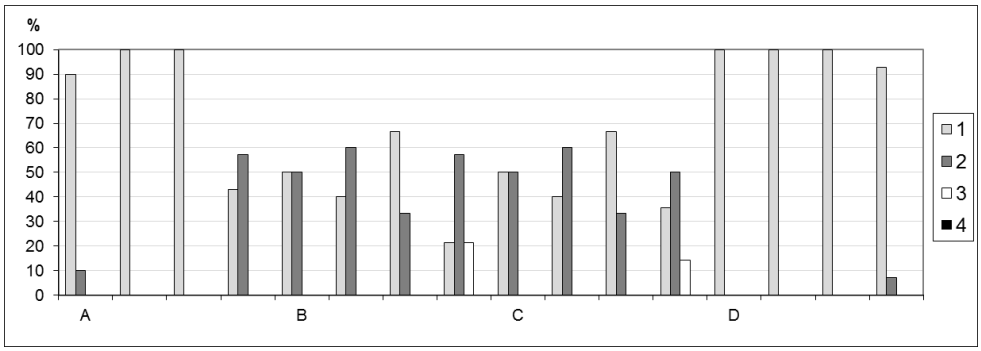


Figure 4: Relative frequency of the answers of the gymnasium students in %

The relative frequency of the answers of the gymnasium students in total is graphed in Figure 5. The result is that: (A) 72% found the lessons very interesting while 28% found them quite interesting; (B) 38% understood everything while 53% understood the majority and 9% understood little; (C) 44% have the feeling that they learned very much new in programming while 50% learned quite much and 4% learned little; (D) 97% would like to continue with the models in the air while 3% not.

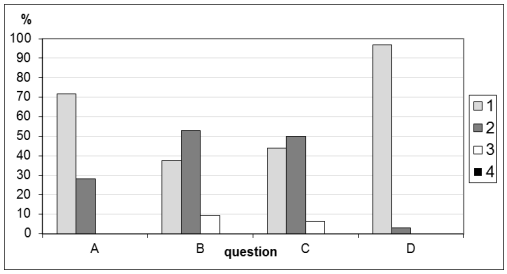


Figure 5: Relative frequency of the answers of all gymnasium students in %

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CONCLUSION

The paper gave the results of an experiment in which Lazarus and C# applications that simulate free fall and projectile motion in a vacuum were developed with 30 undergraduates of Teaching Informatics and 32 gymnasium students in optional informatics lessons. A questionnaire survey was lead. The outcome for the gymnasium students is that 100% found the lessons interesting (72% very and 28% quite), 94% had the feeling that they learned much new skills (44% very and 50% quite), and 97% would like to develop the model in the air. It can be concluded that developing applications that simulate physical phenomena is an attractive way of learning programming and STEM together at upper secondary level. Improving the model and making it more realistic seems to be a highly motivating factor.

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Enhancing Assessment of Students' Knowledge Using Fuzzy Logic in E-Learning

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Abstract

Assessing students' knowledge in the e-learning environment is a very complicated task. This is valid even more if the assessment is used as an input for further processing by an adaptive system that should generate personalised learning content. Assessment of students' knowledge, which is part of the proposed model of an adaptive e-learning system, lies in the focus of this paper. The model as a whole is created for significant optimisation of English language learning which is based on using Learning Management Systems (LMS). In comparison with traditional static models of e-courses, which actually offer a uniform content to all students, the proposed model offers its users/students adaptation in the area of their knowledge level and learning style (their combination respectively). In addition, the model is supported by automated decision-making processes, which are the most significant tool for optimising language learning. Automation of such decision-making processes is required in several areas. Knowledge assessment, which is one of the crucial ones, results in obtaining desired inputs for ideal progress in further steps of student's learning process. Such input information provided by the student carries a certain extent of uncertainty, thus it is necessary to base the decision-making processes on IF-THEN rules supported by a fuzzy-oriented expert system. The adaptive system for decision-making support will then enable automated creation of study variants suited to each individual student's needs, which current learning management systems do not enable.

Keywords

E-learning. Language learning. Fuzzy logic. Adaptive systems. Expert systems.

INTRODUCTION

When designing an e-learning course, the tutor expects certain input knowledge which students should possess when starting the course. There are issues to solve, however. First of all, how to assess students' knowledge. Secondly, what to do with the results of this assessment. This paper will deal with those two questions aiming at providing a proposal of a model supporting adaptive behaviour of a Learning Management System (LMS), primarily focusing on explanation why and how to use fuzzy sets in knowledge assessment.

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Before proceeding to the topic itself, approaches of other important researches have to be mentioned. The most suitable starting point is undoubtedly Brusilovski's work concerning adaptive hypermedia and educational systems (Brusilovski, 1996) and primarily (Brusilovski, 2007). His approach is the basis for other researchers that have been dealing with Intelligent Tutoring Systems (ITS). An example of an ITS represents (Virvou, 2001), who developed „*Passive Voice Tutor"*, which is a system for teaching the Passive voice to Greek students. This ITS, in fact, includes knowledge of one domain, tools for modelling a student, recommendation generator to a student, and user interface (Wenger, 1987). (Fum et al., 1992) created ITS another system, this one aimed at the system of English tenses – *English Tutor*. *English Tutor*, similarly to *Passive Tutor,* is usable only for a limited spectrum of the language, grammar tenses. Moreover, it was overcome by *Passive Voice Tutor* in its ability to identify not only mistake in tenses, but also spelling and other mistakes likeable to occur in the answer. *Passive Voice Tutor* also creates a long-term profile of the student, which is not possible in *English Tutor*.

Comparing the above-mentioned systems, all of them differ from the proposed system. Either they do not work with learning styles and focus only on a limited spectrum of a language (see Virvou and Fum), or they do not use fuzzy-oriented expert systems (Pokorný, 2004) for adaptation of the system (see Brusilovski). Thus, a comprehensive, universal adaptive system that would combine elements necessary for modern e-learning, such as integrating learning styles/sensory preferences, identification of student's knowledge, assigning suitable learning objects and creating a personalised study plan using a fuzzy-oriented expert system, which has been tested and run in practice cannot be found in current sources.

ASSESSMENT OF LANGUAGE KNOWLEGDE

Computer-based learning is very favoured among the users of e-learning, mainly if it concerns languages (Bos and Plassche, 1994). A language can be learnt through e-learning, with limited possibilities though. Thus, the results often show that e-learning of a foreign language falls behind in areas of flexible feedback and individualised approach (Murphy and Tear, 1997). The foundation stone for introducing a personalised approach into e-learning is assessment of student's knowledge. Failing this, it results in inability to conclude what the student needs to learn from scratch, which knowledge to deepen, enlarge, or just revise.

Recently, the use of technology in assessment has expanded considerably from the growth of Computer-Based Testing (CBT) to the introduction of onscreen marking, online results and online results verification. *Technology applied to testing in the form of offering candidates tests via computer aims to make assessment more appealing, efficient and serviceable and brings with it many advantages, including a positive impact on those who enjoy using computers, ease of administration, speed and reliability of marking, greater security, better motivation to some candidates and arguably a more friendly interface than paper-based tests.* (Chalhoub-Deville, 2001) in LMS systems, CBT can be performed by numerous question types. CBTs in the area of languages primarily offer question types, such as "*multiple choice*", "*short answer*", and "*embedded answers (cloze)*". The last one is suitable for combination of various question types. However, if the testing should be auto-grade without any manual interference of the teacher, there is no other choice than to

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choose question types allowing multiple correct answers. For example, using the "*short answer*" for testing future tenses can bring such a situation: „*We are … to start*" anticipates that the students fill in „We are *going* to start", but the student can also fill in „We are *ready* to start". It is also correct, but the system will consider it incorrect. Such a question type is not then suitable for auto-grading as the creator of the test cannot presume all possible answers. Auto-grading will also enable to use the results in further steps of creating a personalised study plan. With respect to meeting the requirement of fully automated testing, the most suitable alternative seems to be "*multiple choice*". The student selects from pre-defined answers. However, this way of testing hides one drawback. The usual number of the pre-defined answers is three of four. It gives a student a certain chance to "guess" the correct answer despite his total ignorance of the topic. The probability decreases with the rising number of pre-defined answers. Chapter "Re-assessment by iteration" tries to suggest how to eliminate this negative side of *multiple choice*.

USING A FUZZY-ORIENTED EXPERT SYSTEM FOR ASSESSMENT

Expert systems belong to the most practically spread tools of artificial intelligence. More than forty years ago, Marvin Minsky (Minsky, 1967) introduced his definition stemming from the Turing imitation test:

"*Artificial intelligence is science about designing machines and systems which will solve a task using such a procedure which, if solved by a human, would be considered a sign of his intelligence.*"

The basic idea of an expert system then lies in using computer-stored quality expert knowledge to solve tasks when the expert is not available. The quality of an expert system corresponds with the quality of knowledge and effectiveness of its computer representation. The most natural and operative way to express such knowledge is to use a natural language. In addition, the most effective form of expressing human knowledge is productive rules of the IF-THEN type. Linguistic description obviously introduces a problem of vagueness of such statements. Expressions such as a "good student" or "bad student" are not strictly defined, cannot be quantified so easily. Thus the most used way of formalising vague expressions, e.g. linguistic expressions, are so-called fuzzy sets, introduced by a University of Berkeley professor Lotfi A. Zadeh (Zadeh, 1965).

He solved the obstacles of the bivalent condition: the item either belongs or does not belong to the given set, which does not cause problems when operating over numbers, but over vague, linguistic expressions. A fuzzy set permits gradual assessment of the membership of the element in the set. Imagine a situation when a student is tested on 120 questions. Using traditional crisp sets, they can be displayed as in Fig. 1:

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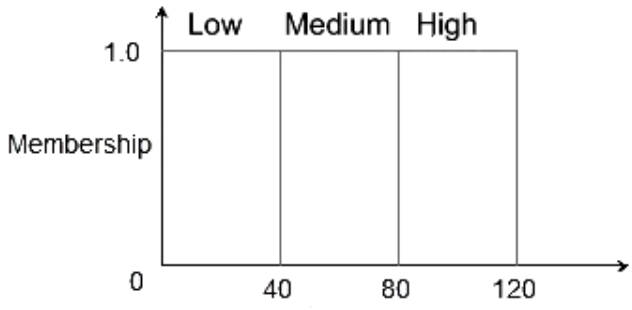


Figure 1 Student's knowledge - crisp sets

or written as follows:

k ∈ <0, 40) - low

k ∈ <40, 80) - medium

k ∈ <80, 120> - high

However, this would mean that a student scoring 39 has low knowledge, 40 medium knowledge and 79 medium as well. Thus, two students with a difference of only one question, i.e. less than 1%, would be classified as having low and medium knowledge. On the other hand, two students scoring 40 and 79, i.e. difference reaching 33%, would be classified as having the same level of knowledge – medium. It is striking that such crisp numbers distort the assessment considerably.

Let's have a look at the same situation modelled using fuzzy sets. A linguistic variable, i.e. student's knowledge, can be of three linguistic values: *low, medium, high*. Linguistic values can differ depending on the expert creating the knowledge base. The same holds for the membership function.

The difference of these two approaches lies in their strength of reflecting the real world. Crisp sets provides only bivalent states, either 0 or 1. Fuzzy sets, however, enable to express the degree of truth in the universum <0, 1>. If a student scores 40 or 80, then the degrees of truth are as follows

$\mu_{low}(40) = 0.5$ $\mu_{low}(80) = 0$

$\mu_{medium}(40) = 0.5$ $\mu_{medium}(80) = 0.5$

$\mu_{high}(40) = 0$ $\mu_{high}(80) = 0.5$

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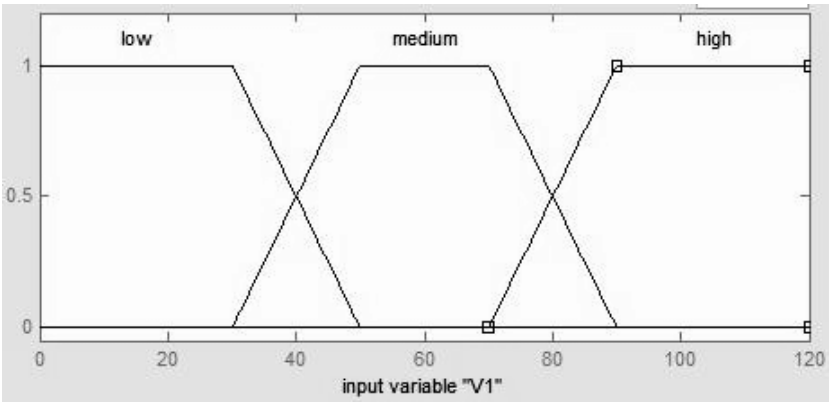


Figure 2 Student's knowledge - fuzzy sets

Assessing students' knowledge by fuzzy sets corresponds with the achieved results. Any other result would change the degrees of truth to individual fuzzy sets. Such form is very suitable for reflecting the real world. An experimental verification of using a fuzzy-oriented expert system for knowledge assessment is described in detail in the following section.

PROPOSED MODEL OF ADAPTATION

The model of adaptation, see Fig. 3, stems from a general model published in (Klimeš, 2011).

In order to be able to identify the structure of a decision-making process, and thus to create prerequisites for finding effective procedures for its algorithmization, we have to deal with decision-making processes from a wider point of view, primarily from a methodological point of view.

One of the characteristic features of decision-making processes is the fact that they often work with uncertain and non-metric information, which often stems from the fact that the input values of these processes are provided by a human on the basis of their estimations, experience, opinions, etc.

Despite the fact that the process contains a whole range of uncertainties, its structure can be fairly easily defined. What's more, elements of a decision-making process can be divided into the following groups:

- set of student's input knowledge;
- set of all (admissible) objectives describing output student's knowledge;
- set of all admissible solutions to achieve the given objectives;
- set of all levels of existence (probabilities) of steps to achieve al admissible objectives;
- set of all evaluations of the given solution;
- time interval.

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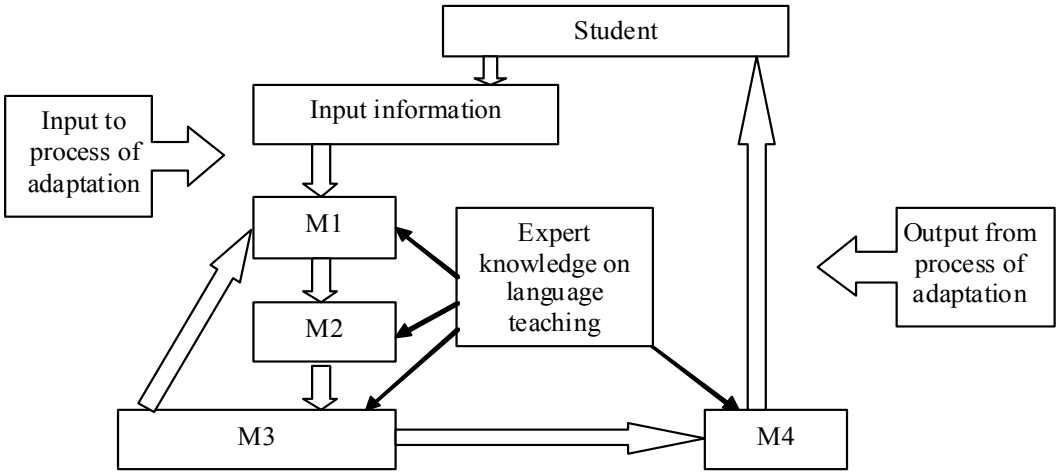


Figure 3 – Decision-making process

The decision-making process is represented by various depicting between these sets. It primarily concerns the following processes:

- (M1) acquisition, completion and evaluation of the input information about the student, i.e. selecting information which is relevant for language learning;
- (M2) definition of language learning objectives and admissible solutions for their achieving, i.e. formulating objectives of the language learning based on the description of the given situation and formulating admissible solutions;
- (M3) modelling the progress of individual proposed solutions – each admissible solution is assigned a set of situations and their time sequence which arises from the given solution;
- (M4) approving one of the proposed solution as the optimum variant to achieve the learning objectives based on the effects of the admissible solutions.

The whole decision-making process is created by a gradual composition of individual processes, as depicted in Figure 3.

The input information entering the decision-making process to generate the optimum studying plan can be divided into the following groups:

- result of a didactic test according to the number of answered questions;
- evaluation of the didactic test according to the categories of grammatical sections;
- time needed for completing the test;

The input information is crucial for further decision-making processes (M2-M4). Correct setting of the first process (M1) lays the highest importance on the knowledge base and fuzzy rules which will be used in this phase. Structuring the didactic test will play a vital role in assessing student's knowledge. Tutors can be inspired by CBT, where there already are several forms in use – let's mention Cambridge ESOL or TOEFL.

While making decisions, the adaptive system will use expert knowledge structured into the following areas:

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- minimum and "ideal" knowledge in individual steps of learning;
- time interval necessary to achieve the output knowledge from the level of minimum input knowledge;
- time available for the studies.

Process M1 - Didactic test

Tutor's most important, though demanding, work is to elaborate and describe a didactic CBT fitted to the purposes of the e-course that is going to be prepared (focus, required input knowledge, expected output knowledge). Based on the answers provided by the student, the system will automatically assess the results using a knowledge base.

Let's present an example of such a test. For our purposes, we can use a standardised placement test that is provided by the Cambridge University (Cambridge University, 2010). In general, placement tests begin with simple questions for beginners gradually bringing the grammatical issues to higher levels. The aim of a placement test is to identify student's level according to the Common European Framework (CEFR) (Council of Europe, 2011). The levels are divided into levels A1-C2. The sample placement test covers levels A1-C1.

Assessment of the placement test as a whole does define the level of student's knowledge, but does not say anything about where the student has made the mistake, what areas he knows and where he falls behind. It means that the tutor/system does not have information on which study materials to offer.

Thus it is necessary to analyse individual questions according to their grammatical focus. In our case, the placement test of 120 questions covers a wide range of grammatical issues.

Individual questions have been subjected to an analysis and sorted out according to grammatical categories. Table 1 shows those categories and questions which they include. Some questions are included in several categories as we will need to identify both correct and incorrect answers – each question has more choices to select from and, if relevant, it is necessary to analyse which incorrect answer has been selected.

Table 1 – classification of questions into categories and areas

Area	Category	Grammar:	Question number:
A1	C1	Present perfect simple	37,42, 44, 48, 54, 61, 63, 120
A1	C2	Past simple	16, 20, 37, 39, 42, 44, 56, 61
A1	C3	Present simple	9, 12, 24, 31, 33, 34, 39
A1	C4	Present continuous	31, 33, 39, 61,120
A1	C5	Future tenses	33, 34, 64, 97
A1	C6	Past continuous	44, 61
A1	C7	Present perfect contin.	72, 120
A1	C8	Past perfect	83
A2	C9	Prepositions	7, 11, 13, 15, 43, 74, 76, 85, 86, 102, 112
A2	C10	Conjunctions	8, 14, 59, 73, 87, 92, 113
A3	C11	Determiners	2, 10, 27, 29, 35, 38, 55, 58
A3	C12	Pronouns	5, 6, 19, 22, 30, 71
	C13	Modal verbs	24, 36, 46, 49, 62, 67, 75, 84, 88
	C14	Vocabulary	3, 4, 17, 18, 25, 26, 28, 40, 45, 47, 77,

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			79, 80, 81, 82, 94, 96, 99, 100, 101, 103, 104, 106, 108, 109, 110, 111, 114, 115, 117, 119
	C15	Phrasal verbs	66, 78, 89, 93, 95, 105
	C16	Forming questions	1, 9, 13, 20, 23, 34
	C17	Conditional clauses	51, 60, 68, 90
	C18	Verb patterns	57, 65, 69, 116
	C19	Passive voice	52, 107
	C20	Adjectives	32, 50

Division of the questions into individual categories enables us to analyse the test into depth. Individual steps are ordered in the sequence they should be processed:

19. Identifying grammatical categories included in the test.
20. Sorting out the questions into corresponding categories.
21. Identifying questions hitting more grammatical categories.
22. Identifying in/correct answer A,B, C, or D respectively (D from question 41) with subsequent assigning the given answer to corresponding grammatical category.
23. Joining categories into areas.
24. Defining rules for completing the model of student's knowledge.

The output is assessment of the need of further studies of the given grammatical category.

The placement test has been divided into categories C1-C20, see Table 1, and areas A1-tenses, A2-joining words, A3-determiners and pronouns. Not every category is assigned to some area as it does not relate to other categories.

Assessment of the need of further studies in individual categories

Sorting out the test itself is the beginning of the assessment process. Individual categories will be subjected to an analysis assessing the need of further studies of individual categories in the given e-course. An experimental assessment has been performed by software tool LFLC (Habiballa et al, 2003), which was designed for work with indefinite information. This software enables to use fuzzy logic to work over knowledge bases created by experts on the given area, here on the area of language learning.

The process of analysing individual categories considers the following input linguistic variables (V1-V4) gaining the listed linguistic values:

- number of correct answers (V1) – *low, medium, high*
- weight of correctly answered questions (V2) – *low, medium, high*
- importance of the category for further study (V3) – *very low, low, medium, high, very high*
- time spent on questions of the given category (V4) – *low, medium, high*

The output linguistic variable is expressed as follows:

- need of further studies of the given category (V5) – *extremely small, very small, small, more or less medium, medium, big, very big, extremely big*.

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The knowledge base used for analysing this part of process M1 contains 135 linguistic rules. There is a possibility of a graphical visualisation of the output, see Fig. 4, which is only for illustrative purposes and serves only to better grasp crucial categories (Walek, 2012). It was designed as an add-on application to LFLC software, which had not had any graphical output before. The visualisation shows which categories are strongly (red) moderately (green) and weakly (yellow) recommended to be offered in further studies. The adaptive system itself processes this information in further steps (processes M2-M4).



Figure 4 – Graphical visualisation of the need of further studies in individual categories

Processes M2 – M4

Next steps in the process of generating an optimum personalised study plan for a student are as follows:

- the study objectives are settled;
- process M2: selecting only those relevant study objectives for the given student (based on data from M1). Process M2 is completed when all relevant partial study objectives have been identified for the given student;
- process M3: generating possible sequences for student's progress through the course;
- process M4: selecting the "most optimum" variant for passing through the course. Such a variant is selected out of the proposed sequences created in M3.

Re-assessment by iterations

However, the "most optimum" variant at the beginning of the study process does not have to appear as the most optimum later, during the study itself. For instance, when dealing with initial assessment of student's knowledge, the student might have scored even in questions where he does not know the answer – the negative of the multiple-choice type of testing. But this drawback is easy to eliminate. Student's progress through the course is monitored and data about time and results are stored and continuously evaluated by the system. Thus, any inaccurate knowledge assessment in the initial phase can be corrected later during the study progress itself. Adaptive characteristics of the system is initialised when necessary and the system can adjust the study plan, thus comes back to M1 and creates an updated study plan. Thus the loop of the decision-making process is complete, see Fig 3. This iteration is repeated several times, depending on the time span of the course. The longer the course, the more iterations it includes.

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CONCLUSION

The paper dealt with the issue of assessing students' knowledge of language in the e-learning environment using fuzzy logic tools. The research has proved that, compared to traditional methods of assessment, using a fuzzy-oriented expert system considerably enhances knowledge assessment and simplifies the process of identifying student's weaknesses. What's more, using the proposed model of an adaptive e-learning system enables to tie the process of assessment with subsequent processes of planning, i.e. generating an optimum personalised study plan for individual students.

This conception will bring into life a fully-fledged running decision-making system to support e-learning of the English language.

However, before this happens, further research will have to be done in the area of appropriate assigning of learning objects, criteria and procedure for generating study variants, and specification of how to choose the optimum study variant.

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Attitudes of Students at Higher Education Institutions towards ICT in Education

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Abstract

The present paper discusses three surveys conducted at University of West Bohemia in Pilsen in 2012 and 2013. It focuses on selected questions from these surveys mapping students' attitude towards learning with the aid of information and communication technologies. The first survey explored in detail the attitudes towards e-learning of 152 students of Introduction to Text Information Processing, an on-line course at the Faculty of Education. The second survey involved 1136 students of technical disciplines at University of West Bohemia in Pilsen. It was conducted after they completed courses taught with the aid of interactive multimedia textbooks (e-books). In the third survey, an extensive questionnaire on students' possession of new technology devices, their competences in using ICT in education and on the actual study activities supported by new technologies was used to explore their general position on the use of ICT in education.

Keywords

Information and communication technologies. E-learning. Blended learning. University. Student attitude.

INTRODUCTION

The use of information and communication technologies has become an everyday part of instruction at higher education institutions. We speak about Digital Native students, about the need for systematic development of distance and blended study programmes relying on technologies and about developing an adequate platform for electronic support of instruction, communication and sharing (Prensky 2001, Zounek 2010). However, the attitudes we encounter towards e-learning and towards the use of new technologies in education are not always favourable. Critical voices and references to weaknesses can be heard in discussions with teachers and students. Frequent criticisms of the new technologies include, for instance, the claims that students who receive all study materials in electronic format feel no need to attend lectures, lack the in-depth approach to learning and tend to believe that whatever they fail to learn, they can always look up somewhere.

New technologies are used at University of West Bohemia (UWB) in Pilsen in multiple ways. Teachers have access to the Courseware electronic teaching support system and to authoring tools for developing interactive multimedia textbooks. In blended learning programmes, they can use the Moodle LMS and develop and teach on-line courses. Since we repeatedly wondered what the students' attitude towards the new technologies was and whether the extensive deployment of technology in teaching had beneficial effects, we undertook several limited-scale surveys in 2012 and 2013.

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RESEARCH 1 mapped in detail the attitudes towards e-learning of 152 students in the subject Introduction to Text Information Processing, which was taught as an on-line course at the Faculty of Education of University of West Bohemia in Pilsen. We anticipated that a course developed and conducted with utmost care and in accordance with all pedagogical principles for successful e-learning would improve the students' position on technology-aided instruction. The following hypothesis was thus proposed:

H_1: At the end of a quality learning programme in e-learning format, students will develop significantly better attitudes towards electronic education.

The hypothesis in RESEARCH 2 was formulated in a similar manner. The survey involved 1136 students in technical disciplines at University of West Bohemia in Pilsen. The survey was conducted after they completed courses taught with the aid of interactive multimedia textbooks (e-books). These e-books, which offered the latest information, case studies and extensive multimedia materials, were developed by teachers in technical disciplines in collaboration with experts from industry under a large-scale project funded from the European Social Fund and the state budget of the Czech Republic. The following hypothesis was proposed for the evaluation survey conducted at the end of the project:

H_2: After completing a course taught with the aid of an interactive multimedia textbook, students will be interested in using multimedia textbooks in other subjects as well.

RESEARCH 3, which was conducted in collaboration with the Faculty of Arts of Masaryk University in Brno, focused on the students' possession of modern devices, the students' competences in their use and on finding the general position on the use of new technologies in learning at higher education institutions. Data was collected from 560 students of University of West Bohemia in Pilsen for multiple purposes, one of which was to verify the following hypothesis:

H_3: Students perceive that the use of ICT in education leads to good learning results.

In the present paper, we will attempt to outline all the three surveys and present their findings in terms of the students' attitudes towards education with ICT support. We devoted the most space to the first survey, as it has already been evaluated in full using relevant research methods. The other two surveys are currently at the stage of evaluation of gathered data and are only included for the sake of discussion of the outcomes of the first survey.

METHODS

RESEARCH 1 took place at the Department of Computer Science and Educational Technology of the Faculty of Education of UWB in Pilsen. The survey was conducted as part of the course entitled Introduction to Text Information Processing, the purpose of which is to introduce students to advanced use of MS Word. Students will find the knowledge and skills developed in this subject useful in preparing their course projects and Bachelor's (Master's) theses. The topics addressed included creating and formatting styles, mail merging, formatting large documents and using macros. Students were divided into experimental groups which were engaged in blended learning and into control groups which took part in e-learning activities. Members of the experimental groups (denoted as

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Group "blended") had access to an e-course which was well proven in previous runs of the subject and was intended to replace the conventional face-to-face lectures and seminars. In the e-course, the lecture texts were available to students in the form of HTML pages with animations and hypertext links. The main purpose of the animations was to facilitate the understanding of complex parts of the subject. The e-course was structured into topic-oriented units comprising study articles, self-tests and exercises. This structure allowed students to focus on those areas they found difficult or on new topics. They could thus skip the areas they were familiar with, devote their time to relevant topics and set their own study pace. In the face-to-face seminars, students developed their knowledge of the subject through hands-on exercises. Students in the control group (denoted as Group "e-learning") had access to the same e-course as the experimental group. However, their exercises were included in the e-course as well. Their entire instruction thus took the form of distance learning. The conditions for awarding the credits for seminars were identical in both groups: the students were required to successfully complete four practical assignments relating to the subject at four face-to-face seminars (their dates were announced at the start of the semester).

The data for the survey was collected from 152 students. At the beginning and at the end of the course, computer attitude scale (CAS) questionnaires were handed out to students to find whether their attitudes towards computers changed to any significant extent after the learning programme. (Přibáň, 2013) The CAS questionnaire used four-point Likert items where students could choose from responses ranging from "fully agree" to "fully disagree". The entire questionnaire was divided into five sub-categories. The first one reflected the student's self-confidence in working with a computer. The more points the students scored, the greater was their self-confidence in operating a computer. The second sub-category was concerned with the liking for computers. The more points students scored, the greater was their passion for computers. Another sub-category focused on the fear of computers. The more points, the greater the student's fear of computers. The second to last sub-category aimed at the perceived usefulness of computers where a higher number of points indicated that the students were more aware of the usefulness of computers in their private and professional life. The last sub-category explored the attitude towards electronic education. The more points the students scored, the more open they were to electronic education. The maximum score in each sub-category was 32. The maximum total score for the entire questionnaire was 160. For the purposes of the present paper, the fifth sub-category dealing with attitudes towards electronic education was selected. This sub-category comprised eight questions with the maximum and minimum achievable scores of 32 and 8 points, respectively.

RESEARCH 2 took place as part of the project entitled Product Life Cycle in Digital Factory Environment, in which 37 interactive multimedia textbooks were prepared using the ProAuthor authoring system. ProAuthor has been developed by University of West Bohemia in Pilsen since 2003. It features split screens where the left side contains multimedia materials and the right side offers texts guiding the reader through the multimedia content. The textbooks offer text, images, photographs, schematics, videosequences, animations, real-world examples, case studies, self-tests and hands-on exercises. They are unique study materials for instruction in the subjects. They also offer information which students have little chance to obtain from any other source.

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The method chosen for evaluating the course was based on a questionnaire. The questionnaire was handed out to students at the end of the semester, prior to awarding credits for seminars (the attitudes expressed were therefore unaffected by the student's success of failure in the exam). Printed questionnaires with twenty questions were filled in manually at the end of the winter and the summer semester of the academic year 2012-2013. The questionnaires comprised questions with scale-type level responses and two open-ended questions. For this paper, the question number 9 was selected: "After the recent experience, would you choose study materials prepared in the same manner for your next study endeavour?" the available responses to which comprised the options "yes" – "generally yes" – "do not know" – "not really" – "no". The data was entered in an MS Excel spreadsheet for evaluation. The data file for each respondent contained 34 items. Questionnaires were completed by 1164 students of 29 study programmes of the Faculty of Mechanical Engineering, Faculty of Electrical Engineering and Faculty of Applied Sciences of University of West Bohemia in Pilsen.

RESEARCH 3 was conducted in collaboration with the Faculty of Arts of Masaryk University in Brno. It was based on the quantitative method and relied on the findings from prior qualitative research. The survey itself was divided into two phases. In the first phase, pilot verification of the questionnaire was conducted at the Faculty of Arts of Masaryk University in Brno. In the second phase, data was collected at both institutions and then processed using statistical tools. The questionnaire was used in its printed form. The respondents were students of teacher training programmes and other (social sciences and technical) disciplines of University of West Bohemia in Pilsen.

The questionnaire contained 25 primary questions on the characteristics of the respondents and on their possession of modern devices, opinions on ICT and on the extent of the use of technical devices in learning. Additional ten questions focused on the experience of participants in tutor-led on-line courses. The second part of the questionnaire was completed by 90 respondents. The questionnaire combined various types of questions – several types of multiple-choice questions, questions with yes/no answers and open-ended questions. The data was collected in the period from May to June 2012 and entered in the IBM SPSS Statistic 20 system in August. At the University of West Bohemia in Pilsen, the questionnaire was completed by 560 respondents from various years and Bachelor's and Master's degree programmes from the Faculty of Education, Faculty of Health Studies, Faculty of Electrical Engineering, Faculty of Mechanical Engineering, Faculty of Applied Sciences, Faculty of Philosophy and the Institute of Art and Design. The large set of data obtained from the questionnaire contained 142 variables for each respondent.

RESULTS

In RESEARCH 1, the part of the CAS focusing on the attitude towards electronic education contained the following statements, to which students were to give their response on a four-level scale:

I study of my own accord without being forced by anyone.
I enjoy solving problems of the type that can become useful in my everyday life as well.

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I prefer learning from books to studying with the aid of computer.
I need face-to-face contact with the teacher during instruction.
Education with the aid of computer and the Internet suits me.
In my opinion, the best form of instruction combines face-to-face seminars and an electronic course available on the Internet.
In my professional career, education through electronic courses will be a necessity.
The most satisfying moment is the one when I discover the solution to a problem on my own.

Agreement with the statements earned students points at a level between the minimum of 8 and the maximum of 32. Data (averaged score assigned by students) gathered before and after the learning programme is plotted in the graph in Figure 1.

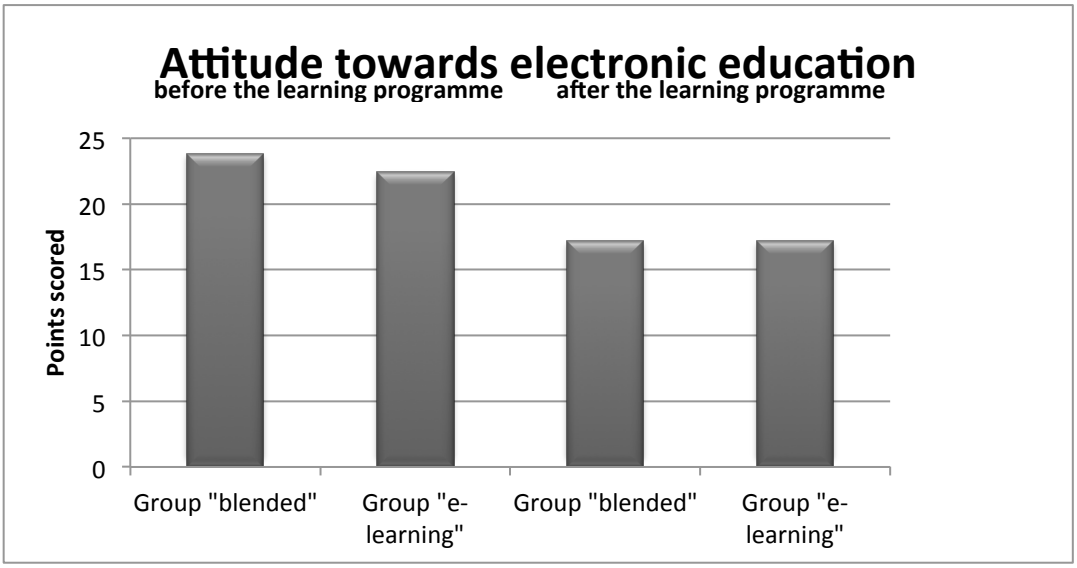


Figure 1: Changes in students' attitudes

Table 1 shows the differences between the attitudes towards electronic education after and before the learning programme. For the sake of clarity, the table only lists the final difference and the statistical evaluation data showing whether a significant change occurred in the particular group in terms of the sub-category prior to and after the learning programme. Where the significant change occurred, the column contains the word "Yes", otherwise it would contain "No". As the evaluation compared results for the same group of students before and after the learning programme, the non-parametric Wilcoxon test was employed and an additional parametric paired t-test was used for verification. The statistical tests were calculated with the significance level $\alpha = 0.05$.

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Table 1: Differences between students' attitudes towards electronic education at the beginning and at the end of the learning programme

Groups	N	Diff. between averages	Wilcoxon	Difference	T-test	Difference
Group "blended"	69	-6.6	63	Yes	7.94	Yes
Group "e-learning"	83	-5.2	25.5	Yes	6.82	Yes

The results suggest that a significant negative change occurred in the attitude towards electronic education. The negative shift in the attitudes towards electronic education can be attributed to the fact that in their primary and secondary education, most students encountered nothing else than the conventional face-to-face instruction. As a result, e-learning was new to them and even difficult for many of those, in terms of the need for motivation and the fact that they had no periodic contact with the teacher, unlike before. In order to prove or refute these assumptions, in-depth qualitative analysis would have to be performed.

Nevertheless, these results allow the answer to be found to the hypothesis proposed in the introduction section. The hypothesis was as follows:

H_1: At the end of a quality instruction programme in e-learning format, students will develop significantly better attitudes towards electronic education.

As there was a negative change in the attitudes, in both groups, it can be concluded that students have not shown a significantly positive change in their attitude towards electronic education at the end of the learning programme.

RESEARCH 2 included a question whether the respondent would tend to choose, after the experience of learning with the aid of a multimedia textbook, materials prepared in a similar manner for his or her further study efforts. The results are plotted in the graph in Figure 2. An affirmative response was given by 865 respondents out of 1164 (380 "yes – certainly", 485 "yes – probably"). Seven respondents gave no answer and 223 respondents chose the "do not know" option. Negative answers were given by 69 respondents (62 "probably not", 7 "certainly not").

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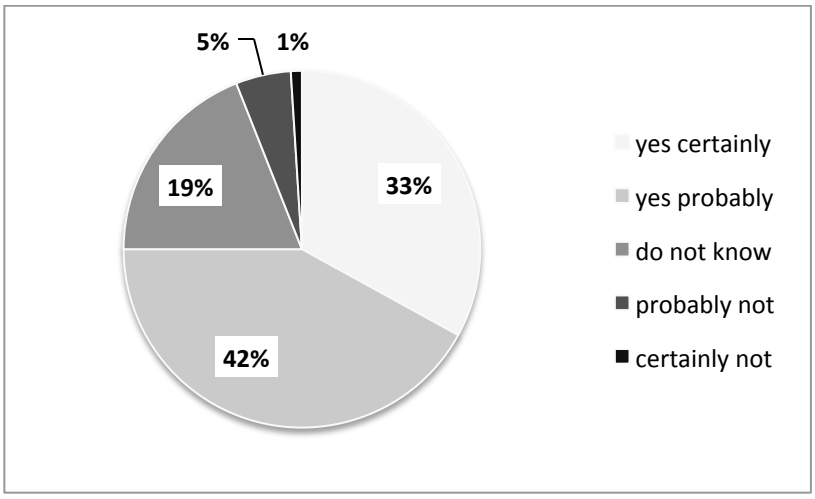


Figure 2: After the recent experience, would you choose study materials prepared in the same manner for your next study endeavour?

In the introduction, we proposed the following hypothesis:

H_2: After completing a course taught with the aid of an interactive multimedia textbook, students will be interested in using multimedia textbooks in other subjects as well.

This hypothesis was proven correct through our survey. The students' interest in multimedia materials is clearly reflected in the results.

RESEARCH 3 included selected actual statements given by students in the previous qualitative research conducted in 2010 at the Faculty of Arts of Masaryk University in Brno. We tried to verify these statements by means of a quantitative survey. We invited the respondents to give their responses on the scale agree – tend to agree – tend to disagree – disagree to statements such as the following:

- I only use ICT because I do not want people to think I am old-fashioned.
- The use of ICT should not be that widespread.

A) Use of ICT in education leads to good learning results of students.

All three statements are related to students' position on ICT. Their purpose is to find whether the students' interest in ICT is not pretended, whether they perhaps feel satiated with new technologies and whether the students, on the whole, see the use of ICT in education as beneficial to learning progress.

Re A): In the question containing the statement "*I only use ICT because I do not want people to think I am old-fashioned.*" (see Figure 3), students were to indicate whether they used new technologies only because the society expected them to, while they would not be interested in ICT by themselves. This statement was rejected by a majority of the students. Out of all 549 valid responses, negative answers were given by 490 respondents (398 "disagree", 92 "tend to disagree"), whereas 59 respondents agreed with the statement (16 "agree", 43 "tend to agree").

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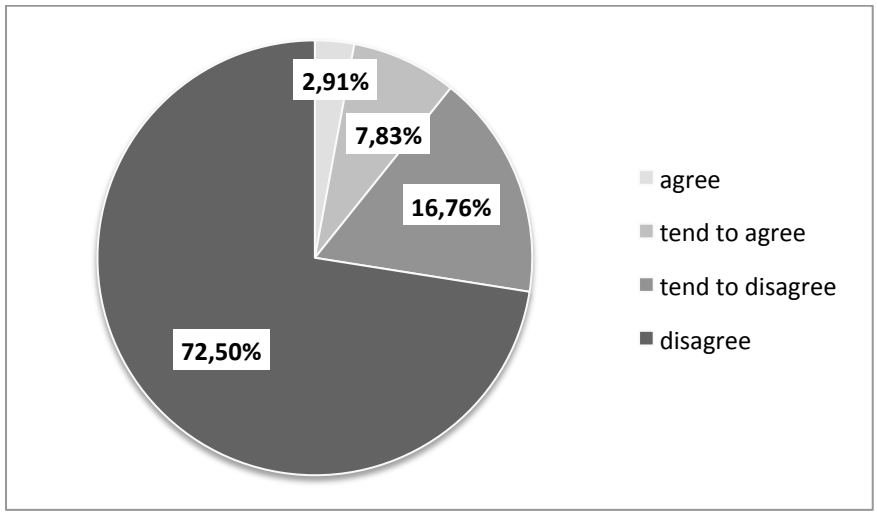


Figure 3: I only use ICT because I do not want people to think I am old-fashioned.

Re B): Another statement "*The use of ICT should not be that widespread*." (see Figure 4) was included to examine the frequent complaints that technologies are expanding to excess. This statement was accepted by only a slight majority of respondents. Out of the total of 544 valid responses, the negative ones were given by 317 respondents (83 "disagree", 234 "tend to disagree") and 227 respondents agreed with the statement (52 "agree", 175 "tend to agree").

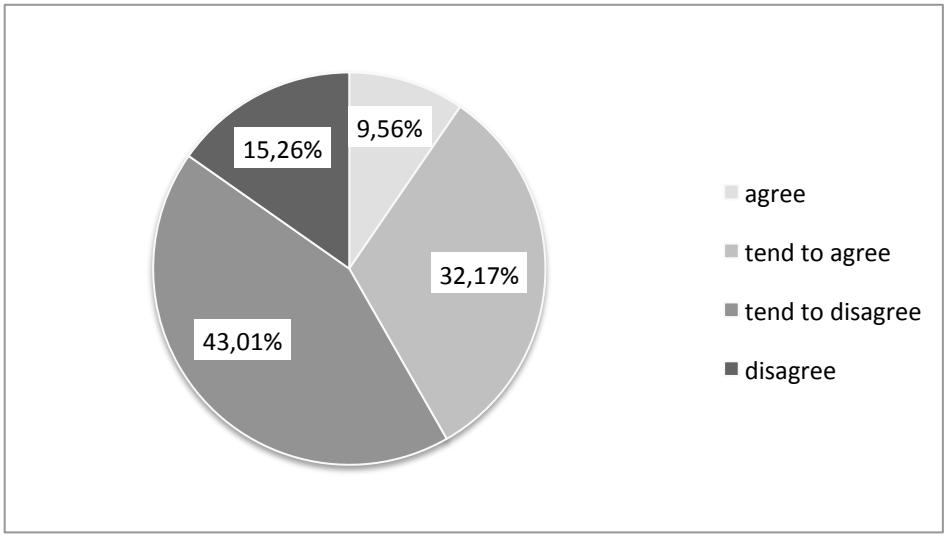


Figure 4: The use of ICT should not be that widespread.

Responses to the C) question containing the statement "*Use of ICT in education leads to good learning results of students*" reflected the students' generally positive view of the role of ICT in education, as evidenced by the graph in Figure 5. A total of 411 respondents stated in the questionnaire that the use of ICT in education leads to good learning results (108 "agree", 303 "tend to agrees"), 108 respondents expressed disagreement (14 "disagree", 94 "tend to disagree"), 14 respondents gave no response.

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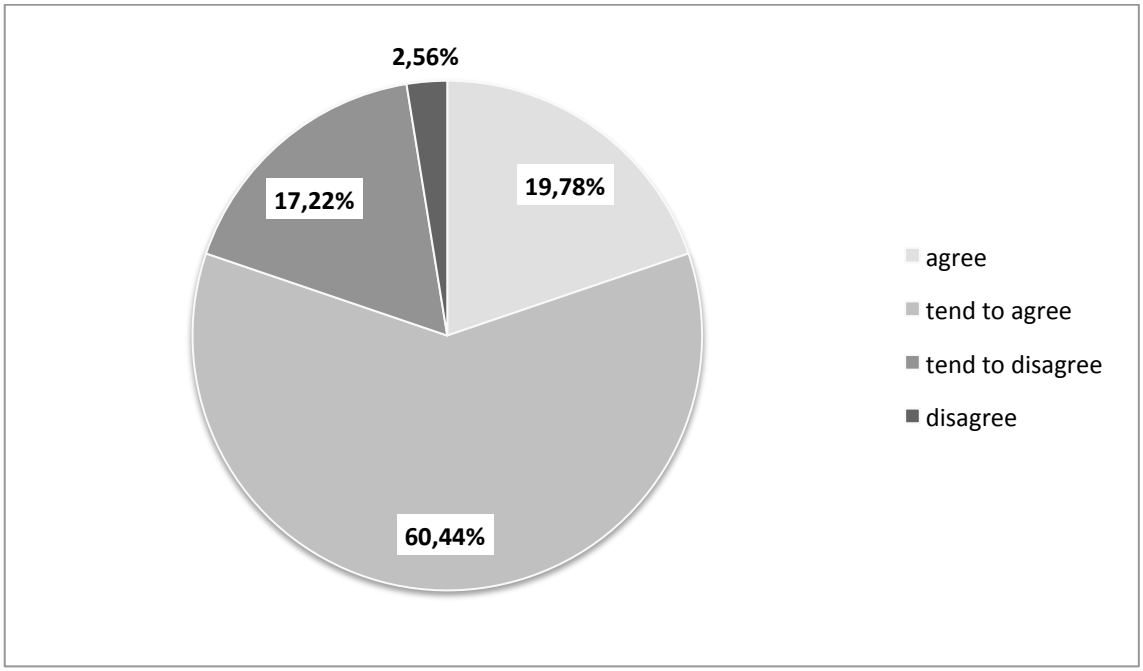


Figure 5: Use of ICT in education leads to good learning results of students.

The graph in Figure 5 and the positive responses of 80.22 % respondents confirm the hypothesis proposed in the introduction to the present paper:

H_3: Students perceive that the use of ICT in education leads to good learning results.

DISCUSSION

The results of RESEARCH 1, which reveal the significantly negative change in the students' attitude towards electronic education, should be explored in greater depth to ascertain whether they perhaps simply reflect the initial positive expectations related to new study experience and the final disillusionment with the fact that self-study requires even more effort than the face-to-face instruction. One could argue that the negative attitude toward electronic learning is due to inappropriate course content or management, but the evaluation survey of the realized course was positive.

RESEARCH 2 included a question which, on one hand, explored the students' attitude towards the use of ICT in education and, on the other hand, had a significant evaluation aspect. This means that the response reflected, to a great extent, the student's satisfaction with the particular multimedia textbook, rather than his or her general view of the use of ICT in instruction. This question was also questionable in terms of its lack of comparison with other types of study materials. For instance, it is plausible that if students worked with and were used to otherwise structured materials in other subjects, their opinions might have been different. In this case, the response is influenced by the fact that study materials for the particular subjects are not available at all. Consequently, the students must be grateful for virtually any material.

The results of RESEARCH 3 provide a proof that the students' general attitude towards the use of ICT in education is positive. For students, the new technologies are a natural

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part of their everyday life, including their higher education experience. Across the various disciplines studied at University of West Bohemia, the cases where students strictly refuse/ignore new technologies were rather exceptional.

In the first research the respondents were asked immediately after the end demanding semester, while on the third research there was a questionnaire not directly linked to particular course implemented using the technology. Maybe, this is just the reason why responses in the third research were much more positive. General attitude of students to technologies is positive, but during particular course they face numerous challenges and difficulties, that often unjustly blame on technologies.

CONCLUSION

The comparison between the surveys undertaken at University of West Bohemia reveals that a number of factors play the role the students' attitude towards education with the aid of ICT. The survey mapping the students' position on modern technologies highlights the variance in computer literacy of respondents, their prior experience and, as a fundamental factor, the effect of the most recent experience forming the student's attitude.

Differences between students at various faculties can be noted. Students at technical faculties are mostly satisfied with the quality of electronic courses presented to them and are comfortable with electronic education. By contrast, students of non-technical disciplines are not much in favour of electronic education. This difference may result from the different learning attitudes and curricula. Students in humanities are used to discuss problems with their teachers and most of their subjects are taught in face-to-face courses. On the other hand, students at technical faculties are used to the focus on self-study and to seminars where self-study topics are purposefully explored.

Future surveys will aim at particular issues relating to precisely defined technologies. The students' attitudes need to be mapped not only in regard to specific technology-related topics but also within a wider framework of students' general attitudes towards higher education institutions, the disciplines they study and the life in general and the everyday use of modern technologies.

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Creating a Sense of Presence in Online Learning Environment

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Abstract

Massive open online courses are to change the HEI status quo. Their dramatically quick entrance even to the formal education makes university managements reconsider the forms they apply at their institutions. Digital era brought e-learning and MOOCS are just the logical result of this era. The problem of (not only) Slovakia is that Methodology of online teaching and Principles of e-course design are still not an integral part of teacher training courses or alternatively the programme focussed on technical and didactic aspects of online teaching does not exist. The article offers a summary of research realised at the University of Presov which was aimed at a) experiential learning in LMS Moodle and b) the possibilities of creating a sense of presence in online teaching and its value. The research sample consisted of 79 students out of which 70% confirmed that based on their positive experience they plan to apply the elements of e-learning in their own teaching. Besides the research results the article also drafts the possibilities that might be applied in e-course designs.

Keywords

Distance Learning. Collaborative Learning. Virtual Learning Environment.

INTRODUCTION

LMS, CMS, LCMS, VLE, MOOC, CAL, MAL are all abbreviations that have penetrated into contemporary pedagogy. Education cannot resist the current trends in technology and should introduce effective tools applying adequate techniques and methods.

Not rarely one can enter the courses that are presented as e-learning, however it is the "printed" version of a textbook transferred to online text divided to the chapters. Limniou and Smith (2010) published the results of their research focusing on VLE that was realised at the University of Manchester stated that most teachers/ tutors use VLE as a means for delivering learning material, announcements and assessments to students. They use it also for uploading learning material and they perceive VLE as a tool to overcome the difficulties of limited time.

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Prensky (2010) states that "Today's students will not live in a world where things change relatively slowly (as many of us did) but rather in a future where things change extremely rapidly—daily and exponentially. So today's teachers need to be sure that, no matter what subject they are teaching, they are teaching it with that future in mind".

Accepting the fact we live in dot-com era, that technology is omnipresent and that internet is a social space we should use its strengths and engage the learner in active and self-directed learning and at the same time realizing the power of collaborative work. This article presents several ways how to create a sense of presence in online teaching, and some possibilities how to build social interaction in an e-course.

VIRTUAL LEARNING ENVIRONMENT AND LEARNING MANAGEMENT SYSTEM

"The environment of a VLE can range from web sites to virtual classrooms to 3D immersive worlds. When considering websites, a set of web pages does not constitute a virtual learning environment unless there is social interaction about or around the information." (Dillenbourg, In: Barkand, Kush, 2009). Currently, when we talk about e-learning system we deal with the learning management system that enables us to manage and administer class virtually on-line.

The terms Virtual learning environment and Learning management system are frequently understood as synonyms. Pinner (2011, p.6) draws the attention to the differences between the two and claims that "LMSs are being designed and implemented primarily for training and in-house staff development, rather than education". He (ibid) defines VLE as an environment that can be "characterised by constructivist pedagogical principles and are often used as a place to collaborate and extend discussions rather than merely hosting trackable learning objects". He adds that "VLEs, being constructivist in their design, feature the ability to allow students to create their own materials, collaborate with others and generally take more ownership of the online content, which can help boost their autonomy and motivation" (Pinner 2011, p.7). Dobozy and Reynolds (2010, p. 98) discuss the terminology and mention confusion concerning the use of terms such as LMS, LAMS and VLE. They understand LMS "as transactional platforms that are mainly used by lecturers as document depositories and for posting announcements or collecting (and marking) assignments". On the other hand, to define VLE they quote Weller who in most of his publication considers VLE and LMS to be synonymous. He defines VLE as "a software system that combines a number of different tools that are used to systematically deliver content online and facilitate the learning experience around that content" (Weller, 2007, p.5).

A SENSE OF PRESENCE IN VLE

Stephen Downes (2012) makes the distinction between LMS (in his understanding VLE is a synonym) and personal learning environment and explains that LMS is centralised repository of content and services. Individual learners access the LMS and obtain the content in one place. They can also perform activities on LMS including having discussions, conference or live synchronous conferences. The personal learning environment (PLE) in contrast places not the place to the centre, but rather a learner, individual who is in a

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centre and he/she accesses things like LMS, ibooks, google docs, what makes PLE decentralised. In formal education mostly VLEs are used (using naturally the external sources as well) but the added value is the possibility of challenging collaborative learning, belonging to the group and possibility to find the answers and solutions within the group and in VLE. This, however, must be planned ahead before the course realisation and what more "to create presence in the online environment, we need to think, feel, and behave differently than we do in the face - to – face environment because we have to make an effort to be aware of the intentions of others and their thoughts, emotions, and behaviors when they are connected to us via technology". (Lehman, Conceição, 2010, p. 2)

One of the main steps in creating effective course is a creation of an online community. The key "factor" affecting learning are learners themselves. Rogers (in Weller, 2007, p. 11) suggests five categories of attitude towards innovation, which are now part of common parlance:

- Innovators;
- Early adopters;
- Early majority;
- Late majority; and
- Laggards

Conrad and Donaldson (2004) categorised phases of engagement in e-course and named 4 phases in which learner's and teacher's roles differ. In the first phase when a learner is the role of newcomer teacher usually provides "socialising activities", helps learners to know each other and helps them to get oriented in a VLE and course itself (ice-breakers, (threaded) discussions about community issues. Palloff and Pratt (2007, In: Lehman, Conceição, 2010, p. 8) "consider social presence to be a critical element in online community building. They say that in online environments there is a greater chance for learners to feel isolated because of a sense of loss of contact and connection with others. Social presence gives learners a feeling of connecting and belonging to a community".

When a learner feels more secure in an environment (technology and group) his role or position shifts to co-operator. In this phase teacher may provide activities focused on critical review, expressing opinions, reflections and sharing ideas. In the third phase the shift of the teacher's role is evident. While teacher in the first phase is manager and social negotiator in the third phase he moves from the central position and becomes facilitator rather than controller. The activities require small groups to collaborate, problem solving is a possibility how to make activities more authentic and real-like. The last phase moves a learner to the position of a partner and initiator and it is a learner who is active and initiates the discussions.

What we need to realise is that the cooperation and interaction is not natural to majority of learners in Slovakia. We instinctively work individually not relying on others and thus students may not feel comfortable in a group work and they prefer lurking rather than active engagement, i.e. teacher needs to learn a lot about his learner and especially well-managed activities and tasks in the first phase may help him/her to find out more about their learning styles, approaches to learning, educational background and intelligence types. Šimonová, Bílek (2012, p. 301) support this idea in their research and

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introduce that "Under the current conditions of information society, strong attention should be paid to students´ awareness of learning preferences and styles, and the teacher's style of instruction. Students have different types and levels of motivation, attitudes to teaching and learning, they respond differently to specific instructional practices".

Conrad and Donaldson (2004, p. 4) state that: "Bruner, Vygotsky, and Piaget all embraced the philosophy that humans do not learn in a vacuum but rather through interaction." Various studies report the positive effect of interaction "on the increase in the quality and didactic effectiveness within educational process" (Mayer, 2001, Mayer & Chandler, 2001, In: Turčáni, Magdin, 2012, p. 332).

Watts (2010) defined three main types of interaction in an online distance learning course:

- learner-to-content interaction
- learner-to-learner interaction
- learner-to-instructor interaction.

Chickering and Gamson (1987) illustrate the importance of interaction in learning and postulated seven principles for good practice in undergraduate education, out of which five are directly connected to interaction:

- encourages student-faculty contact (learner-to-instructor interaction)
- encourages cooperation (learner-to-learner interaction, learner-to-instructor interaction)
- encourages active learning
- gives prompt feedback (learner-to-content interaction)
- emphasizes time on task (learner-to-content interaction)
- communicates high expectations (learner-to-instructor interaction, learner-to-learner interaction)
- respects diverse talents and ways of learning

We have already mentioned (threaded) discussion as a tool that might be used to help learners and teachers to get to know each other. In one way learners work individually and they may react to each other. Their presence in a discussion is "voluntary" even though teacher tries to make learners take even participation. The teacher monitors the discussion, stimulates it and navigates it to make sure the discussion fulfils its aim.

Wiki is another asynchronous tool that is frequently used in e-courses. Compared to the threaded discussion it requires cooperation and the result can be based on mutual work. Wiki is a collaborative writing tool which helps learners to give them a feeling of belonging to a group. Wiki is a shared space (simply said a document) where all participants can write and edit at the same time and thus to create one document. Some LMSs have in-built wiki-space, but there are wikis available online that might be used as external service. West and West (2009) bring criteria or question that teachers should consider when selecting the right wiki service and they mention – key features, e.g. number of users, ability to create separate groups, pages security, amount of administrative control; ease of use – skills learners need to navigate the web; cost – presence of adverts on web; support – availability of technical support, server space etc.

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Even though the major advantage of e-learning is that it is built predominantly as asynchronous model of education and participants do not need to be at the same place at the same time (and we use asynchronous tools) it still offers capacities and tools for synchronous online chats or discussion. Pair work or groupwork are interaction patterns where students need to collaborate and they often intuitively switch to synchronous communication (e.g. using skype –group call or chat or hangouts google). Bender (2010, p.130) suggests several types of synchronous online conversations, namely role-playing in synchronous time, virtual office hours, online guest lecturer, demonstration of a web site and community building. As online conversation lacks visual stimuli like mimics and gestures it is necessary to set the rules for communication, especially how to enter discussion, how to react to a particular person and how useful it is to express emotions (either using emoticons or expressing feelings in e.g. brackets).

METHODOLOGY

Sample - descriptive data

The research was realised during summer semester 2012/13 and the main research tools were experiment (n=79) and questionnaires (n= 37). The sample was divided into 4 separate groups (2 groups of 2nd graders at the Faculty of Education and 2 groups of 1st graders at the Faculty of Arts). One group of the FE students and 1 group of the FA students were enrolled to LMS Moodle and the other groups had traditional face-to-face in-class lessons where the number of lessons, aims and content were same. The students in the sample were all teacher-training students, i.e. future teachers who might use their experience in their professional career and were able also to assess the pedagogical and didactic aspects of the course. It is important for them to realise what does it mean and how does it feel to be a novice to e-course as "if you want to learn about teaching, start by looking into learning" (Megyes and Malderes, 1996, In: Straková, Lojová, 2012, p. 24). Table 1 brings the basic statistics of a sample.

Table 1: Sample description – basic data

	No of students experimental group	**No of students control group**	**Total**
Faculty of Arts	**20**	**23**	**43**
males	*3*	*3*	*6*
females	*17*	*20*	*37*
Faculty of Education	**17**	**19**	**36**
males	*0*	*0*	*0*
females	*17*	*19*	*36*
Total	**37**	**42**	**79**

The Moodle courses used various tools. The texts in pdf format and powerpoint presentations were used to present the theoretical material. Several animated presentation included were done using the Articulate software. The activities were prepared mainly by using an authoring tool Hot Potatoes. Wiki and threaded discussions

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(in LMS Moodle) were used for asynchronous discussions. The chat (also a part of Moodle) was used for synchronous communication.

Data Analysis

The sample was divided into two groups to check the efficiency of the course what was measured in the final knowledge test and the Mann-Whitney U test was used to confirm that there was no significant difference (p= 0,1167) between the groups. The box-and-whiskers graphs present the grade distributions in the groups. (The grades A, B, C, D, E, Fx were coded as 1,2,3,4,5,6). The mean value in an experimental group was 2,72 (i.e. grade 2 - C) and in the control group it was 2,23 (i.e. grade 1.5 or B).

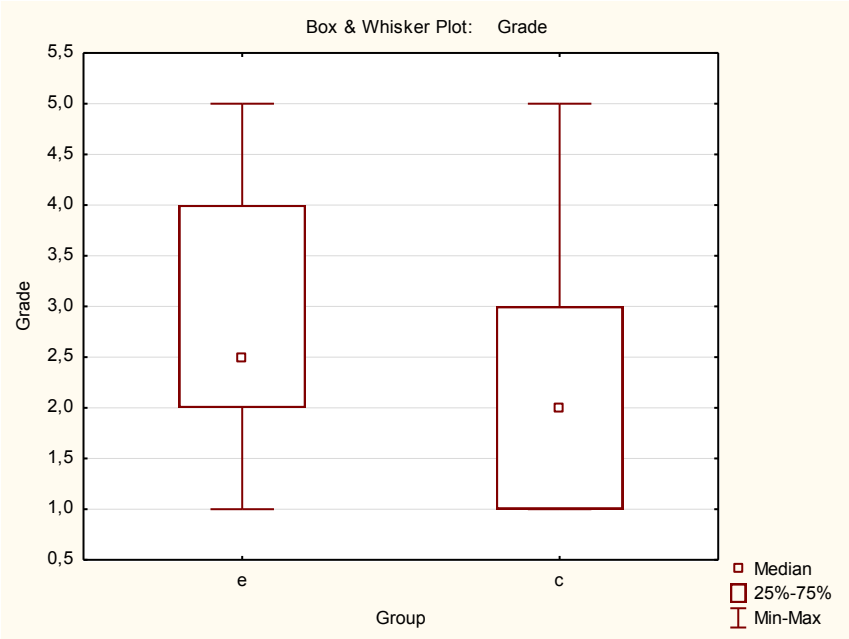


Figure 1: Distribution of the final grades in the groups

The two questionnaires were distributed to all students in control groups (n=37). The first one (consisting of 4 questions based on 5 point Likert scale and 1 open question) was run before the experiment to find out more about the students' attitude towards e-learning as well as to learn more about their experience with e-learning. The aim of the first questionnaire (variables marked as B (before experiment)) was to find out more about their prior experience with e-learning and their attitude towards it.

The second questionnaire (consisting of 4 questions based on 5point Likert scale and 3 open questions) mapped their subjective evaluation of their progress in a course as well as their subjective evaluation of the tools used in a course. The variables are marked as A (after experiment).

The correlations between the variables of questionnaires were calculated. The level of statistical significance was set to p=0,05 and these are marked in the table 2 with the red colour and two asterisks.

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RESULTS

Significant correlation appeared between B1 (attitude towards e-learning) and B2 (presumptions to be more efficient) questions. There is a very strong correlation between the attitude and expectations to be more effective. That is also an evidence of positive motivation and how positive attitude may influence the results (what is not a subject of this study).

Furthermore, the prior experience with e-learning (B3) positively correlates with the feeling of necessity of synchronous communication (A2) what might be also a proof that the skill of taking part in synchronous activities is important and needs certain training.

Finally, the prior experience (B3) appears to be positively correlated to the persuasion that they are more autonomous, independent and more responsible for the results in comparison to traditional in-class lessons (A4).

The variables B4 (learning style suitability), A1 (positive influence of cooperation on a course on learning) and A3 (the benefit from asynchronous meetings) did not correlate with other variables.

Table 2: Correlation coefficients and their p-value

Variable	Correlations (divai.sta) Marked correlations are significant at p < ,05000 N=37 (Casewise deletion of missing data) Include condition: group="e"							
	B1 attitude towards e-learning	B2 presumptions to be more efficient	B3 prior experience with e-learning	B4 Learning style suitability	A1 Cooperation contribution toward learning	A2 necessity of synchronous communication	A3 necessity of asynchronous communication	A4 persuasion that they (Ss) are more autonomous
B1	1,0000	**,7523**	,2429	,2093	,1063	,0139	,1638	-,2264
	p= ---	**p=,000****	p=,148	p=,214	p=,531	p=,935	p=,333	p=,178
B2		1,0000	,0049	,2156	-,0879	-,2208	,1916	-,0945
		p= ---	p=,977	p=,200	p=,605	p=,189	p=,256	p=,578
B3			1,0000	-,0328	,1526	**,3390**	-,1128	**-,3879**
			p= ---	p=,847	p=,367	**p=,040****	p=,506	**p=,018****
B4				1,0000	,1905	,1715	,0947	,0390
				p= ---	p=,259	p=,310	p=,577	p=,819
A1					1,0000	,2669	,0381	-,2228
					p= ---	p=,110	p=,823	p=,185
A2						1,0000	,0313	,0625
						p= ---	p=,854	p=,713
A3							1,0000	,1837
							p= ---	p=,277
A4								1,0000
								p= ---

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The open questions gave us positive feedback and 26 students out of 37 (70,27%) are decided to use e-learning in some way in their own teaching. They mainly mentioned computer assisted learning, however they highlighted the importance of creating the presence of teacher. A vast group of respondents mentioned the importance of instruction clarity and appreciated the possibility to discuss their questions during the fixed agreed time (e-consultations).

DISCUSSION

The research suggests that online learning might be an alternative to in-class lessons. It is not common in formal education, however it is finding and building its position especially in commerce and life-long learning. It is a way how to manage one's time and study at the same time.

The positive results (or equally satisfying in comparison to in-class groups) should be discussed along with the "added value" connected to self-discipline, taking responsibility, time management etc. Several comments given by the learners were noteworthy. E.g.

I had the problems at the beginning. Even though I knew deadlines, I postponed my work until the end (what would have probably happened in the face-to-face class as well) but in Moodle the possibility to upload the task simply vanished what would not happen in regular class ☹.

First, I had problems to be open in discussions – it is permanent when it's online…

The first chats were horrible. People hadn't read the rules and it was a jungle of ideas instead of a constructive debate, but later on, it was ok…

Table 3: Descriptive statistics – before and after experiment questionnaire

Variable	Group=e Descriptive Statistics (divai.sta) Exclude condition: group='c'				
	Valid N	Mean	Minimum	Maximum	Std.Dev.
B1	37	3,324324	2	5	0,883618
B2	37	3,081081	1	4	0,795067
B3	37	2,594595	1	5	1,535858
B4	37	2,945946	1	5	0,998497
A1	37	3,810811	2	5	0,967179
A2	37	3,135135	2	4	0,855121
A3	37	4,027027	2	5	0,897109
A4	37	4,081081	3	5	0,829269

From the table above (table 3) it is evident that learners were rather hesitant before the experiment (mean values 3,32; 3,08; 2,59; and 2,94) and their attitude was more

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positive A3 and A4 questions (both slightly above 4) confirming the e-course has a positive impact on their responsibility for their learning and they felt they benefitted especially from asynchronous activities.

Even though we tried to highlight the importance of engaging the online learner and to show the importance of creating sense of presence in online teaching it must be added that it should not be overestimated. The e-learning has its characteristics, the VLE has its advantages and individual learning as well as cooperative learning should be challenged via problem-based task. The students should be given a possibility to apply critical thinking and gain the ability how to place an argument.

CONCLUSION

Keeping pace with technology development is a part of teacher's development. It is not an easy task, but it should be especially methodology and educational technology teachers who transfer the theory into practice in the groups of pre-service teachers training. These students will teach soon and are expected to come well prepared to teach in digital era. Being digital native is not enough, one must know how to use technology effectively and even when rather not to use it.

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Online Learning Systems in Various Forms of Studies

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Abstract

Nowadays, using the electronic support in education is quite common. In future, we may expect greater broadening of new forms of study, including e-learning, blended learning and the like. Learning with support of online learning systems is becoming an important digital competence. On-line learning systems are mostly used in higher education. Many of researches are directed to evaluate the effectiveness of using these systems. Despite of these researches, we try to point out some aspects based on own experiences. Presented results were gained using face to face communication during lecturing, questionnaires and also via analysis of courses designed by teachers during the lessons. We teach a lot of students in full-time, distance, complementary and continual studies in which we have used e-courses in different way. Own experience from education as well as results from realization of several projects and researches is summarized. Negatives and positives of using e-courses for various groups of students will be described.

Keywords

Computer Science Education. Electronic support. E-courses. Codes of good practice.

INTRODUCTION

A recent survey shows that the traditional way of teaching cannot be conducted if we want to effectively and flexibly react to the needs of the market society. Education of computer science has been changed in last decade also in Slovakia. The Ministry of Education of Slovak Republic redefined the system of primary and secondary schools in Slovakia and also defined a new system of education adapted to the international standard ISCED. The subject of Informatics became compulsory from the 2nd grade of the elementary school. The emphasis is on developing of student's skills and abilities. Teachers had to adopt their teaching methods. Information and communication technology (ICT) can improve the operational processes of any business and the education industry is no exception (Stefanovic et al., 2011). As development in ICT field is progressing rapidly, it is crucial not only to sustain the correct trend in education by using modern tools but also search for and implement newest methods and forms of education. Kostolanyová states that, we live in a society in which information and communication technologies (ICT) are

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becoming a driving force for its development. E-learning is obviously a part of this (Kostolányová, Šarmanová and Takács, 2011).

E-learning is understood as a method of distance learning type of training. Distance education has a history that spans almost two centuries (Spector at al., 2008), and this time period represents significant changes in how learning occurs and is communicated (Moore, Dickson-Deane and Galyen, 2011). The definition of e-learning is first appeared in the research from Relan and Gillani (1997). According to them e-learning is synonymously with web-based instruction: "The application of a repertoire of cognitively oriented instructional strategies implemented within a constructivist … and collaborative learning environment, utilizing the attributes and resources of the World Wide Web". Learning activities involving computer networks as e-learning, and stresses that e-learning is not merely distance learning. A time when the support of e-learning was a matter of prestige and fashion is almost over. It is common to consider the e-learning as a part of educational methods now (Drlík and Skalka, 2011). Electronic learning (e-learning) environments offer the possibilities for communication, interaction and multimedia material delivery that enhance learner-directed learning, especially in higher education (Stefanovic et al., 2011). There are many good practices, but still a lot of things should be done to come to the critical mass of high quality educational content which is free for everybody and easy to use in different learning contexts and needs. (Virtic, 2012).

Development and conducting of distance learning courses using Content Learning Management System is becoming an important digital competence (Smyrnova-Trybulska, 2012). The target function of LMS managing the instruction is the direction of communication as to the student´s knowledge and abilities, thus changing the amount and demandingness of the materials submitted to the student (Balogh and Koprda, 2012). On-line learning systems are mostly used in higher education, but an increasing of using these systems at elementary and secondary schools last several years is obvious. Since the year 2006, on the basis of projects Leonardo, Operational program of education as well as on National and university grants on Department of Informatics, Faculty of Natural Sciences Constantine the Philosopher University (FNS CPU) in Nitra, were developed a lot of e-learning courses designated to support teaching predominantly informatics subjects.

METHODS

E-learning implementation at universities is a long-lasting and complicated process. This process has to overcome a wide range of internal and external factors influencing e-learning effectiveness and content quality resulting in stakeholders satisfaction and acceptance of web-based learning. (Drlík and Skalka, 2011). In the article the author describe experience with e-courses in different forms of study – full-time study/extramural form of study, qualification study and continual education. Own experience from education as well as results from realization of several projects and researches is summarized. Negatives and positives of using e-courses for various groups of students will be described.

Electronic teaching support at Department of Informatics

The Department of Informatics (Constantine the University) in Nitra is using LMS Moodle since the year 2006 as an e-learning support (current version 2.6). Every subject

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from the study program of Department of Informatics has its own e-course into which are students obligated to sign in at the beginning of the semester. By means of the on-line course we deliver in face-to-face study complex electronic support. The course in this form serves as the primary study material and source of learning aids; as medium for communication between students after lessons and solves administration related with monitoring learning activities of students during the semester with logging and analysing their results. Courses have unified structure – introduction, learning lessons (thematic dividing is usually done according to number of weeks in the semester) and closing stage. Each learning lesson should involve electronic material used during the lecture, forum to the lesson, other study materials and set of resolved and unresolved tasks. Apart from learning lessons, the course contains informational lessons that include e.g. terms for exams, listing of sample test questions or discussion forum.

During the several years of teaching we have a lot of notes to teaching with electronic environment support and we also realized experiments among the university students of the first grade aimed to electronic testing (from 2007 to 2009, 132 respondents) and determination the quality of teaching with e-learning course (from 2010 to 2011, 219 respondents). In both researches the questionnaire method was used.

Electronic teaching support at Department of Nursing

In years 2008 and 2009 were in LMS Moodle environment implemented all courses created in the scope of project E-learning in Community Care (further EICC), CZ/07/LLP-LdV/TOI/134001 (3 courses in Slovak and 11 courses in English language). Goal of this project was to create a program of specialized education for non-medical health personnel in the area of community care with the help of modular system and prepare individual modules for e-learning form of study (Cápay et al., 2009). One of the functions of Department of Informatics was to provide creation and fill in the courses where the content side was the responsibility of guarantors and tutors of particular partner organizations.

The courses were tested on the students of distance form of study at the Department of Nursing, Constantine the Philosopher University in Nitra as well as the students of detached department in Prešov and all the participants were at the time of study actively working in the various health institutions as nurses and/or midwives. The main objectives of the research were to get relevant feedback on the quality of chosen modules. The 30 students were asked to fill in the questionnaire at the end of the course. Since the questionnaire was realized non-anonymously, we needed another, more objective sources that would enable us to evaluate real advantages and disadvantages of designed form of study. Very interesting and useful course usage information was gained also from the log-on file analysis. That can help us better understand the behaviour of the student in the e-learning environment. Comparing the data got by two research methods it is possible to get more relevant information of the real process of participants' study, eventually also interpret the differences between the responses, system statistics and real behaviour (Cápay et. al. 2011b).

Electronic teaching support at Faculty of Social Sciences and Nursing

Like most universities in Slovakia, also our university tried to integrate e-learning into educational structures in university level. Despite of management support, this process

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failed. E-learning, or better blended learning, become popular only among natural sciences departments. The main reason was too much autonomy of faculties and their different understanding of the learning process (Drlik and Skalka 2011). The effort to change this situation started with the project Virtual Faculty – Distance Learning at the Faculty of Social Sciences and Nursing of Constantine the Philosopher University in Nitra in 2010 and finished at 2013. The project was founded by the operational program Education. The project aim was the creation of virtual faculty. Based on several years of experience we can say that the main problem is not the choice of LMS but insufficient teachers preparation for managing education by e-courses in blended and distance learning forms (Drlík, et al., 2008). Its effectiveness requires the involvement of pedagogues trained for e-learning education and able not only to manage the education but also to prepare appropriate materials and activities for this type of education. Other aim was developing e-learning courses accessible to students 24 hours a day, 7 days a week. In 2013 we realized the experiment among social workers students aim to quality of teaching with and without the electronic support. The experiences with the project managing were also noted.

Electronic teaching support in continual learning

Education at the Department of Informatics is not focusing purely on teaching students in bachelor's and master's study programs. It deals also with educating teachers with pedagogical practice from primary and secondary school, high school and university surroundings. The project „Further education of the teachers of primary and secondary schools in the subject of Informatics started in 2009 and finished in 2011. The objectives of the project were to design, prepare and realize modern further education for informatics teachers at primary and secondary schools supported by digital technologies. Despite the fact that main part of education were face-to-face encounters with participants, usage of e-courses (together there were approximately 90 active courses) allowed us significantly manage the complex process of communication as well as assigning and evaluating tasks. In 2012 we were interested how teachers that participated in the project implemented and use of ICT, whether on primary or secondary schools, or active use of acquired innovative approaches and methods in education. The investigation of was conducted by means of electronic questionnaire among 211 participants.

RESULTS

E-course managing

Difference between full-time and extramural form of study is mainly in the way of e-course usage during the education process itself. During our own practice at Department of Informatics and log-on files analysis we realized that there is another study approach in full-time (standard count of face to face lessons for each subject is 13) and extramural student (standard count of face to face lessons for each subject is 4). We found out that extramural students tend not to actively use the e-courses – usually they access them just to get sources from lessons. We recommended using a separate course with different managing of its content. From the point of view of a full-time study student the course is "growing" – every week a new thematic block is showed. The newest block is highlighted to which the student should pay highest attention. At the end of semester is the entire

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course available, i.e. all sources are accessible. Students know in each and every moment what is latest topic and what will be exercised during practical seminar. New information is also available in the form of discussion forums or via mass email by using services of virtual environment. From the point of view of a extramural form of study it has no meaning to open a new part of the course on weekly basis as it is not possible to guarantee weekly lectures or practical lessons as with full-time students. Therefore, extramural students have the same type of course revealing as full-time students but it is displayed via thematic unit groups or the whole course.

Work on the EICC project has showed us possibilities how to create courses based on requirements of others. Highest concerns had teachers during transformation of classical materials into electronic form.

LMS sources

Providing of electronic material has its disadvantages. Students usually rely only on what is and will be in the e-course and think that nothing else is needed for successful completion of the subject. They are not motivated to search for additional sources and as a result they lose critical thinking where they can develop and form their thoughts or techniques. They even usually do not make written notes. Many students count on the immediate information too much. They anticipate that exercises from practical seminar will be accessible immediately after the class.

In 2009 we have realized an experiment among students of nursing. The most of participants preferred e-learning (63%) to traditional (23%) or combined (13%) education. As many as 90% of the students stated that they welcomed the opportunity to study at home. In the questionnaires, half of the students wrote they studied mainly in the evenings. The log file analysis showed (Cápay et al. 2011a) that the most access entries were between 4 pm and 5 pm, i.e. in the afternoon. The pictures (50%) and videos (40%)| as the form of study materials were preferred in comparison to text, animation and audio (Cápay et al. 2011b). According to questionnaires answers the students most often accessed the activity “quiz”. The second most common activity was submitting the assignments. Based on the analysis of the logging file we can closely observe not only how often students really accessed individual materials but also in what order they access these activities or potentially how often these couples of activities occurred. The most visited categories of the course components were: main page, quiz (self-test), forum, practice assignment, report and feedback entrance output as well as the combination of pairs of these categories. The least visited, on the other hand, were: study material, help and literature.

In 2013 we found out that e-course usage is perceived very positively by teachers as well as by students during the pilot incorporating into teaching. On the other hand, highly praised were statistics, discussions and possibilities to add other on-line sources in the courses. Consequently we can state that the most used activities were discussion forums, upload and tests.

We also found out that elementary and secondary school teachers prefer using links to websites, embedded sources and files. Activities, such as testing, are done via traditional methods, outside the system. From their point of view the main positives is the distribution of study materials and efficiency improvement of education organization.

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Teachers at higher education use more often activities and assignments. They usually use a time control access. Saving of student's electronic portfolio during continuous monitoring of his learning activities and results is considered to be a useful tool of electronic environment.

Discussion

The problem-based online discussions are an effective tool for promoting active learning as well as for applying the individual approach. When using an online forum for discussions, all the ideas and solutions of the community are saved into a common digital repository (Palmarova and Lovaszova, 2012). But very problematic seems to be a communication of the extramural students. They often do not show effort to actively communicate or contribute to the discussion forums (they are mostly active before concrete deadline for handing in their projects or exams, etc.). Every student at the point of enrolment obtains own university email address to which he receives copies of every message from universities portals. According to the setting of automatic replies we can easily find out that extramural students check this email address more sporadically then full-time students. This often generates problems when coordinating deadlines and tasks which are being sent via email. In last year's social networks are used for communication much more. Hence, it is important to maintain contact with active representative of a group of students who will get important information over to other students via closed social group.

Teachers' role in education

In years 2010 – 2011 we have realized an experiment among 219 computer science students, focused on determining quality and manner of teaching with e-learning course. The experiment was realized sequentially, always in summer semester. We were surprised by the fact that the participants in their answers for question, whether the e-learning course was sufficient and they did not need the teachers explanation, answered definitely negative. This fact has confirmed that e-learning course is an outstanding teaching aid but not always it can in full size substitute direct contact between teacher and student. (Magdin, Turčáni, 2012). One of the findings of our survey conducted in 2007-2009 was that the students did not clearly prefer computer testing and evaluation to teacher's assessment. It showed that the attitude of students is to large extent influenced by the level of their previous experience with e-testing (Cápay, Magdin and Mesárošová, 2011). This fact has confirmed that e-learning is an outstanding teaching aid but not always it can in full size substitute direct contact between teacher and student. In 2013 we realized the experiment among social workers students that also answered that differences in teaching and learning styles before and after course creation are obvious. Adopting e-learning does not guarantee improved learning. This is because mixing technology and the content does not necessarily yield effective learning (El-Ghalayini, El-Khalili, 2012).

DISCUSSION

The design of different types of learning environments can depend on the learning objective, target audience, access (physical, virtual and/or both), and type of content. It is important to know how the learning environment is used, and the influences of the tools

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and techniques that distinguish the differences in learning outcomes as the technology evolves. Between the main positive aspects include e-learning form of study is available and accessible 24 hours a day. Each student has his/her own routines and is used to study in different time periods according to individual needs. From teachers point of view are the main positives for teaching especially (apart from distribution of study materials and efficiency improvement of education organization) usage of student's electronic portfolio during continuous monitoring of his learning activities and results as well as in final examination (records about his activity in the system, hand in tasks, tests, forum entries, etc., everything is interactively available anytime). Simultaneously it is shown that students prefer illustrative nature and compactness of information (education videos prior to text) and possibility of fast spreading of information in the form of sharing (social networks, data storage).

CONCLUSION

From personal experience from projects along with classical teaching we can state that e-learning has its positives but also negatives. E-learning in current form is not possible to perceive as a creation of e-course which we can afterwards use several years. E-course is not a printed publication and thus it is constantly updated and innovated. Update should focus not only on content but on student, from whom we need to gain feedback about his activity in the course, as well.

We can assume that the questionnaire method is not relevant for gaining the information about the process of study in the e-course because the user can embellish the responses or sometimes he/she is not even able to say how often he/she accessed the other parts of the course. Analysis of users' behaviour via the method of usage analysis seems to be one of more relevant possibilities how to describe and visualize real behaviour of the user in the e-course.

LMSs facilitates teacher to keep his methodical portfolio dynamic and offer electronic students´ portfolio in every moment.

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Social Applications in Engineering Education – Kazakhstan Case Study

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Abstract

This paper brings result of the research dealing with a trendy issue of social applications. The research was conducted with university students from Kazakhstan. The objective of this paper is to present findings gained from the questionnaire investigation followed by semi-directed discussion on the role of social software applications in engineering students´ private and university lives. The inhere described investigation was run last year with students of Karaganda State Technical University. Similar research has already been repeatedly conducted with Czech and Polish students. The research with Kazakh students is unique due to the fact that Kazakh university environment, its cultural background significantly differs from our environment. The issue of social applications is focused on students, on frequency of their use of selected applications, willingness and appropriateness for study purposes.

Keywords

Social applications. Web 2.0. Communication. Learning Management System.

INTRODUCTION

The contribution brings an insight into the trendy issue of social applications. Social applications represent a current hot issue intensively utilized in both private and professional lives. Social applications complete their specific missions, they are used for creation of professional communities, enable widening of marketing activities, etc. The area of education is of no exception.

Brief history and main mission of most widely utilized applications is provided as a technical background to a case-study on awareness and utilization of selected social software applications and willingness to use them in the process of engineering education.

The objective of this paper is to present findings gained from the questionnaire investigation followed by semi-directed discussion on the role of social software applications in engineering students´ private and university lives.

The survey and discussions were carried last year at the Karaganda State Technical University.

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SOCIAL MEDIA LANDSCAPE

Over the last decade, the take-up of social applications has been tremendous and affected both private and professional lives because they brought with them noticeable changes. Social computing has got embedded in the process of education, as well, bringing new possibilities and innovations. The phenomenon of Web 2.0 encompassing social media applications brought new ways of communication and cooperation together with acquisition, sharing and publishing content in the virtual space, which seemed promising in its infinite potential.

Current phase of the Internet development is characterized by changes in the design of structure and by different ways of utilization of new tools opening up to that time unrecognized options in the area of communication, publishing, sharing content, self-presentation, etc. (Hub & Zatloukal, 2009)

Social software applications are defined as those that enable wide range of interaction, collaboration and sharing between users. (Cachia, 2008)

The term 'Web 2.0' was coined by O'Reilly as a common denominator for recent trends heading towards the 'Read-Write Web', allowing everyone to publish resources on the web using simple and open, personal and collaborative publishing tools, known as social software. (O'Reilly, 2005) They contain applications for blogging, podcasting, collaborative content (e.g. Wikipedia), social networking (e.g. LinkedIn, Facebook), multimedia sharing (e.g. Flickr, YouTube), social tagging (e.g. Deli.cio.us) and social gaming (e.g. Second Life).

The main features of 'Web 2.0' tools are dynamism, openness and free availability. According to MacManus and Porter, the power of social software lies in content personalization and remixing with other data to create much more useful information and knowledge. (MacManus & Porter, 2005)

All these features fit the needs of educational process; collecting and sharing materials, discussing problems, cooperation on common projects where development of communication skills is run in a surprisingly natural environment. (Balogh,, Turčáni,& Burianová, 2010), (Kapusta, Munk. & Turčáni, 2009). (Poulová & Maněnová, 2010).

The biggest players on today's social media landscape are Facebook, Twitter, MySpace, Google+, LinkedIn, and YouTube. Facebook is generally accepted as synonym to social network. (Lauschmann, 2012). Google+ is currently the youngest social network and strong rival of Facebook.

As for the Czech Republic, Facebook clearly dominates local social media landscape. Currently there are 3.8 million of users. Google+ is far behind but is getting more and more users, currently there are 400 thousand active users. Other big players are LinkedIn (400,000) and Twitter (150,000 users). Lide.Cz (880,000) and Spoluzaci.cz (630,000) rank among local important social nets. (Anon., 2013) From the global perspectives the statistics look alike. Facebook passes 1.19 billion monthly active users, total number of active registered Twitter users has reached 645,750,000, and Google+ over 550million users and LinkedIn 238 million users. (Bernstein, 2014)

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RESEARCH SAMPLE

The presented case-study builds on previous wide research on social software applications and their role in the process of engineering education from the perspective of university students (Poulova & Cerna, 2011), (Cerna & Poulova, 2012). This study brings the latest data from survey which was conducted last year in Karaganda, Kazakhstan with engineering students.

The research sample consisted of 65 full-time students from the Karaganda State Technical University, Kazakhstan. Although there were students of the third, fourth and fifth years (see Table 1) their age ranged from 19 to 24 years (see Figure 1).

Table 1: The year of my studies.

Year of study	Number of respondents
1	0
2	0
3	31
4	29
5	2
did not respond	3

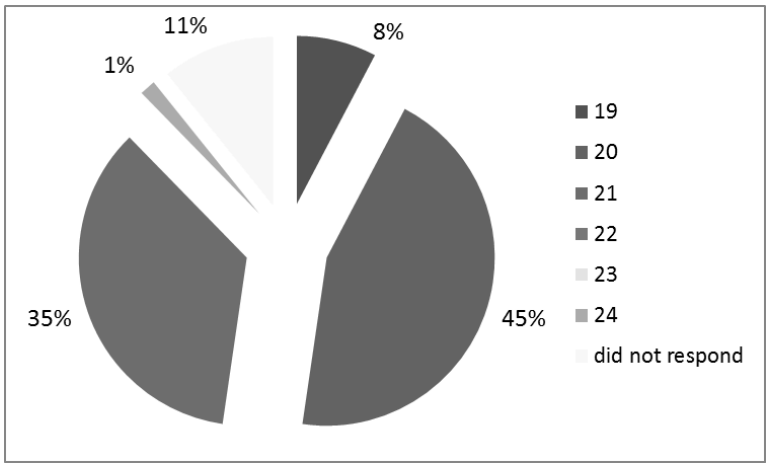


Figure 1: Age of respondents

When it comes to gender of the sample, the group was well-balanced; it consisted of 31 men, 31 women and 3 respondents did not specify gender.

SURVEY ON AWARENESS AND UTILIZATION OF SELECTED SOCIAL SOFTWARE APPLICATIONS

The research tools are described in this chapter together with the way of processing data.

The applied questionnaire was the same as in previous research. Only one modification was done, one currently fast spreading Google+ social net was added. The original questionnaire was formed by the team of experts from the pedagogical, technology and psychology departments. The survey instrument was pilot tested; just

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minor adaptations were made after the first stage. While filling in the questionnaire, students were informed that participation in the study was voluntary and anonymous; it took them just about 8-10 minutes to complete the survey.

The study problem of the research concerns various types of social software applications. Before implementing new applications into the process of education it is important to be acquainted with the current situation, to what extent students are familiar with social software applications.

Basically there are two main areas being explored:

- the first one strives for finding out the awareness of students of the existence of selected social software applications. In case the students are familiar with them they are asked to note down frequency of their use, as well.
- and the other explored area is to find out the level of satisfaction significant feature influencing utilization of web sites and applications. (Li Xiao 2005)

The questionnaire consisted of four parts:

- the first section contained set of software applications. Students were asked to mark whether they know individual software applications. If the marked ´Yes´ then they were to choose the frequency of their visits.
- the second part concerned the level of satisfaction with the set of applications. The third part was focused on utilization of these applications in both their higher education and further education.
- the third part also dealt with the educational issue like the previous one. This time three areas were in focus; the level of students´ satisfaction with study materials, ways of communication and testing options was explored.
- the last one concerned the demographic data

A set of surveyed social software applications was compiled; it encompassed the following applications with various functions:

- Social nets like Facebook and Google+ presented as social utilities connecting people with main mission that is communication
- YouTube as application enabling sharing predominantly music recordings as well as presentations and instructions from various areas
- Wikis which can serve as platforms for cooperation developing common knowledge
- Skype as exclusively social communication application
- Blog as a form of online reflective diaries,
- Social-bookmarking fitting for storing and sharing web-links
- Sharing photos (on-line photo albums),
- On-line computer games like Second-life,
- Learning Management Systems like BlackBoard and Moodle. These robust systems are often hosted by the individual institutions.

A few questions were open so as we could get chance to learn more on issues we were interested in – like social nets and learning management systems.

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After collecting completed questionnaires a follow up discussion was opened. The discussion lasted about 40 minutes, due to the fact that the topic was close to respondents, they were ready to communicate and share their experience openly and appreciated researcher´s interest in respondents´ opinion and own contribution.

RESULTS AND DISCUSSION

The goal of the survey was to map utilization of selected social software applications networking systems among university students; on awareness, utilization and especially willingness to use them systematically in their university studies. (see Table 2)

Table 2: Utilization of social nets.

Do you now ...?		Table 1		Table 2		Table 3		Table 4		Table 5		Table 6	
Yes	58	Very satisfied	9	Yes	16	Yes	21	Very satisfied	8	Very satisfied	15	Very satisfied	6
No	7	Satisfied	18	No	38	No	28	Satisfied	13	Satisfied	16	Satisfied	16
		Dissatisfied	5					Dissatisfied	5	Dissatisfied	1	Dissatisfied	2
		Very dissatisfied	0					Very dissatisfied	1	Very dissatisfied	0	Very dissatisfied	0
		I do not use it	31					I do not use it	29	I do not use it	24	I do not use it	29

Twitter

Do you now ...?		Table 1		Table 2		Table 3		Table 4		Table 5		Table 6	
Yes	46	Very satisfied	6	Yes	6	Yes	11	Very satisfied	5	Very satisfied	6	Very satisfied	4
No	19	Satisfied	10	No	48	No	37	Satisfied	6	Satisfied	10	Satisfied	8
		Dissatisfied	3					Dissatisfied	3	Dissatisfied	2	Dissatisfied	3
		Very dissatisfied	0					Very dissatisfied	1	Very dissatisfied	1	Very dissatisfied	0
		I do not use it	42					I do not use it	39	I do not use it	32	I do not use it	37

Other social nets

Do you now ...?		Table 1		Table 2		Table 3		Table 4		Table 5		Table 6	
Yes	44	Very satisfied	17	Yes	32	Yes	30	Very satisfied	12	Very satisfied	19	Very satisfied	12
No	15	Satisfied	22	No	23	No	20	Satisfied	19	Satisfied	15	Satisfied	14
		Dissatisfied	3					Dissatisfied	3	Dissatisfied	4	Dissatisfied	3
		Very dissatisfied	1					Very dissatisfied	1	Very dissatisfied	0	Very dissatisfied	0
		I do not use it	17					I do not use it	21	I do not use it	16	I do not use it	25

The first part of this chapter brings the findings on the awareness of the existence of selected applications and frequency of their visits. Figure 2 provides a general picture of the students´ awareness of the existence of the surveyed applications.

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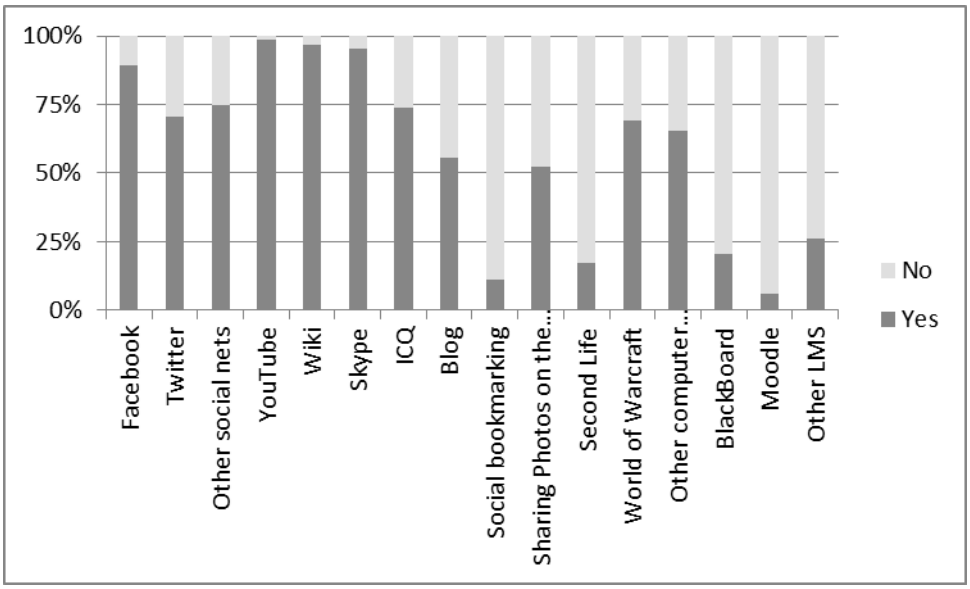


Figure 2: Awareness of the existence of selected applications

Facebook, wiki, YouTube, Skype, followed by Twitter and ICQ, are the most known applications. The absolute winner is YouTube reaching 99% closely followed by wiki, Skype and Facebook.

We would like to point out that that awareness of the existence of the application does not mean that students use it. For example Facebook, 90% of students know Facebook but only 52% use it. As for Blog, 55% stated that they know it but 70% do not use it at all. (see Figure 3)

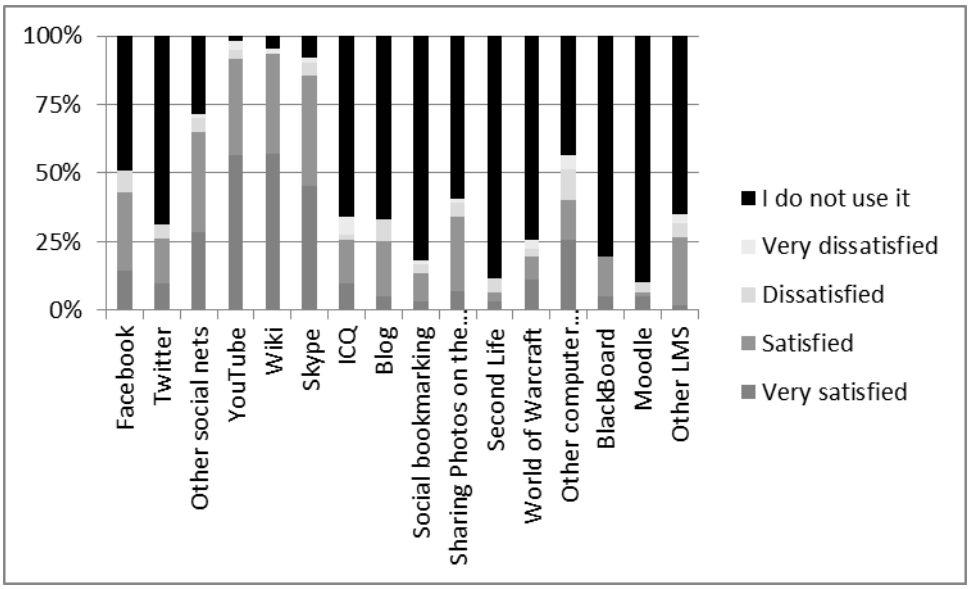


Figure 3: Level of satisfaction with selected applications

In the focus of our interest was the use of Learning Management Systems. 20% of students know Learning Management System Blackboard but only 6% know LMS Moodle, which is quite popular in the Czech Republic.

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A history of Bookmarking as a method for organizing and storing resources on-line is short but anyway it has got a wide popularity. Social bookmarking is surprisingly completely unknown application to Kazakhstan students. Only 11% of asked respondents knew this application.

On the other site Wiki is a famous phenomenon among Karaganda students. (This time we speak only about Wikipedia not about wiki in sense of collaborative space for various groups of people). Just 3% do not know this kind of social software.

The next findings relate to the specialized part of the research where the aspect of education forms the core.

The strongest potential is visible in Wiki, followed by YouTube, computer game and other social nets than Facebook and Twitter. The other promising software applications in higher education are Skype, Facebook and LMS, see Figure 4.

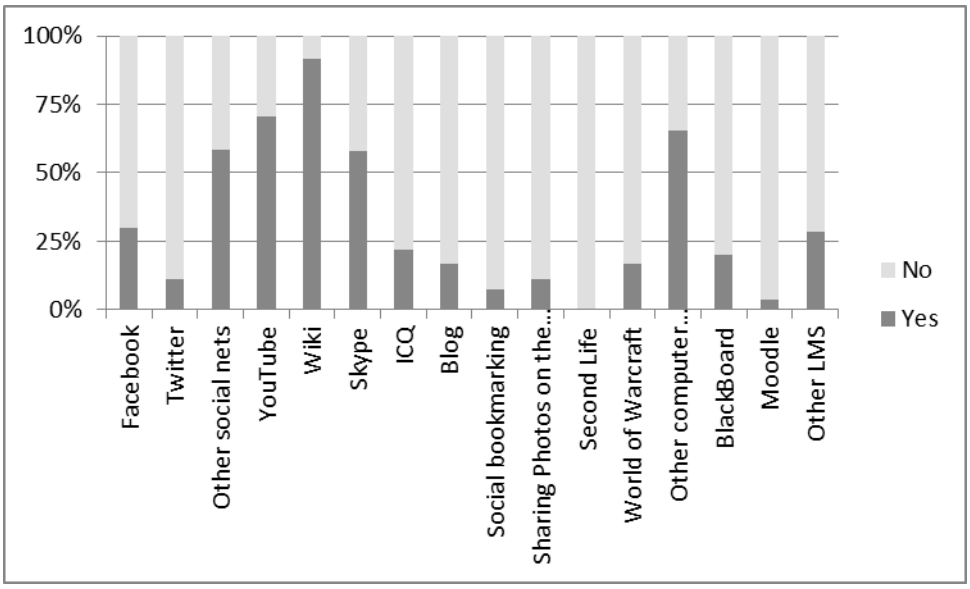


Figure 4: Software applications utilized in higher education

Three areas studied in detail of each social software application were:

- communication,
- quality of study materials and
- possibility to test their abilities and gained knowledge.

Students evaluated their level of satisfaction with those three areas.

Following graphs (Figures 5, 6, 7) shows the outputs on satisfaction with three selected areas. Graphs were adapted to reflect only situation in most preferred applications with results bringing meaning to eliminate plenty of data of low importance.

When it comes to assessment of study materials Wiki and YouTube followed by Skype and other social network than Facebook and Twitter dominate the level of satisfaction issue, see Fig. 5.

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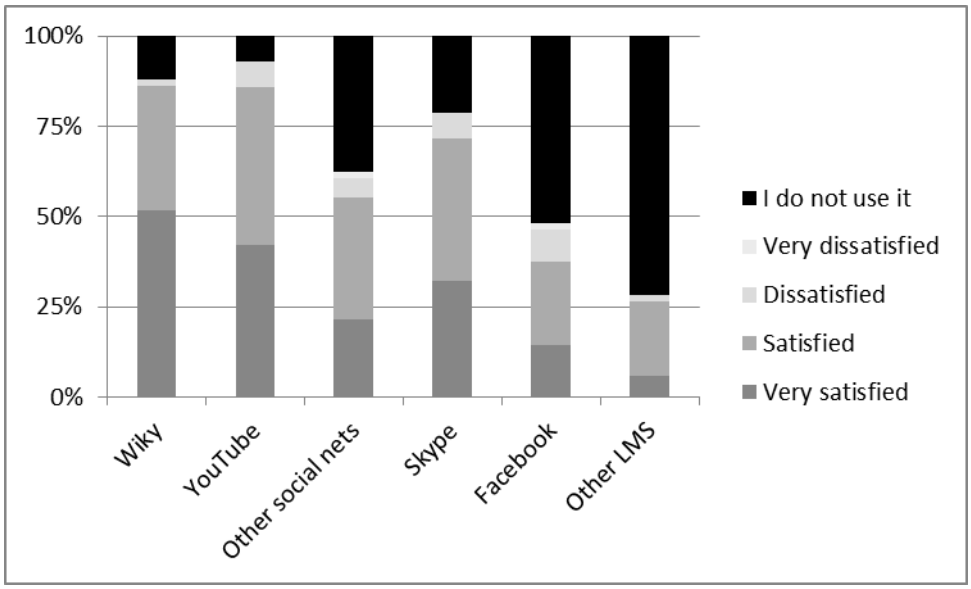


Figure 5: Satisfaction with study materials in preferred applications

As for satisfaction with Communication tools offered by individual applications Skype, YouTube and Wiki dominate, see Fig. 6.

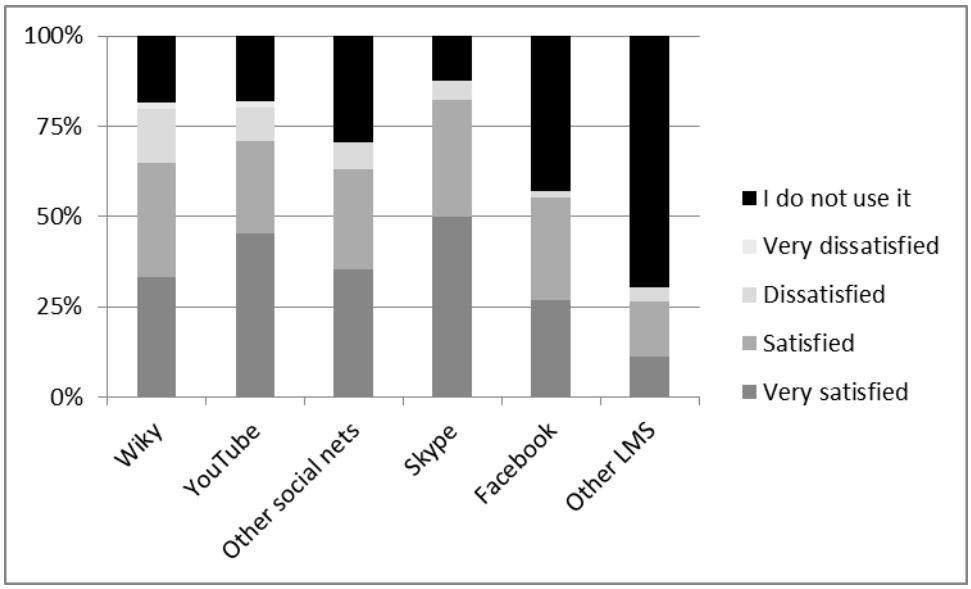


Figure 6: Satisfaction with communication in preferred applications

Last explored area was assessment of tools enabling testing of gained knowledge and skills. Respondents have chosen the same set of important application like in the case of satisfaction with communication.

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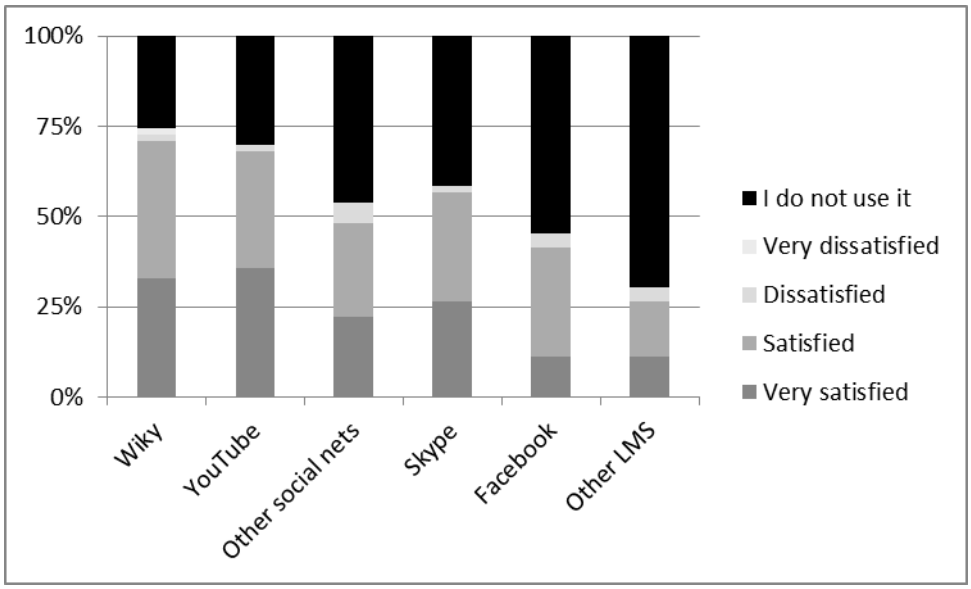


Figure 7: Satisfaction with testing options in preferred applications

CONCLUSION

The paper brings an insight into just a segment of the current phenomenon of social applications. The paper might enable readers create an idea on the issue, think of the challenges, pitfalls and benefits both in private and university environment.

A thorough knowledge of the potential and possibilities of using networks creates a promising environment for their use. To what extent are they supposed to be implemented into the process of education and to what extend are teachers willing to adapt their way of teaching and not to damage the covey of information and creation of students' knowledge. Moreover it was proved that our students are predominantly passive users. What to do about that? Won´t the process of education become rather superficial? Life of most of newly created applications is also ephemeral.

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On the Efficiency of Using Didactic Software in Chemistry Instruction

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Abstract

The paper presents results of the two-year survey focusing on the efficiency of using didactic software on the interactive whiteboard within chemistry instruction on the lower secondary school level compared to the traditional process of instruction where ICT are not implemented. Phase 1 focuses on the explanation and practising/fixing knowledge of chemical nomenclature of inorganic acids and hydroxides. The survey in the first phase was based on the quasi-experiment, where the ICT-supported and non/ICT-supported process of instruction were alternately applied, i.e. the interactive board and 3M didactic software "Didakta-chemie" versus no ICT used in the process of instruction. The didactic tests of our own design were applied for verification. In phase 2 we dealt with efficiency of the didactic software for final revision of knowledge in the field of inorganic chemical nomenclature. The survey was based on the traditional pedagogical experiment where the didactic software "Didakta – Chemie" on the interactive board was the independent variable and the dependent variable was defined by learners' results in the above mentioned d didactic tests. The experimental group proved higher level of knowledge immediately after the instruction, while no statistically significant differences in experimental and control group were detected in retention tests.

Keywords

Early Chemistry Instructio. Didactics Software. Instruction Efficiency. Interactive Whiteboard.

INTRODUCTION

The current period is characterized by using information and communication technologies (ICT) in all spheres of life and step-by-step the ICT have become an inseparable part of the instruction process. Computers and beamers are found in most classrooms and the presentation-supported explanations are not considered an innovative but standard means. The ICT development provides new possibilities of implementation in the process of instruction. The interactive board is a relatively new means which should support learners´ knowledge, motivation and teachers´ competence in using them in teaching.

The ICT-supported instruction of chemistry as a general-education subject has not been widely spread; it is rarely used for presentation of the learning content to support the clearness of teacher´s explanation. Current trends in education emphasize learner´s

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active participation in the process, which is not supported by this approach, while the interactive board and the didactic software correspond to it.

The didactic software is defined as an instructional software or programme which works in the role of motivation, exposition of the learning content, practising and fixing new knowledge and skills, evaluation of the reached level (Dostál, 2009; 2011). This topic is introduced in detail by e.g. Brdička (1995), Cavas (2011), Lamanauskas (2007), Aberšek and Kordigel-Aberšek (2010) or Turčáni and Magdin (2012).

The use of didactic software has not been widely spread in general chemistry education. A reason might be its lack of availability, insufficient teachers' knowledge in what such programmes provide and their scepticism in the question of their efficiency when used apart from learners' individual activities in computer laboratories.

The main objective of our research survey was to answer the question whether the process of instruction is more efficient if the didactic software for presentation the learning content on the interactive board is used in comparison to the process when it is not used. We supposed learners reached better knowledge if the didactic software and interactive board were used in traditional chemistry lessons (i.e. when the learning content was presented to the whole class by the teacher). This hypothesis was structured into three partial ones relating to single phases of the instruction (explanation, practising/fixing the knowledge, revision) and verified by pedagogical experiment and quasi-experiment (Gavora, 2010, p. 149). We focused on teaching of inorganic chemical nomenclature; we used the commercial didactic software Didakta - Chemie by Silcom Multimedia Software (Didakta – Chemie, © 2002 – 2013) on the lower secondary and lower secondary grammar school.

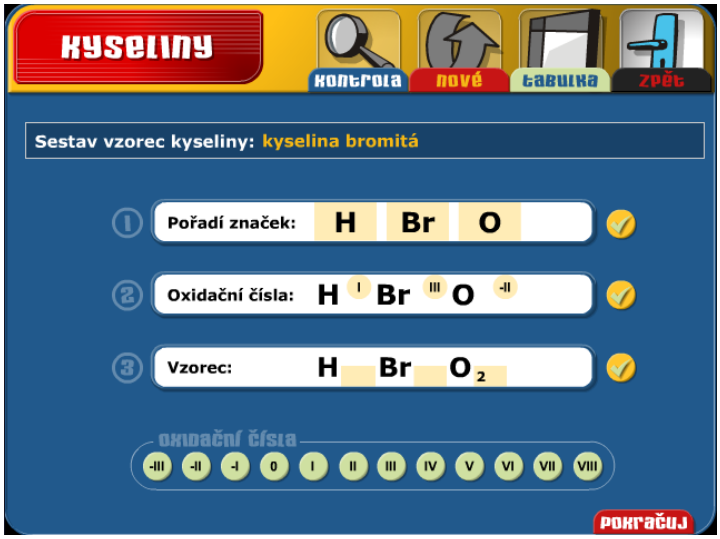


Figure 1: Screen of software Didakta – Chemie: Acids Chemical Nomenclature

DESIGN AND COURSE OF RESEARCH

The research was held in 2012 and 2013 at two types of schools: lower secondary school in Hradec Kralove region and lower secondary grammar school in Central Bohemia region. We worked with the didactic software "Didakta – Chemie" produced by Silcom

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Multimedia and used it in the phase of explanation (i.e. presentation of the learning content), practising and revising new knowledge in the field of inorganic chemical compounds nomenclature; its brief description follows. Details on other didactic software for chemistry instruction are available e.g. in Chroustová, Bílek (2012), on the web page of e-shop "*ABC vzdělávání*" (Chemie, 2011) or on the web page of Department of Teaching and Didactics of Chemistry of Charles University (Výukové materiály: WWW stránky, 2009 – 2014 ©).

Didactic Software "Didakta – Chemie"

Didactic software "Didakta – Chemie" was designed for lower secondary school learners and adequate lower secondary grammar school students. It focuses on practising and testing knowledge in five main topics in chemistry curriculum: "Structure of matters", "Chemical nomenclature", "Chemical reaction", "Calculations" and "Organic compounds". Each topic was sub-structured and provides tasks of pre-defined difficulty. The programme advances step-by-step being continuously assessed, mostly providing one correction and possibility to be printed as work sheets, which enables to use it without computer as well. Learners´ results are summarized in tables providing data on test scores, content learned, types of tasks, timing and final grade relating to learner´s success in per cent (Didakta – Chemie, © 2002 – 2013).

Course of Research – Phase 1

In research phase 1 we focused on the increase in efficiency when using the didactic software for presentation the learning content on the interactive board for explaining and practising new knowledge. The research activity was held in June 2012 at the lower secondary school; the research sample included 23 learners of the 8th grade (14 years old).

We provided comparison of instruction effectiveness identified by didactic tests. The instruction was held by turns, either using the chemical didactic software Didakta –Chemie on the interactive board 3M, or without these teaching aids. In the research the method of quasi-experiment was applied (Gavora, 2010), i.e. the above mentioned aids were implemented in one lesson and were not used in the following one. Totally four lessons were taught in this way focusing on topics of acid and hydroxide nomenclature. The phase ran as displayed on figure. 2.

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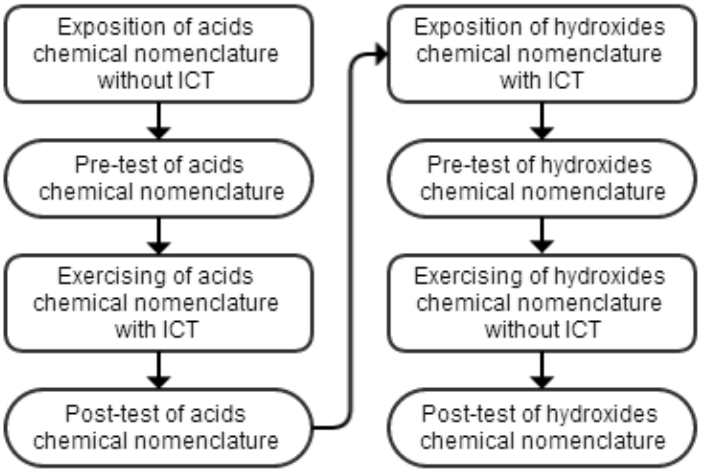


Figure 2: Research design – phase 1

In lesson 1 the topic of "Nomenclature of Acids" was introduced, i.e. explained by teacher to learners without ICT implementation, only the traditional blackboard was used. First, learners acquired the algorithm of creating the nomenclature from non-oxygenic acids, the procedure was displayed on the blackboard, including samples. Second, the same algorithm was applied on deriving the nomenclature from the formula. The analogical procedure was used for explanation the nomenclature of oxygenic acids.

In lesson 2 the didactic test on nomenclature of acids designed by author was applied (called pre-test in this survey). It monitored learners' knowledge after the explanation. It took 15 minutes and learners had been informed it was not graded but its main objective is to learn what they remembered from previous lesson. After the test the correct answers were presented to the learners in the form of PowerPoint presentation and the appropriate algorithm of deriving formulas was summarized. Then, exercises of practising the algorithm were provided to the learners using the didactic software "Didakta – Chemie" on interactive board. Learners were led step-by-step through the topic of oxygenic and non-oxygenic acids; the same procedure was put down in learners' exercise books so that they could immediately repeat and fix it. Single learners solved the examples on the whiteboard. It was clearly seen their motivation is higher than when working in the traditionally-led lesson when ICT were not used.

Lesson 3 was scheduled next week. It included another didactic test (post-test) monitoring learners´ knowledge of nomenclature of acids after practising/fixing in the previous ICT-supported lesson. Then the explanation of another topic (nomenclature of hydroxides) followed being supported by the didactic software "Didakta – Chemie" on interactive board. As mentioned above, the software mainly focused on practising activities, which was why it provides tasks of advanced level so that learners are able to solve them. The programme enables to change the task but always follows logical consequence. In this lesson this feature did not appear and the tasks reflected the appropriate level of learners' knowledge.

In lesson 4 the didactic test monitoring learners´ knowledge of nomenclature of hydroxides was applied (pre-test) and this topic was practised and fixed in the traditional way, when the ICT were not used. Learners worked on the traditional blackboard solving

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the same tasks as in previous lesson. Their involvement was significantly lower compared to the previous lesson, when the ICT were implemented in learning.

In lesson 5 the level of knowledge on nomenclature of hydroxides was monitored by the didactic test (post-test).

Course of Research – Phase 2

In research phase 2 we devoted to carrying research activities at the lower secondary grammar school (13-year-old learners) in April and May 2013. The research sample included 26 learners. The situation the class differed from the previous group - these learners had never worked with the interactive board or didactic software.

We focused on the efficiency of instruction in final revision of the nomenclature of inorganic compounds which were learned some time before (from nomenclature of two-element compounds to nomenclature of oxygenic acids). The pedagogical experiment was applied using didactic tests (Gavora, 2010, p. 125). The course of pedagogical experiment is displayed in figure 3. The didactic tests included tasks matching the formula to the compound, and other similar tasks towards checking whether learners understand the principles of creating formulas and the role of level of oxidation number. Reflecting the pre-test results (during lesson 1), which described their knowledge of nomenclature, learners were divided in the control group (A) and experimental group (B). In lesson 2 basic principles of creating nomenclature and formulas were revised and practised (according to the pre-test results). Group A was taught by their teacher following the scenario designed by the author - researcher, no ICT were used within the revision. In group B the didactic software "Didakta – Chemie" on interactive board were used for practising formulas. The use of these didactic means worked as the independent variable, while learners´ results in didactic tests were the dependent variable. Post-test detecting changes in learners' knowledge was applied in lesson 3, the retention test followed six weeks later.

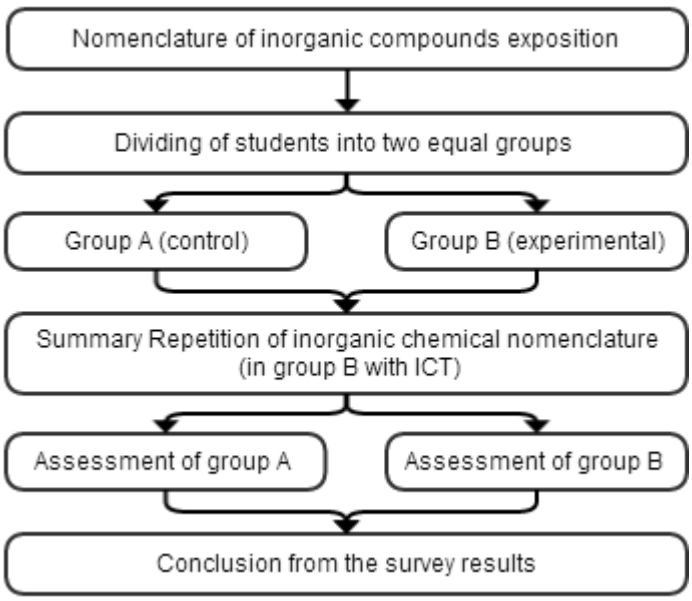


Figure 3: Course of the pedagogical experiment

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RESULTS AND DISSCUSSION

Research Results – Phase 1

Didactic test results are displayed in boxplots in figure 4 showing relative amounts of test scores because of different maximum test scores points.

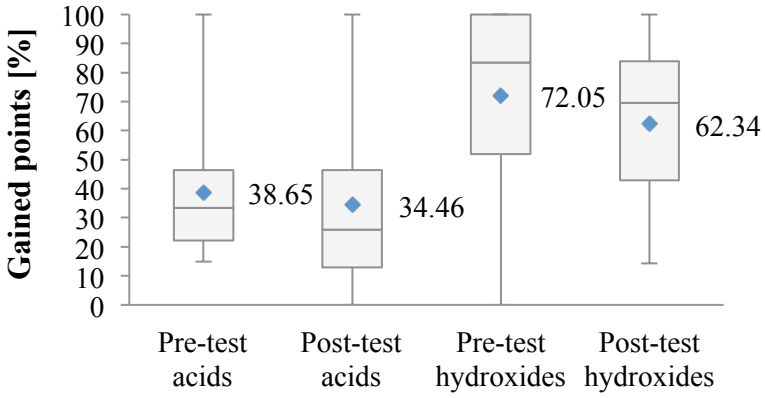


Figure 4: Test scores in didactic tests

Most learners performed pre-test scores below average (82.6 %); the highest scores (65 %) were reached in matching nomenclature to formulas; weak scores (18.75 %) were in creating nomenclature (16.25 %).

Significant increase was not discovered in post-test scores after revising and practising the learning content. Problems were detected in tasks focused on deeper knowledge of the terminology (e.g. oxidation level number, use of analogy) compared to tasks aiming at creating formulas and nomenclature the explanation and practising had focused on. Results are displayed in figure 5.

In the pre-test, which monitored the level of knowledge in hydroxide nomenclature, the significant increase was detected compared to the pre-test focusing on acids nomenclature. Most learners reached above 50%-test score in the didactic test. It might have been caused by using the interactive board for explanations and/or by the fact this topic of hydroxide terminology was easier for learners to understand than acid nomenclature, and learners had been acquainted with the form of testing. As in the above mentioned test, the highest test scores were reached in matching the formula with the term.

In the post-test monitoring knowledge in hydroxide nomenclature, which followed after the practising without ICT use, lower test scores were detected with most learners (59 %). Despite their test scores were higher than in pre-test in the task on creating the formula, the decrease was detected in creating the adequate term. As a matter of interest, in determining the oxidation level number in the given compound learners reached higher test scores than in post-test on acid nomenclature, as they had known what they were expected to do. On the other hand, the test score in final task focusing on acid nomenclature remained low.

The results being incomparable, they were evaluated separately for tasks focusing on creating the formula and term, and their changes in single tests, i.e. in task 1 in pre-test

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and post-test and task 4 in post-test, where both longer practising of algorithms for creating formulas and terms and deeper understanding of the learning content and logical thinking were required. Results are displayed in the form of boxplot in figure 5.

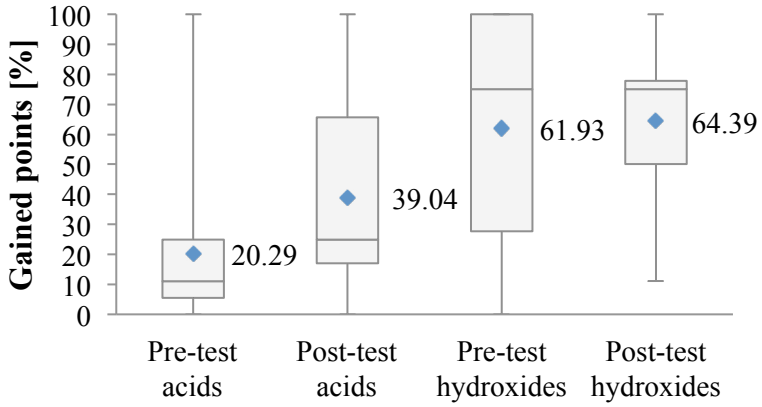


Figure 5: Test scores: selected results of didactic tests

The selected results in figure 5, focused on creating formula and term, show strong increase in post-test compared to pre-test in acid terminology where the ICT were used for explanation and practising the topic. In this post-test all learners improved their performance.

On the other hand, in hydroxide nomenclature higher test scores were detected in pre-test than in post-test, i.e. again in case when the ICT were implemented.

The hypothesis "Learners reach higher test scores in acids and hydroxides chemical nomenclature in the ICT-supported instruction (i.e. when the didactic software on the interactive board is used) compared to traditional instruction without the software and interactive whiteboard", was verified by statistic processing of the data collected from didactic tests on $\alpha = 0.05$ significance level. In total test scores of pre-test and post-test in acids nomenclature no statistically significant difference was detected ($p(1) = 0.295$). But, if the tasks focused on creating formula and terms of acids were calculated, the null hypothesis ("The use of didactic software on the interactive board provides no impact on test scores in didactic tests") was rejected. The one sample t-test proved the significantly higher test scores in creating formula and terms of acids in post-test compared to pre-test ($p(1) = 0.016$). Similar approach was applied in evaluation of hydroxide nomenclature test scores where no significant difference was detected both in the whole pre-test and post-test ($p(1) = 0{,}150$) and in selected tasks (as mentioned above) ($p(1) = 0.409$).

Taking all the results into consideration we cannot state that the use of didactic software on the interactive whiteboard causes the increase in test scores. If we concentrate on tasks focused on acquiring the creation of formulas and nomenclature, which was the explicit part of the explanation and practising of the learning content, we found out the use of ICT led learners to knowledge improvement.

Research Results – Phase 2

The mean test scores in didactic tests in control (A) and experimental (B) groups are displayed in figure 6.

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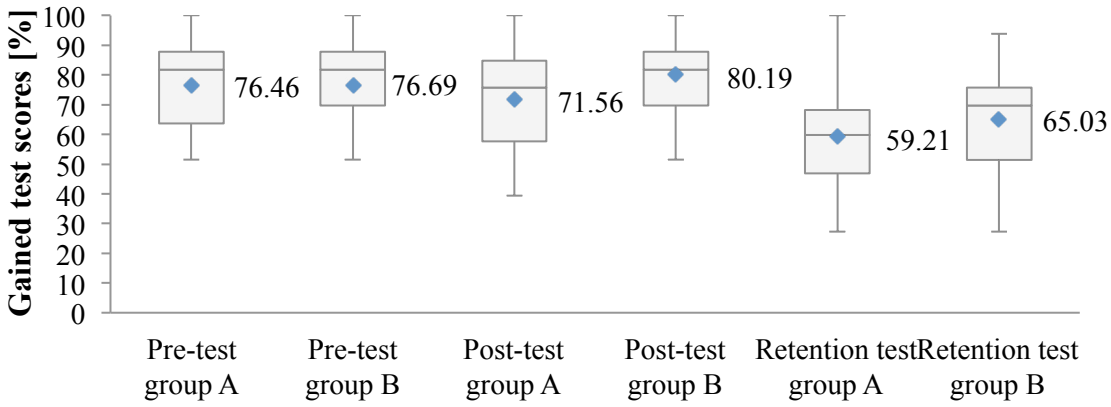


Figure 6: Results of didactic tests in the pedagogical experiment

The results of pre-tests show both groups were equal in knowledge of nomenclature of inorganic compounds after the explanation. Thus the same conditions can be stated for following phase of the pedagogical experiment, i.e. for practising the learning content under different conditions and applying the post-test in both groups.

If the mean test scores in pre-tests and post-tests of both groups were processed by the pair t-test, no significant difference after final revision of the learning content was detected in any group (p_A (1) ≐ 0.08, p_B (1) ≐ 0.19). In post-test of group A, which practised nomenclature without the didactic software on interactive whiteboard, the mean test score was even lower than in pre-test, and neither any significant difference was detected when compared post-test scores by the t-test (p (1) ≐ 0.12). Thus, reflecting results of the whole test, the null hypothesis ("Learners do not reach higher test scores in final revision when the didactic software on interactive board is used compared to the traditional way not supported by ICT") cannot be rejected. But slightly higher mean test scores were detected in the experimental group (B) in post-test when working with the didactic software on interactive board. This fact led us to more detailed analysis of results in didactic tests.

We structured tasks in two groups; group 1 included standard tasks dealing with creation of the formula and term of the compound, in group 2 tasks requiring non-traditional, deeper processes and understanding the learning content were included. In tasks-group 1 the significant difference in knowledge level of learners was detected in the experimental group when test scores were processed by the t -test (p_B (1) ≐ 0.047), while the control group did not perform any difference. In group 2 the significant difference was detected by t-test in the control group in non-favour of efficiency of practising (p_A (1) ≐ 0.044), i.e. learners reached lower test scores after practising when the didactic software on interactive board was not used. In group B no statistically significant difference in knowledge was discovered. To sum up, in final revision learners reached the same mean test scores level if the ICT (i.e. the didactic software on interactive board) were not used in the process of practising the learning content, i.e. in the standard process of creating nomenclature and formulas, but they performed significantly lower test scores in tasks requiring deeper understanding of the learning content. On the other hand, if the didactic software on interactive board was applied in the process of final revision, tests

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scores in standard tasks (group 1) were significantly higher and on the same level as in pre-test in tasks requiring deeper understanding the content (group 2).

In the retention test the expected lower test scores were detected. When comparing the post-test and retention test scores processed by the pair t-test, the significant difference was detected in both groups on the given significance level ($p_A(1) \doteq 0.008$, $p_B(1) \doteq 0.006$). These results proved decrease in learners´ knowledge six weeks after the learning content had been acquired, which is the expected result with 7th-grade learners (13-year old).

If the retention test results of both groups were processed by the two sample t-test, no statistically significant difference was discovered ($p(1) \doteq 0.24$). After six weeks both groups reached significantly lower test scores in standard tasks ($p_A(1) \doteq 0.0001$, $p_B(1) \doteq 0.0018$), the experimental group performed significantly lower test scores in non-standard task as well ($p_B(1) \doteq 0.0339$). No significant difference was detected in comparison of the experimental and control groups, which proved (to some extent) the difference between learners revising the learning content with or without ICT implementation was missing. Thus it seems the higher efficiency of the ICT implemented in the process of instruction might be in their regular use so that they became a standard element.

CONCLUSION

Within the above described research activities with lower secondary and lower secondary grammar school learners the positive impact on the efficiency was detected when the didactic software on interactive board was used in the acid and hydroxide nomenclature instruction. The higher efficiency was proved in solving standard algorithmic tasks focusing on creating nomenclature and formulas of acids and hydroxides. In the explanatory phase of introducing new learning content with ICT-support learners reached higher test scores than when ICT were not used. Learners´ knowledge and mainly their motivation to active doing/learning initiated just by the modern ICT applied in lessons lead us to conclusion that the use of the didactic software on interactive board makes the process of instruction more efficient. Despite the results of this research did not prove the higher efficiency in final revision process running without the ICT support, results in single tasks show stronger fixation of knowledge immediately after the ICT-supported instruction. Other results showed increased efficiency in fixing the learning content when they had been regularly implemented in instruction. In our case of the didactic software on interactive board applied in frontal instruction higher interest of learners was detected, they were highly motivated. Thus we can state the didactic software can be applied towards increasing the motivation (at least) in difficult topics in frontal instruction and make them familiar with it so that they can use practise the learning content individually which is highly required in nomenclature and formulas of compounds. Above all, these technologies provide new possibilities, e.g. fast and save presentation of learning content, active acquirement etc. And, teacher receives efficient and impressive environment for displaying advanced graphical elements of the learning content towards attracting learners' attention (i.e. Balogh, Koprda, 2012).

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Finally, we can state that relating to the wider ICT implementation in education the need for researching the impact of efficiency on the process of instruction is increasing. As our results show the increase in efficiency cannot appear without complex changes in other didactic categories.

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Teaching, Learning and Self-Learning Process in Todays Innovative School

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Abstract

One of the basic questions facing educators today has always been "How do we start improving the teaching/learning process?" Fortunately we do not have to begin from scratch to answer such a complicated question. The experts recommend that one should start by defining the nature of thinking. Before we can make a better process, we need to know more about how people process information, how people think. New discoveries in the field of developmental cognitive science and neuroscience hold great promise for improving current teaching methods. It can be argued that teaching is something unique, unpredictable, and closely related to a person as an individual in society. A formal constant can be established for these individuals, on the basis of which they are objectivised and formalised. By writing them down in the form of a mathematical model conditions are created for the development of a virtual teacher or intelligent e-learning material which will be briefly shown in this paper.

Keywords

Innovative pedagogy. Cognitive science. Individualised e-material. Self-learning.

INTRODUCTION

When the European Union's (EU) heads of state and government met at a summit in Lisbon in 2000 (Lisbon declaration, 2000), they set a goal of making Europe 'the most competitive and dynamic knowledge-based economy in the world'. In a knowledge economy, the 'most effective modern economies will be those that produce the most information and knowledge, and make that information and knowledge easily accessible to the greatest number of individuals and enterprises'. This policy briefly suggests that individuals and companies can easily collaborate and compete globally, and that the solution for Europe in meeting the Lisbon goals is to invest heavily in education and skills.

Statistical evidence briefly demonstrates the high return on investment in education. It makes recommendations for ensuring that Europe's school systems become more flexible and effective in improving learning outcomes, and argues that Europeans' capacity

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to compete in the global knowledge economy will depend on whether its higher education institutions can meet the rapidly growing demand for high-level skills.

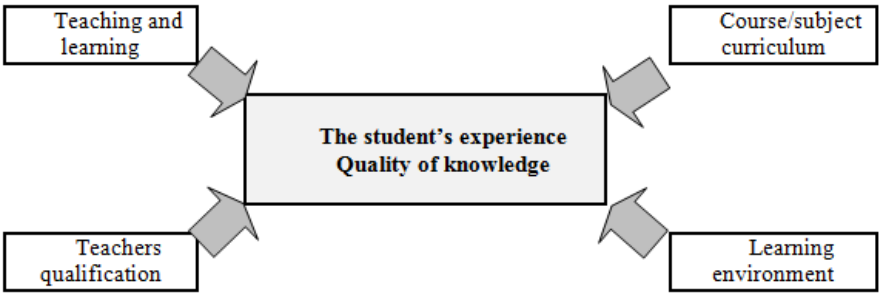


Figure 1: 4 pillars of the education system.

International comparisons demonstrate the challenges confronting Europe but also illustrate the success of efforts to meet such challenges. Education and skills will be most important in this process. Those statements are approx. 13 years old. Let us look at this problem from today's perspective. What influences a student's experience is briefly shown in Figure 1. (Aberšek, 2013)

One of the basic questions facing educators today has always been "Where do we begin in trying to improve the teaching/learning process?" Fortunately we do not have to begin from scratch in searching for answers to this complicated question. The experts recommend that one place to begin is in defining the nature of thinking. Before we can make a better process, we need to know more about how people process information, how people think.

COGNITIVE SCIENCE AND INNOVATIVE PEDAGOGY

New discoveries in the field of developmental cognitive science and neuroscience hold great promise for improving current teaching methods (Anderson, 2007). Yet there remains a significant gap between the scientific discoveries that could improve our education system and the application of this knowledge. If we want to introduce innovation in schools we must primarily take into account the whole complexity of this system, which is symbolically represented in Figure 2: the appropriate infrastructure and with it connected teaching practices, connectedness (social interaction) and learning practices, assessment, leadership and values and, last but not least, contents, curricula and organization must be taken into account (Flogie, 2013).

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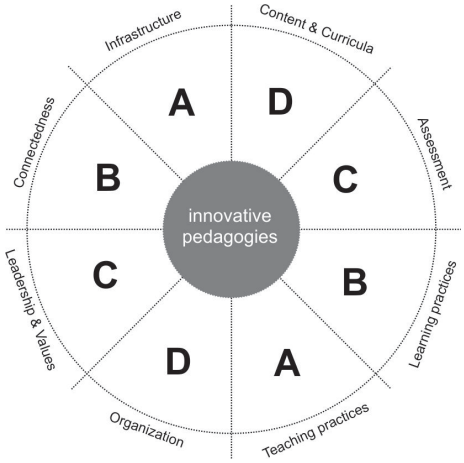


Figure 2: School system and innovative pedagogies

It is obvious that the students' experience and the quality of their knowledge are most important. From this point of view, in recent years we have talked a lot about efficiency of teaching and the learning process. We all know that two diametrical possibilities exist in these processes, namely "classical" class teaching in large groups (with low efficiency) and individual teaching, 1:1 teaching or one teacher for one student (for example: Socrates and Plato, Plato and Aristotle, Aristotle and Alexander the Great etc.). So the average efficiency, if normal (Gaussian) distribution is assumed, according to Figure 3 oscillates between 50% for teaching in the class and 98% for individual teaching (Aberšek, 2013). These are our limits.

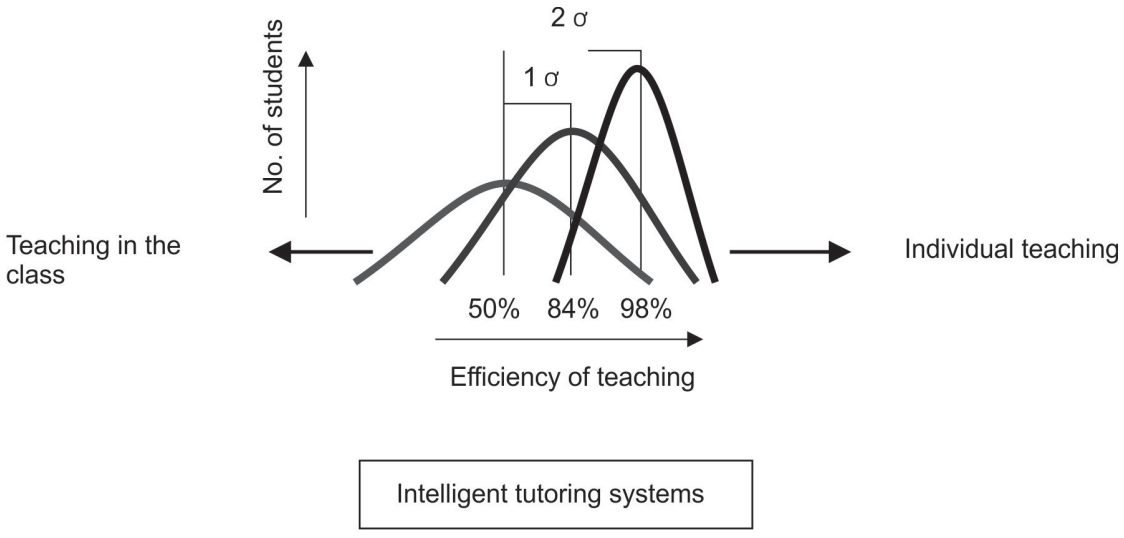


Figure 3: Efficiency of teaching process

If we want to increase the efficiency of (today's) teaching process from 50% we must somehow incorporate philosophy of a 1:1 pedagogy in the regular class room process. This is only possible through the use of technology, with innovative 1:1 pedagogy, which means every student would have their own tutor, specifically their own i-tutor (intelligent computer tutor - netbook). A lot of research in education is concerned with the development of intelligent applications such as Intelligent Computer-Aided Instruction (CAI), intelligent tutoring system (ITS) and intelligent learning environment (ILE) (Allen and

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Seaman, 2008, Aberšek, 2010) and also with applications that can be justified as being consistent with educational theories.

Providing these forms of intelligent tutoring, poses unique challenges, because it requires an intelligent system that can model domains as well as student behaviours and mental states that are often not as structured and well-defined as those involved in traditional problem solving. Advances in AI techniques for reasoning under uncertainty, machine learning, decision-theoretic planning, as well as the increasing availability of sensors that can help capture the relevant user states, are promising means for the field to face these challenges (Bermudez, 2010). Success in these endeavours has the potential to have a great impact on our society, and on its ever-increasing need for high quality teaching and training. The most promising way for today is the use of intelligent educational systems that promise increasing efficiency according to Figure 3 of up to 84% (Conati, 2009). The most important part of such systems is the use of artificial intelligence that makes the following possible:

- representation of knowledge and teaching/learning process,
- intelligent selection (selection of most appropriate tasks, i.e. individualisation),
- learning from previous experience (experience based learning), etc..

CASE STUDY

To prove the theory of 1:1 pedagogy and to achieve similar results like the individual teaching, a pilot individualised e-material for students in lower secondary school was made. Individualised e-material was made for students in subject course Technic and technology in the 8th grade. The content of individualised e-material was learning content of Gears which is the last content of the subject course.

Developing such individualised e-material is not a simple task, especially if it had to be adapted for an individual student. Developing required a thorough preparation in terms of content and design which was mostly based on pedagogical and didactical theories of pedagogic 1:1. Individualised e-material is also based on theory of programmed instruction and its structure is branched and hierarchical. It enables and encourages self-learning, it is flexible, dynamic and interactive (Skinner, 2005; Dolenc, Aberšek 2012).

Three steps were needed to create qualitative and most of all individualised e-material:

- Learning content was rearranged and cut into the smaller pieces (learning steps),
- Learning steps were sensibly combined into a whole in such a way that it provides feedback to students, teachers and creators with the help of collected metadata
- On the bases of metadata and evaluations of students' educational achievements learning steps were optimized.

Methodology of the research

The object of this research is the development and evaluation of a pilot model of individualized e- material for lower secondary school, in a subject course Science and

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Technology in the 8th grade. The topic of the individualized e-learning material is Gears, where students are achieving the lowest results in national assessments (RIC, 2013). The pilot study was divided into three stages:

- Preliminary study with early stage individualized e-material
- Full scale study with individualized e-material
- Full scale study with optimized part of individualized e-material

The pilot study is being carried out on a population of students, where a traditional teaching model, with a teacher in the classroom is being directly compared to teaching with an individualized e- material, without the help of a teacher in the classroom (self-teaching). The first two stages were already completed, the last one is still undergoing study. The prime topics are:

- the deviation between levels of knowledge in the individualized e-material (self-learning) and traditional teaching
- how the acquired metadata can be used for: improving materials, increasing knowledge of the individuals and analyzing and evaluating materials.

Participants and sample selection

The individualized e-material was tested on a subject course Technic and technology in the 8th grade in randomly chosen elementary schools (suburban and urban). The preliminary study with early stage individualized e-material sample consists of 33 students and it was tested in 2 elementary schools. Full scale study with individualized e-material sample consists of 115 students and it was tested in 6 elementary schools. Full scale study with optimized part of individualized e-material sample consists of 200 students and is currently tested in 10 elementary schools and is still undergoing study.

Partial research results and discussion

In the preliminary study with early stage individualized e-material it was possible to successfully test technical functioning. Individualized e-material was adapting to the students and the system for collecting and transforming metadata was functioning on all computers, systems and browsers. With the appropriate analysis and evaluation of the collected metadata it was established that the early stage of individualized e-material needs to adjust certain contents and didactic pathways, which proved to be inadequate, especially the system of transferring metadata (Dolenc, Pesek, Aberšek, 2013). Results obtained in summative assessment were equal to teaching in the class and were oscillating around 50% (Fig. 4).

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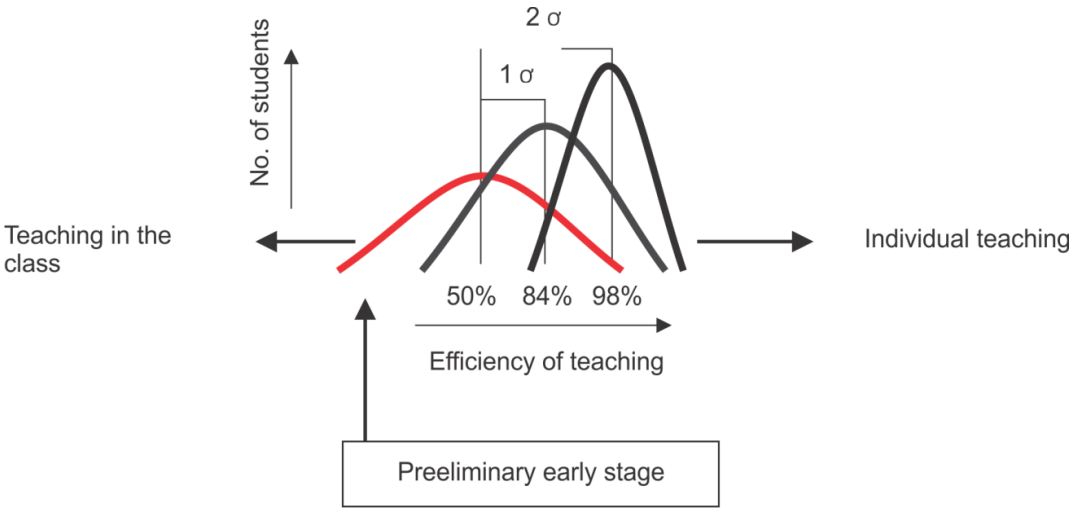


Figure 4: Efficiency of the teaching process compared to preeliminary early stage study

In full scale study with individualized e-material it was possible to successfully test pedagogical functioning. Results obtained in the experimental group show progress in comparison to classical teaching; nevertheless they are still behind the suggested 84% and are oscillating around 60% (Fig 5). With an appropriate analysis and evaluation of the collected metadata it was possible to establish which part of the individualised e-material the students had solved normally, without major complications and with which they had struggled.

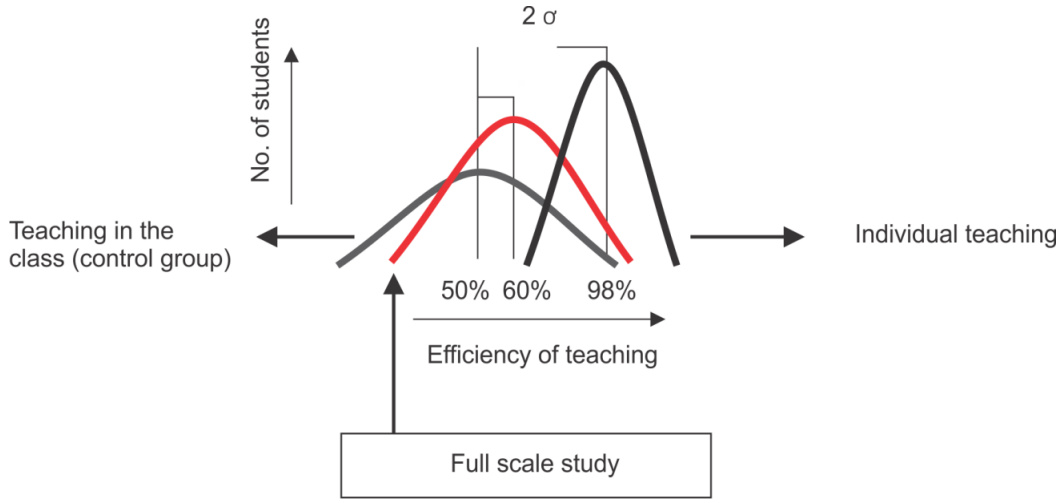


Figure 5: Efficiency of the teaching process compared to full scale study

From comparing the ideal results from Figure 4 to actual results obtained in the research from Figure 4 and Figure 5 it is clear that we achieved progress with our intelligent e-material but not in the way we expected. The foremost advantage of our intelligent e-material is that it is explanatory. In short, from the results (gathered metadata) we have pinpointed the difficulties and thus provided necessary pedagogical and didactical solutions. Because the first step in this process is optimization, the 10% increase from preliminary early stage to full scale with just resolved technical functioning gave us a positive trend and confirmed that the right methods were chosen. In the last full scale study with optimized individualised e-material, which is still undergoing study, we

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will definitely be able to improve results and achieve desired results as with individual teaching.

CONCLUSION

Modern research in education processes shows that the highest educational goals cannot be achieved without active participation of the student. In order to follow the appropriate development of the student's potential it is therefore of utmost importance that we continuously follow and evaluate the educational process, and implement the necessary corrections when needed. This way of working is to a great extent enabled by modern electronic learning material, but only if it is correctly designed (from the viewpoint of pedagogy and didactics) and technologically implemented. Such material must also, among other aspects, evaluate the user and upon poor results change the path to achieve the planned goals. With cleverly set goals not only can the participants obtain the prescribed knowledge suitable for their level, but we can also enable continuous adaptation of the path towards those goals. We believe that ITS designed and based on the presented model can lead to fulfilling all of the mentioned requirements.

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Problems of Automatic Generation of Questions for the Purpose of Testing the Knowledge in a Management Science Course

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Abstract

The contribution presents an example of automatic generation of questions for quizzes in a Management Science course. We focus on the problem of building linear models. We are not aware of the fact there is any article dealing with the automatic generation of questions for this specific type of problems so we present our own approach. We used cloze questions for this type of problems. The cloze questions are the questions with embedded answers. The cloze questions allow more sub-questions of different types. We prefer the sub-questions with a multiple choice answer. We used the MATLAB system to generate questions created from randomly generated input parameters. The parameters are also a part of the possible answers. We try to solve the problem how to generate models with a feasible solution. The generated files are translated into the XML Moodle format and can be used for creating a question bank in LMS Moodle. Translating them into the LaTeX format and creating questions in PDF is another possibility. These tools are being used at our institution to create quizzes in a course of Financial Mathematics. We show how it applies to Management Science and in particular to building linear models.

Keywords

LMS Moodle. Automatic generation. Cloze questions. Linear programming. Management Science.

INTRODUCTION

The need to examine the knowledge is an important part of teaching process in any course. There are various forms of testing the knowledge – oral examinations or different forms of written examinations or their combination. One of the possibilities is the use of examination quizzes.

The use of examination quizzes is suitable for large groups of students when oral examinations may consume too much time. The advantage of using quizzes consists also in greater objectivity as all students have the same questions or the same type of questions and this way the comparison of their knowledge level can be more accurate. Especially in distance learning, it is sometimes impossible to use other forms of examination.

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The disadvantage of using quizzes in comparison with oral examinations is the need for a large number of variants due to copying and spreading the used test questions and answers to the questions by students. Some students even learn the answers by heart without understanding the problems.

The solution may be the automatic generation of questions with randomly generated input parameters. This way we can even create a unique set of questions for each student.

The automatically generated questions can also be used for students of the distance learning with the aim of self-testing and practising any required topics.

The aim of this article is to show a way how to automatically generate questions for specific problems in a course of Management Science. In particular, we will try and show how the automatically generated questions with randomly generated input parameters can be used for the practice of building linear programming models when there could be more than one correct model for the same task.

THEORETICAL BACKGROUND AND LITERATURE REVIEW

Within the framework of the teaching process at schools we currently use a number of up-to-date technologies, both in face to face learning and in distance learning, e.g. (Kapusta, Munk and Turčáni, 2009). The use of a bank of questions for automatic generation of questions for quizzes is, nevertheless, still quite popular e.g. in mathematics. The questions are created from the templates with randomly generated input parameters. The use of multiple-choice tests for mathematics in contrast to tests with open-answer questions has become a common approach nowadays (Snajder, et al., 2008). There are different ways of creating a bank of automatically generated questions in general. In literature we can find authors using the declarative programming (Prolog) for creating questions in mathematics. Another group of authors uses non declarative programming languages.

Declarative programming is used e.g. in (Pinto, et al., 2007), (Snajder, et al., 2008), (Xiao, 2001), (LeActiveMath, 2004-2006), (PmatE, 1990) where the systems that provide multiple-choice tests for mathematics are proposed. Tomás and Leal (2013) presented an application of constraint logic programming to create multiple-choice questions for math quizzes. In their AGILMAT system there are two components – an expression generator and an exercise generator and a solver. The grammar for the expression generator was proposed by Tomás and Leal (2002). This generator produces templates and the exercise generator and solver produce exercises and their solutions. Each template can be used to generate a single exercise or several of them based on the same type. This way, the difficulty level of the distinct versions is similar (with only the coefficients changing). The exercises are then converted to LaTeX. The generator is implemented in the Prolog based constraints programming language. Constraints are also used for the derivation of plausible wrong solutions in the quiz questions. The solver includes buggy algebraic rules that translate the well-known common errors. A variable is used to control the number of buggy rules applied. If this variable is restricted to be zero, the solver produces correct answers.

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There are other e-learning tools that use the buggy rules for creating exercises. For instance the reasoner for symbolic differentiation SLOPERT, developed in Prolog, was used by LeActiveMath and MathBridge (Goguadze, 2011), (Zinn, 2013).

Other authors do not use the declarative programming. Fikar (2007), in a technical report, presented automatic generation of quizzes using MATLAB system and XML for generating quizzes in a course of Control Engineering. The MATLAB system is also used by Gangur (2012) for automatic generation of questions in a course of Financial Mathematics.

In (Gangur, 2011) a generator is used to generate quizzes containing cloze questions. A cloze question is a question together with an answer to it. It is possible to use different types of questions, such as questions that require numeric answers, short answers and questions with embedded answers (cloze questions). The cloze questions allow more sub-questions of different types. The system MATLAB is used to calculate the results of the problems with randomly generated input parameters. The generation process generates a file with questions according to the chosen template in the XML format. This file is translated into the style of the selected LMS (Learning Management System) Moodle and a question bank is created. The file can be also translated into the LaTeX format and then used for creating quizzes in the PDF format. The quiz can be prepared as a teacher version with results and a student version without results. The parts of the generating systems include the solver and the input data generator. The generator inserts the generated input data into the question text and into the output answers prepared by the solver. The generator allows a question that requires a numeric answer, a question with a short answer and a question with a multiple-choice answer. The generator allows processing the questions with embedded answers. In case of a cloze question it generates answers for more sub-questions. This tool is being used at the authors´ home institution to create quizzes in a course of Financial Mathematics for the third year undergraduate students.

The authors of this article are not aware of the fact there has been any article published dealing with the creation of questions for practising linear models building.

AUTOMATIC GENERATION OF QUESTIONS FOR LINEAR MODELS BUILDING

Similarly to the above described non declarative programming we prepared a bank of question in LMS Moodle for testing the knowledge in a course of Management Science. This bank of questions can be used for students both to practise and generate examination quizzes. We are able to create automatic self-tests based on questions with randomly generated input parameters. There are several instances created for each of the question templates. We used the MATLAB system to calculate the results of the given problems created from randomly generated input parameters.

When preparing the bank of questions for the course of Management science we had to solve some specific problems that had not been solved by other authors. The main problems concerning the subject of automatically generated questions with randomly generated input parameters which can be used for practising the linear programming models building are as follows:

- there is usually more than one correct model for the same task;

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- the issue of how to check the correctness and functionality of the resulting model;
- the issue of how to generate the models with a feasible solution;
- the issue of how to invent the plausible wrong solutions for the objective functions and constraints.

For practising some tasks in the Management Science course we used the open-answer numeric questions. This type of questions is used for example in the chapters Waiting line models or Inventory analysis. We used the multiple-choice questions for the other tasks. In this case only one of the possible answers is correct. The cloze question then allows more sub-questions of different types.

The examination part of the Management Science course consists in testing the ability of building the linear models. Linear programming is a technique for the optimization of the objective function subject to a set of linear equality or inequality constraints. Below is an example of a linear programming problem:

"*Determine the number of units for each type of the final product to be produced to get as much profit as possible, when at the same time the limited amount of material is available.*"

The students are then asked to:

- define the variables for the problem,
- formulate a linear objective function, and
- formulate the linear equality or linear inequality constraints including the range of values of the variables.

This part of the examination is difficult and requires certain experience. There are different types of problems in linear programming, such as production planning tasks, transportation problems, assignment problems, blending problems, cutting problems with cutting alternatives, portfolio optimization problems (Plevny and Žižka, 2005), (Anderson, Sweeney and Williams, 1988).

One of the problems related to preparing the bank of the questions is how to check the automatically created linear programming models as there could be ***more than one correct model for the same problem***. Consider the transportation problem when the goods are transported at a loss of 5% of the load. We can define the variables with the number of loaded units or the variables with the number of delivered units. This difference in the definition of the variables leads to two different models and both these models can be correct.

Another problem is how to check ***the correctness and functionality of the resulting model***. Consider the below stated simple objective function for maximizing the total value of the four variables:

$$\text{maximize } z = x_{1,1} + x_{1,2} + x_{2,1} + x_{2,2} \quad (1)$$

$$\max g = x_{1,1} + x_{1,2} + x_{2,1} + x_{2,2} \quad (2)$$

$$\max \; x_{1,1} + x_{2,1} + x_{1,2} + x_{2,2} \quad (3)$$

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These examples demonstrate the variability of the correct answers. All the above mentioned answers (1), (2) or (3) could be accepted as correct, and there are many other correct answers.

Moreover, there is a problem of ***generating the input parameters randomly***. With the simple random generating of parameters it is highly possible to formulate the task without any feasible solution. For example, if all the input numbers were randomly generated in the transportation problem we could have the above problem starting: "*We need to transport the goods from two suppliers with capacities of 100 tons and 200 tons to three consumers with the demands of 300, 400 and 500 tons...*" In this example the sum of the suppliers' capacity is less than the sum of the demands. In respect with these requirements this problem has no feasible solution.

The last of the indicated problems is how ***to invent the plausible wrong solution*** to the multiple choice sub-questions. The correct and wrong answers are designed in the MATLAB system and only one of the four or five answers has to be correct. The randomly generated input parameters of the input text are also included in the possible answers.

SPECIFIC EXAMPLES OF SOLUTIONS TO THE PRESENTED PROBLEMS

As there could be more correct models for the same task we decided to define the variables in the input text. Some of the coefficients (constants) of the task are then randomly generated. When the variables are defined we use them to *formulate the objective function* as well as to *formulate different types of constraints*. Therefore we use the cloze questions that allow more sub-questions with embedded answers. As we can write the correct answers in many ways, as described in the previous section, we used the multi-choice sub-questions with only one correct answer from four or five possible answers. The generated parameters are included in the possible answers.

Below we present an example of the input text of a cloze question with four sub-questions. The question text contains the variable input parameters. They are marked with symbols ## on both sides. The input text contains mathematical expressions marked with <math> and subscripts marked with <sub>. The type of sub-question "mcv" means multi-choice vertical.

Example 1: Input text for one of the transportation problems

```
We need to transport goods from two suppliers with the capacities of
400 and 300 tons to two consumers with the demands of ##x## and ##y##
tons. The goods are transported at a loss of 10% of the load. The
transport from the first supplier is implemented by railway wagons
with the capacity of ##z## tons. The price for one used wagon is CZK
5000. We pay CZK 300 per a ton loaded at the second supplier´premises.
Let <math>x_{i,j}</math> be the number of tons of goods loaded at i-th
supplier to be transported to the j-th consumer, and let
<math>y_j</math> be the number of the railway wagons used for
transport from the first supplier to the j-th consumer.
     <subquestion type="mcv" id="1" file=""><text>Select the objective
function to minimize the costs of the used railway
wagons</text></subquestion>
```


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```
    <subquestion type="mcv" id="2" file=""><text>Select the constraint
ensuring the capacity of the railway wagons will not be
exceeded</text></subquestion>
    <subquestion type="mcv" id="3" file=""><text>Select the
constraints ensuring meeting the requirements of the
consumers</text></subquestion>
    <subquestion type="mcv" id="4" file=""><text>Select the range of
the values for the variables x<sub>i,j</sub> a
y<sub>j</sub></text></subquestion>
```

The problem of generating the tasks that have a feasible solution can be solved by generating the input coefficients randomly in the given interval between the minimum and the maximum value. In the Example 1 above the total supply of 700 tons has to be at least as high as the sum of all the demands. Therefore we generate the demands in the range between 100 and 300 tons for both consumers. The basic procedure is illustrated by the following example.

Example 2: The part of the code for the transportation problem.

```
max_x = 300;
max_y = 300;
max_z = 40;
min_x = 100;
min_y = 100;
min_z = 15;
[x,y,z]=Input_data_generator(max_x,max_y,max_z,min_x,min_y,min_z);
```

The plausible wrong solutions to the quiz questions were inspired by the real incorrect answers of students in the examination tests. The possible answers include the generated parameters. Let us present the form of the transportation problem in LMS Moodle.

Example implemented in LMS Moodle

"We need to transport goods from two suppliers with the capacities of 400 and 300 tons to two consumers with the demands of 122 and 246 tons. The goods are transported at a loss of 10% of the load. The transport from the first supplier is implemented by railway wagons with a capacity of 29 tons. The price for one wagon is CZK 5000. We pay CZK 300 per a ton loaded from the second supplier´s premises. Let $x_{i,j}$ be the number of tons of goods loaded from *i*-th supplier to *j*-th consumer and let y_j be the number of the railway wagons from the first supplier to *j*-th consumer."

a) Select the objective function to minimize the costs of the used railway wagons:

- $\min z = y_1 + y_2$
- $\max z = y_1 + y_2$
- $\min z = 5000 \cdot y_1 + 5000 \cdot y_2$
- $\min z = x_{1,1} + x_{1,2} + x_{2,1} + x_{2,2}$

b) Select the constraint ensuring the capacity of the railway wagons will not be exceeded:

- $x_{1,1} <= 29, x_{1,2} <= 29$

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- $x_{1,1} + x_{1,2} <= 29, x_{2,1} + x_{2,2} <= 29$
- $x_{1,1} <= 29 . y_1, x_{1,2} <= 29 . y_2$
- $x_{1,1} + x_{1,2} <= 29 . (y_1 + y_2)$

c) Select the constraints ensuring meeting the demands of the consumers:

- $x_{1,1} + x_{2,1} <= 122, x_{1,2} + x_{2,2} <= 246$
- $x_{1,1} + x_{2,1} >= 122, x_{1,2} + x_{2,2} >= 246$
- $0,9 . x_{1,1} + 0,9 . x_{2,1} <= 122, 0,9 . x_{1,2} + 0,9 . x_{2,2} <= 246$
- $0,9 . x_{1,1} + 0,9 . x_{2,1} >= 122, 0,9 . x_{1,2} + 0,9 . x_{2,2} >= 246$

d) Select the range of the values for the variables $x_{i,j}$ a y_j

- $x_{i,j} >= 0$, y_j integer
- $x_{i,j} >= 0$, $y_j >= 0$, y_j integer
- $x_{i,j} >= 0$, $y_j >= 0$
- $x_{i,j} >= 0$, y_j binary

There are other possibilities of practising linear models formulations. Some of the tasks are reversed. We create the constraint in the form of linear inequality and ask students to interpret it as in the following example. Numbers 8 and 13 in the task are the randomly generated values. Notice that the same numbers are included in the possible answers.

"A company produces purses, belts and dog-collars. Let y_1 be the number of purses produced, y_2 the number of belts produced, and y_3 the number of dog-collars produced.

$y_1 + y_2 \geq 8\, y_3$ (1)

$y_1 + y_2 + y_3 \geq 13$ (2)

- a) The meaning of the condition (1) is:
  - The sum of the purses and the dog-collars produced must not be higher than 8 times the number of the belts produced.
  - The sum of the purses and the belts produced must not be higher than 8 times the number of the dog-collars produced.
  - The sum of the purses and the belts produced must not be lower than 8 times the number of the dog-collars produced.
  - The sum of the purses and the belts produced must be at least by 8 percent higher than the number of the dog-collars produced.
  - The total number of the products produced will be at least 8 pieces.
- b) The meaning of the condition (2) is:

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- The sum of the purses and the dog-collars produced must not be higher than 13 times the number of the belts produced.
- The sum of the purses and the belts produced must not be higher than 13 times the number of the dog-collars produced.
- The sum of the purses and the belts produced must not be lower than 13 times the number of the dog-collars produced.
- The sum of the purses and the belts produced must be at least by 13 percent higher than the number of the dog-collars produced.
- The total number of the products produced will be at least 13 pieces."

Using the cloze questions we can define more suitable objective function for the same input text and variables. We present the example in LMS Moodle with different objective functions. The values 13, 10 and 54 in the example were generated randomly.

"To produce the resulting product we need 13 components of the type A and 10 components of the type B. Let y_1 be the number of the components A produced, y_2 the number of the components B produced and v the number of the final products produced. The sale price of the resulting product is CZK 54.

a) Select the objective function to maximize the number of the final products produced:

- max $z = y_1$
- max $z = y_2$
- max $z = y_1 + y_2$
- max $z = v$
- max $z = 54\ v$

b) Select the objective function to maximize the total number of the components produced:

- max $z = y_1$
- max $z = y_2$
- max $z = y_1 + y_2$
- max $z = v$
- max $z = 54\ v$

c) Select the objective function to maximize the revenue from the sales of the resulting products:

- max $z = y_1$
- max $z = y_2$

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- max $z = y_1 + y_2$
- max $z = v$
- max $z = 54\ v$

d) The meaning of the condition $y_1 \geq 3\ y_2$ is:

- The number of the components A produced must be at most 3 times higher than the number of the components B produced.
- The number of the components A produced must be at least 3 times higher than the number of the components B produced.
- The number of the components B produced must be at most 3 times higher than the number of the components A produced.
- The number of the components B produced must be at least 3 times higher than the number of the components A produced."

The plausible wrong solutions to the quiz questions were inspired by the real incorrect answers of students in the examination tests. The examples of the typical incorrect answers of students are demonstrated on another sub-question added to the previous task. The first answer is correct.

e) Select the constraint(s) ensuring the sufficient number of components produced for the production of the final products:

- $y_1 \geq 13v\ ;\ y_2 \geq 10\ v$
- $v \geq 13y_1 + 10y_2$
- $y_1 \leq 13v\ ;\ y_2 \leq 10\ v$
- $v \leq 13y_1 + 10y_2$

On the examples above we tried to illustrate how all the problem areas described in the previous chapter may be solved.

We used MATLAB system to generate questions created from randomly generated input parameters. The output of the generating process is a file in a universal XML format. We can translate the generated file with the help of XSLT transformation rules to the style of the selected LMS Moodle or into the LaTeX format, which is appropriate for creating quizzes in PDF or HTML format (Gangur, 2011).

CONCLUSION

We have presented an approach for generating quizzes in a course of Management Science using the MATLAB system and LMS Moodle. The main importance of the article can be seen in presenting possible ways of automatic generation of questions even in cases where the correct answer is not unambiguous (there are more than one possible correct variants of the answer). Further in the contribution we present possible ways of solving the secondary problems which may occur in case of automatic generation of

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questions focusing on building linear models. We deal for example with ensuring the feasibility of the solution of the generated questions or with the way the wrong answers are designated.

In the practical part of the article we presented examples of the solutions of the above described partial problems on the examples from the quizzes in the Management Science course implemented in LMS Moodle using the system MATLAB to calculate the results of the given problems created from randomly generated input parameters. For the questions focusing on building linear models we used the cloze questions with embedded answers. The cloze question allows more sub-questions of different types. We used the multiple-choice sub-questions with only one correct answer from four or five possible answers for each sub-question. For other tasks in the Management Science course we used the numeric questions.

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Teaching Geographic Information Systems with E-Learning Support

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Abstract

Students of natural sciences have to be able to use modern tools for acquiring and processing spatial data, which are an internal part of research in multidisciplinary academic fields. Environmental science is one of the fields, where physical and biological sciences are integrated to the study of environment for solving environmental problems. For students of Environmental science it is necessary to become familiar with Geographical Information Systems (GIS). Every student is an individual and study of GIS is typically time-consuming for them. Therefore the best way to teach them this subject is through freedom, which is based on E-learning and software licensed under GNU GPL. This combination ensures more effectively used time for teacher and also for students and is independent from costly solutions. Engaging practical tasks can lead to more enhanced interest of students in studying in such field. For this purpose we have created a tool based on e-learning and open GIS solutions. Individual tasks are distributed using LMS Moodle and every solution is verified by a lecturer to be accepted. Maps created by students in this process could be used as a part of a geodatabase which is administered by the Department of Ecology and Environmental Sciences, for further landscape ecology research. The database stores user credentials, so in case of using the data by a third person there is no problem with citation. This solution leads to enlargement of local geodatabase and is also positive motivation for students, who can feel the touch of real research just by learning.

Keywords

Geographic Information System. E-learning. Environmental Ecology Education. Secondary Landscape Structure Map.

INTRODUCTION

Methods of acquisition, processing and visualization of information are constantly streamlining and modernizing. Every university should react to this development by innovation of content and form of education and this is a difficult task of adapting to the needs of professional practice. Science education graduates are expected, in addition to the acquired expertise, to also have a certain level of skill in ICT. Effective use of web applications, text editors and at least basic experience in working with graphics for the needs of pedagogical and professional practice have become a standard for graduates of all tertiary study programs at the FNS CPU in Nitra. However, the current professional

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practice has much higher requirements in area of the use of ICT on graduates from individual study programs. Currently it is necessary for the students of the DEES to become familiar with GIS and to be able to use them for the purpose of collecting, editing, analysis and visualization of spatial data.

Teaching of GIS at the DEES is realized through attendance form combined with e-learning. The possibility of using e-learning increases the efficiency of teaching GIS and with its tools supports the scientific work of students and contributes to the development of new spatial data – map layers.

GEOGRAPHIC INFORMATION SYSTEM (GIS)

Just like the field of geography, the term Geographic Information System (GIS) is hard to define. It represents an integration of many subject areas. A broadly accepted definition of GIS is the one provided by Dueker and Kjerne (1989):

„GIS is a system of hardware, software, data, people, organizations, and institutional arrangements for collecting, storing, analyzing, and disseminating information about areas of the earth."

Geography + Information + System. Geography relates to all the features and process that occur on the surface of the earth. Information is the hearth of GIS, where vast amount of data are stored and analyzed (Audet and Ludwing, 2000).

Aronoff (1989) defined GIS as a computer-based system that provides the following four sets of capabilities to handle georeferenced data:

1. Data capture and preparation
2. Data management, including storage and maintenance
3. Data manipulation and analysis
4. Data presentation

Their capacity to retrieve, store, analyze, model and map large areas with huge volumes of spatial data has led to an extraordinary proliferation of applications.

Geographic information systems are now used for land use planning, ecosystems modeling, landscape planning and assessment, transportation and infrastructure modeling, market analysis, visual impact analysis, watershed analysis, facility management, real estate analysis, and many other applications.

GIS makes geographic analysis and location analysis easier, so users of GIS application increases and the scope expands (Audet and Ludwing, 2000).

GIS have been identified as one of the 21st Century Tools for Communication, Information Processing and Research which will help to develop student abilities in investigating, evaluating, integrating, creating and analysing issues and information at various scales and locations (Partnership for 21st Century Skills, 2004). The use of GIS tools has become a standard also in scientific activities and is an essential part of research methodologies for the study of phenomena that can be localized in space.

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Therefore, the knowledge and skills students acquire through GIS use in educational process may also enhance their future career prospects.

The GIS training course has been included in the curriculum in the bachelor as well as in the master level of study. The objective of GIS at the bachelor's level is for students to be able to use GPS tools in direct spatial data collection, transformation of the data and their further editing in GIS environment. Students learn to create their own map layers using digitization of base maps and cartographically correct map visualization.

At the master's level, the priority is to acquire knowledge and experience in the field of spatial analyses of modeling and process simulations.

Currently there are many commercial and freely available software packages for preparation, processing and analysis of geographic data. The course at the bachelor's level is carried out using the QGIS software.

QGIS is a user friendly Open Source Geographic Information System (GIS) licensed under the GNU General Public License. QGIS is an official project of the Open Source Geospatial Foundation (OSGeo). It runs under Linux, Unix, Mac OSX, Windows and Android and supports numerous vector, raster, and database formats and functionalities (www.qgis.org).

The course at the master's level is carried out using the GRASS GIS software. GRASS GIS (Geographic Resources Analysis Support System) is a free and open source Geographic Information System software suite used for geospatial data management and analysis, image processing, graphics and maps production, spatial modeling, and visualization. GRASS GIS is currently used in academic and commercial settings around the world, as well as by many governmental agencies and environmental consulting companies. It is a founding member of the OSGeo Foundation (http://grass.osgeo.org/).

Use of open source software GIS in the learning of teachers and specialists for landscape ecology brings several advantages:

- There is no need to have a budget for this Professional software. Its installation, use and updating is free of charge.
- Openness of the software allows easy data exports and their transformation from one software to another, which enables to combine several different software in tasks solving.
- The main advantage is that teachers and students can install them freely in their computers and work in professional GIS software is independent from availability of computer room.
- By offering certain rights and possible availability of the source code of software the development of GIS tools may take place also outside large firms. This fact can be a strong motivating factor for students who can develop new tools or transform existing ones.
- Graduates who come to professional practice are not only professionally competent, but they know the possibilities and advantages of Open Source software as an alternative to the use of professional GIS software, and are able to use them directly.

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- Use of Open Source GIS software is a convenient alternative for life-long education in the field of GIS. The use of GIS software in education process at the lower and higher secondary level is a modern and efficient means of teaching science applicable in the teaching practice of the current educational system. This results in an increased interest in this area and the option of education using Open Source offers in addition to trained teachers also a free tool for schools.
- There is a variety of available materials and manuals.

LMS MOODLE AND ITS USE IN TEACHING GIS

A Learning Management System (LMS) is a software application for the administration, documentation, tracking, reporting and delivery of e-learning education courses or training programs (Ellis 2009). An educational LMS is designed to deliver instructor led courses which includes two way interactions between learners and instructors and also between learners and other learners (Sharma and Vatta, 2013).

There are many pieces of software available that provide virtual learning environment systems, both commercial and Open Source Software. One such system that has been gradually gaining worldwide popularity is known as Moodle (Al-Ajlan and Zedan, 2008) (Brandl, 2005). According to evaluation of open source E-learning platforms, which was carried out by Graf and List (2005), Moodle obtained the best results in general as well as in the specific adaptation evaluation. Another comparative studies from Al-Ajlan (2012) have also positive evaluation results for Moodle and author strongly recommend Moodle as the best choice for higher education generally. The design of Moodle is based on socio-constructivist pedagogy. This means its goal is to provide a set of tools that support an inquiry – and discovery-based approach to online learning. Furthermore, it purports to create an environment that allows for collaborative interaction among students as a standalone or in addition to conventional classroom instruction (Brandl, 2005). Adaptability, personalization, extensibility and adaptivity capabilities of Moodle are the main reasons of choosing it as core source of information and contact platform for students in our e-learning course. Technical system requirements are the same as for GIS software, which is another in a series of many benefits.

The course Introduction to Geographic Information Systems is intended for bachelor level students of the program Environmental Science at the Department of Ecology and Environmental Sciences FNS CPU in Nitra. It is a fundamental study material of a subject Information Systems in Ecology. The course aims to teach students to use Geographic Information Systems (GIS) tools for a direct collection of spatial data from landscape, transformation of the data into GIS desktop applications and their further editing. Students should create custom map layers, which they should be able to purposely classify and cartographically correctly visualize using digitization of base maps

The content is thematically divided into seven chapters:

1. GIS – basic characteristics
2. Geographic data and spatial models
3. Geo-space modeling
4. Representation of spatial models

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5. Creating thematic maps
6. Collection of spatial data
7. Global positioning system

It consists of a theoretical part and practical exercises. Exercises are included into the course in a way to logically follow the above described theoretical basics. Exercises include also movies illustrating the curriculum topic which is being dealt with, and at the end of a lesson are included suggestions for tasks to repeat the learned information. The course uses advantages of LMS Moodle with modules such as discussion forum, test, glossary, etc., along with links to external sources of installation packages of tools, web GIS services and freely available data sources.

FILLING GIS GEODATABASE USING LMS

One of the cornerstones of scientific research activities but also GIS education is working with geo-data – their collection, editing, transformation, creating, gathering and subsequent use. The very fact that departments can develop valuable data usable in scientific activities was the motivation to use possibilities offered by GIS course seminars and individual work of students to create useful map layers which would gradually fill the departmental geodatabase. In order to fill the departmental geodatabase arose an initiative which would allow filling the information database with data created by students, in order for them to have the opportunity to recognize the potential of their generated data for the scientific-research practice already during the training. The task assigned at the end of a semester serves for this purpose and the process of its solving follows a scheme (Figure 1).

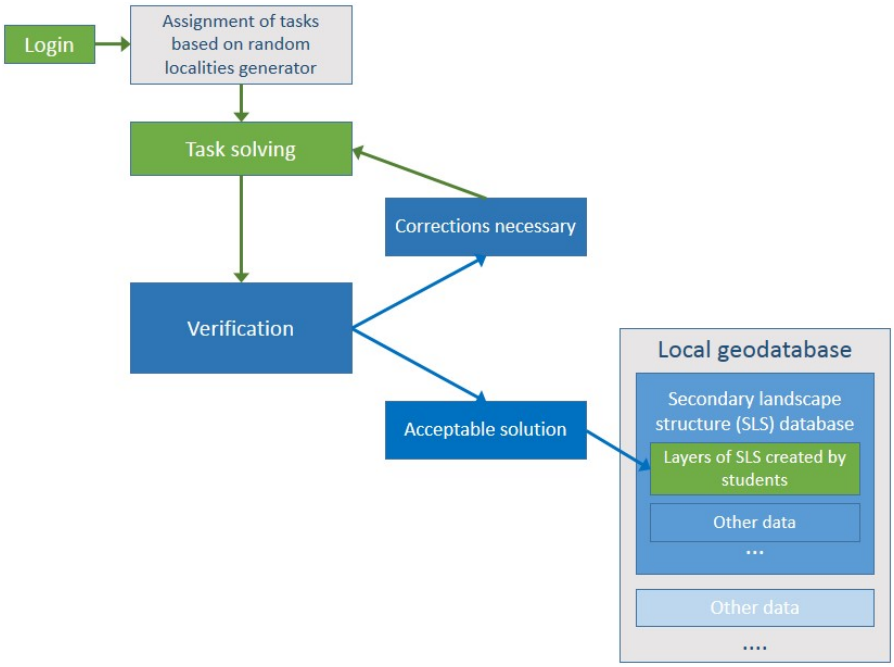


Figure 1: The structure of input, evaluation and assignment of tasks solved by students into the departmental geodatabase

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Students have the access to assignments directly through the e-learning course, where after entering their personal login and password a php script generates a task with the same wording for a whole group, but specifically modified for each student. The uniqueness of assignments is ensured by the choosing a part of a real area in which students are supposed to create a map of secondary landscape structure based on methodology of Ružička (2000) and Petrovič at al.(2009). The model area is divided by grid into sectors with assigned identifiers and each student has to work on one specific sector only. Composition of the resulting solutions leads to a map of secondary landscape structure of the area for a particular time period (Figure 2). The correctness of solutions is checked by a teacher who decides whether the task is solved correctly in terms of content and technical performance. He decides when it is necessary to redo the solution and methodically directs students to prevent possible errors. Only when he is satisfied with the solution the ready-made solution is included into the database, which the department has begun to develop so that the results are available also for other purposes. Each layer in the database has a registry including its author, in order to prevent any problem to cite the resulting data.

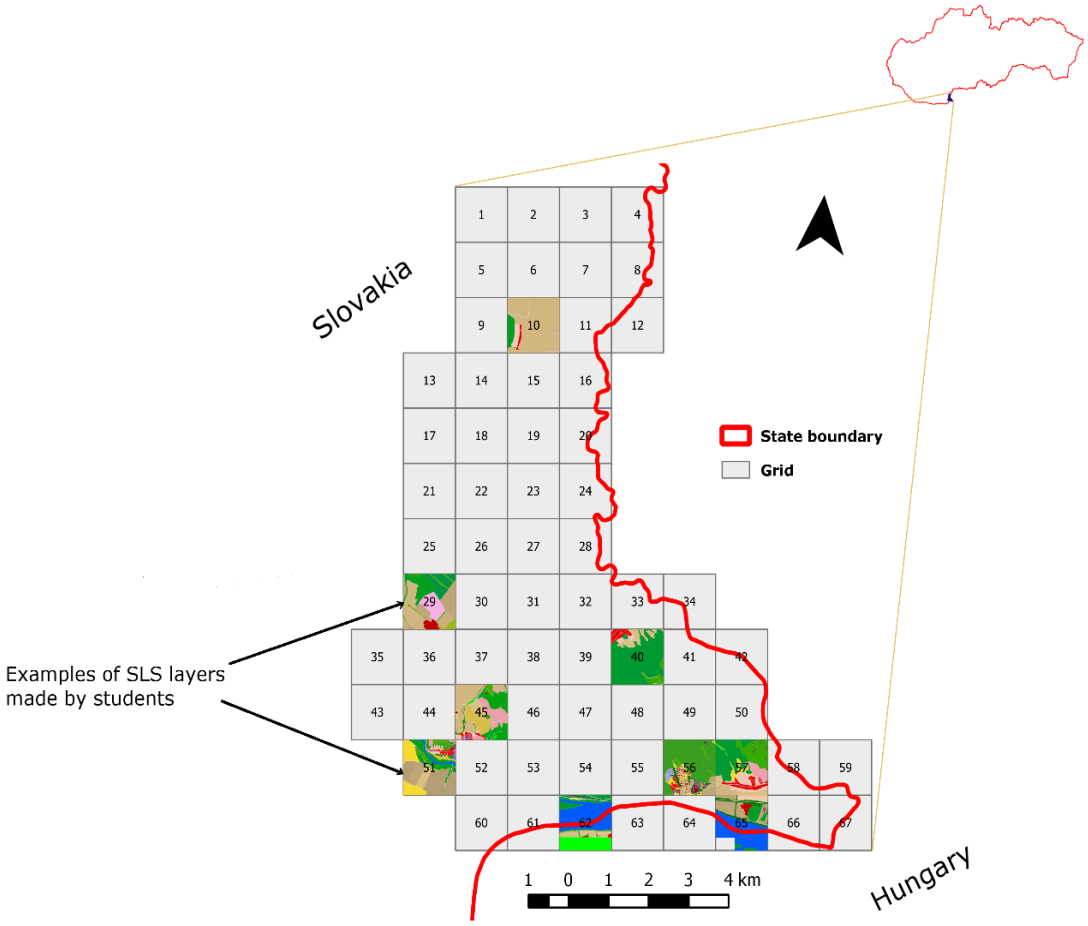


Figure 2: Example of filling the grid squares of a selected territory of Southern Slovakia with Secondary landscape structure maps made by students

Sufficiently well-developed information about area can then serve for the needs of further research and education in the area of landscape-ecological planning, or as support layers for zoology, geography and many other related fields. The essence of creating such

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map lies in its laborious making, as the process cannot be automatized, like, for example, obtaining of a land cover map. During the solving process students will practice and reinforce the majority of skills which they have to master in order to use mapmaking for example in their final theses and it gives them prerequisites for better prospects in their careers. As the mapmaking itself tends to be time-consuming, the whole process is carried out through e-learning and students have the opportunity to work at home. Submission of the ready-made solutions is also carried out through the internet, allowing flexible use of time for both sides of the educational process.

DISCUSSION

The system of filling the geodatabase with the data created in the environment of GIS by using LMS has a much broader use than is described this case study based on the mapping of the secondary landscape structure. Due to parallel production of a map by several users the system can be applied in different research areas. The following conditions have to be fulfilled. The production of the final map must be allocable to accurately limited adjacent areas - segments, while working on individual segments must be independent of each other. It means that each user can independently on other users create geographical objects (features) within the segment allocated to it on the basis of well-defined methodology. The next condition is the same level of generalization in individual segments. In practice it means, that each segment of the map must be created in the same scale with the same level of detail processing. The equally important condition is a unified definition of basic topological rules according to Egenhofer (1989) for each segment of the resultant maps. The necessity is work in the same coordinate system and the creation of homogeneous formats of map layers.

The system can be applied to produce maps in various fields of science and research. The digitalization of maps, it is a time-consuming method of collecting spatial data, where the scanned input maps or aerial survey in raster formats are manually vectorized in GIS environment. We can digitalize historical and contemporary maps in this way and focus on a variety of natural and administrative boundaries of the selected area and create thematic topological maps of larger units except of secondary landscape structure. Another exploitation is possible in environmental monitoring, biological and ecological research, for example monitoring the quality of the individual components of the environment, mapping biotopes, invasive plants and spatial ecology of animals. In the case of animals we can divide area by the grid that is defined in Fauna databank of Slovakia.

We observe the special use of spatial analyses that are demanding for time of calculation. We can reduce time of calculation by dividing the task into several segments. The example is the analysis of visual or morphometric analysis of relief as a slope, an aspect and a curvature.

CONCLUSION

E-learning supported education process may lead to great enhancement of learning new abilities using some features of Problem – based learning. Our strategy for accomplishing the main objective is to teach students to use most of GIS tools for their

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current and future needs, to give them vision of practical contribution to real science tasks. Example of such task is to create Secondary landscape structure map. This cannot be accomplished comfortably without E-learning, because problems which students must handle to create a thematic map are usually very time-consuming. During solving such exercise they can frequently use supporting study materials like video manuals, example shape files, tables, special file formats and text documentation, alongside with discussion forums to communicate with classmates and of course their lecturer. Moodle and GIS software licensed under GNU GPL give freedom – there are no costs for obtaining the software, even none additional costs for upgrading to the latest version and the selection of operating system depends only on students' preferences. This all makes E-learning a very flexible tool, which can spare lecturer's time and gives an opportunity for individual approach to every student.

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Dynamic Simulation and Visualization in MS Excel Spreadsheet

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Abstract

One of the most important tasks in teaching of mathematics and science is to use a suitable method for developing of theoretically acquired knowledge. Drawing on their own experience, the authors have found that the best method to be used is the system approach. System approach together with modelling and computer simulation can be understood as one of the most important method in teaching of mathematics and science and simultaneously can be used as suitable method for practical developing of theoretically acquired knowledge. The paper focuses to the theory of modelling, simulation and visualization of solution of real process. The case study, described in the paper, present possibilities of implementation of system approach in creation of mathematical model as well as dynamic computer simulation model, visualization and animation of the process. The case study presents possibility of dynamic visualization of mechanical motion – trajectory of ballistic shot. The solution is demonstrated in MS Excel worksheet and chart.

Keywords

Animation. Computer simulation. Mathematical modelling. System approach. Visualization.

INTRODUCTION

The term “developing of theoretically acquired knowledge” can be connected with the terms “system”, “model”, “computer simulation”, “dynamic visualization”, “animation” or “multidisciplinary approach”, which are important in current approach to scientific, technological and professional practice.

Many universities are realizing that modelling and simulation is becoming an important tool in finding the strategy for solving and understanding numerous and diverse problems. The examples can be found e.g. in Hubálovský (2012), Dvořák and Šedivý (2012) or Milková (2012).

In this paper we first briefly introduce the theory of system approach, modelling and simulation as a method of multidisciplinary and system approach to education.

Secondly, the case study illustrating step by step process of development of computer simulation, visualization and animation will be introduced. The case study will present

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possibility of dynamic visualization of mechanical motion – trajectory of ballistic shot in MS Excel worksheet and chart.

THE SYSTEM APPROACH, MODELLING AND SIMULATION

System approach and education

System approach, scientific modelling and computer simulation are the terms which are closely related.

System approach enables description of the real processes, without which mathematical model and computer simulation model cannot be realized.

From the education point of view the system approach can be applied:

- In the field of sciences - in case of models and simulations of science processes and phenomena;
- In the technical field - in case of the process control of machines and simple robots;
- In the humanities and social studies - in case of the processes and phenomena associated with this issue;
- In management - in case of the management processes and quality control processes.

The other information on system approach in education can be found e.g. in Houška and Beránková, (2007).

Modelling

The main goal of modelling is not only describing the content, structure and behavior of the real system representing a part of the reality but also describing the processes. The process can be understood as series of transformations that changes the input values to output values. From the system point of view the process is dynamic system in which the values of the characteristic of the system elements are changed under the influence of the external elements. The first step in the process of computer simulation is creation of conceptual model of the studied real system / real process. Conceptual model can be represented in different way. The most used representations are:

Mathematical equations establishes mathematical model of the studied real system. The model can be obtained either theoretically based on basic physical properties of the system, or numerically by means of the measured values. Determination of parameters of theoretical model developed from empirical data is called system identification.

Scatter charts (scatter plot) is a type of mathematical diagram using Cartesian coordinates to display values for two variables for a set of data in 2D types of the chart. The scatter plot takes two sets scalar variables and uses them for two axes in 2D space. Time depending variables create dynamic scatter chart representing time depending conceptual model of the dependency of system outputs on its inputs.

Dynamic visualization of the dynamic properties of real phenomena via 2D scatter chart created in MS Excel program will be shown in the case studies of this paper.

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Simulation

The process of modelling is closely related to the simulation. Simulation can be understood as process of executing the model. Simulation enables representation of the modeled real system or real process and its behavior in real time by means of computer. The simulation enables also visualization and editing of the model.

A typical simulation model can be written both through specialized programming languages that were designed specifically for the requirements of simulations, or the simulation model can be created in standard programming languages.

From the above considerations, it is clear that simulation is a process that runs on the computer. In some publications, therefore, can be found the term ”computer simulation“. It generally is valid that computer simulation is a computer-implemented method used for exploring, testing and analysis of properties of the conceptual (mathematical or process) models that describe the behavior of the real systems or real process which cannot be solved using standard analytical tools, which is discussed e.g. in Hubálovský (2011) or Balogh, Turčáni and Buriánová (2010).

Case study demonstrated the dynamic simulation and visualization of the mathematical functions in MS Excel is presented in the paper.

Significant function of the simulation

Simulation has from the scientific point of view several functions (Hartmann, 1996). From *educational point of view* the simulation, simulation model and visualization of simulation results on the screen help students better understanding the basic features of the processes and systems and develop their intuition. It is also essential that the teaching by means of simulation is much cheaper and faster than the teaching carried by real experiment. In some cases providing the real experiment cannot be feasible.

DYNAMIC SIMULATION, VISUALIZATION AND ANIMATION IN MS EXCEL CHART

Before the modelling and dynamic simulation of the mathematical functions will be demonstrated in the case studies, the principle of the dynamic simulation and visualization in MS Excel has to be discussed.

Dynamic simulation model

Dynamic simulation is created based on the dynamic mathematical model. Dynamic mathematical model is model, which represents dynamic real system, e.g. the system which is time dependent.

Time dependent system is based on the system theory such system, which changes its status during the time. In sciences like mathematics, physics, chemistry we are speaking about the time dependent variables, which describe status of the system.

Visualization

Term visualization is close related to the simulation. Visualization is a technique, which shows both input data and output data and its dependencies reached from the

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simulation model. Visualization helps data analysis and interpretation. Commonly used tools for visualization are 2D charts, tables, flowcharts, diagram etc.

Animation

Special type of the visualization of the dynamic simulation data is animated diagrams.

Animation generally means a way how a static image can be seemingly set in motion. The principle of an animation is recording of a sequence of images which slightly differ. During a quick viewing of subsequent images an impression of movement occurs, due to the phenomenon of the persistence of vision. The frequency of changing of individual images is proportional to the displacement of the object in consecutive images. (The bigger the displacement of objects in each image is, the greater the frequency of changing these images must be to maintain a sense of motion).

There are many visualizations types of software, which enable animate dynamic simulation date. In the paper we will describe MS Excel us powerful tool for animation of time dependency variables in the scatter chart.

The principle of the animation of the scatter chart in MS Excel is based on the change of one or more parameters of the charts input data of the dynamic objects or curves. The objects or curves step by step change its position in relation to the static baselines which are time dependence function of one or more parameters. A change of these parameters can be achieved by using so-called *iterative calculation* of values in the cell.

Iteration

In general, iteration means repetition of certain activities - the word comes from the Latin *iteretur - repeat*. The iteration in mathematics and numerical methods is a process of applying a function *f* repeatedly, using the output value x_{n+1} of the function as input argument x_n of the function in the next step. This can be written by mathematical formula

$$x_{n+1} = f(x_n). \tag{1}$$

A typical example of the use of iterations is the numerical solution of nonlinear equations by the general iterative method (Milková, Hubálovský and Pražák, 2010). A typical example of a nonlinear equation is the transcendental equation

$$x = \cos x. \tag{2}$$

To find the approximate solution, one has to properly set the initial value of *x* (e.g. x_0 = 1), to provide the iteration ($x_{i+1} = \cos x_i$) and to see how the value of *x* is changing. The termination of the iterations is determined by the required accuracy - ε. The calculation will be terminated if the following condition is fulfilled:

$$|x_{i+1} - x_i| < \varepsilon. \tag{3}$$

Apart from solving of the nonlinear equations, the iteration calculus can be used e.g. for determination of values of recursively given sequences.

The sequences are defined either by explicit formulas for the *n*-th terms or recursively which means that the previous values of terms of the sequence are used to generate the

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value of the next term of the sequence. In other words one needs to know the initial value x_0 and the recurrence construction to be able to find subsequent terms of the sequence.

Such a sequence is called a recursively defined sequence. It means that for a given x_0, we can compute an arbitrary term of sequence x_t, where t = 0, 1, 2, …, according to the relation:

$$x_{t+1} = f(0, x_t, t_{max}) \quad i = 0, 1, \ldots, t_{max} \qquad (4)$$

This relation, together with an initial value x_0 is called a first order recurrence equation. The solution to this equation is any sequence x_t generated by this equation. The termination condition in the case of recurrently given sequences is given by number of sequence terms t_{max}.

Iteration in algorithm development and programming

Iteration in algorithm development and programming means a repeated call of the function whereas the argument of the function is the result of the previous function call. In this sense, the iteration corresponds to the aforementioned case of recursively given sequences. The iteration in algorithm development and programming is therefore called recursion.

An important part of recursion is a terminating condition which determines when the recursion is to be stopped. The recursion in programming is quite often used, as well as e.g. the assignment statement `A:=A+2` can be understood as a form of recursion based on equation (4) with the number of repetition t_{max} = 1. This expression means that the new variable value equals to the original value increased by 2.

Iteration /recursion in the MS Excel

The circular reference can occur in the formula of the cell in the Excel sheet. This means that the formula in a cell refers to the value of the same cell, eventually that the formula of the cell refers to the value of another cell, which has a formula linking back to the original cell (Hubálovská and Hubálovský, 2013).

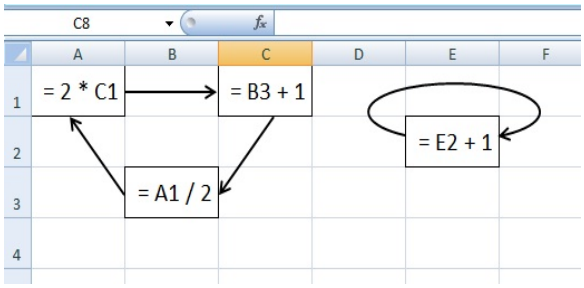


Figure 1: Examples of circular reference in MS Excel

The examples of the circular references are shown on the Figure 1. The value of such cells can be determined only by the iterative calculation. If such an iterative calculation is not possible in MS Excel option tools (default is disabled), the calculation will be executed and an error message will be shown.

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The iterative calculation in version of MS Excel 2007 can be enabled in the ”Excel Options“ dialog box (which is reached by clicking to the Excel option button in the main menu) in the folder ”Formulas“ – see Figure 2. The ”Enable iterative calculation“ checkbox has to be checked.

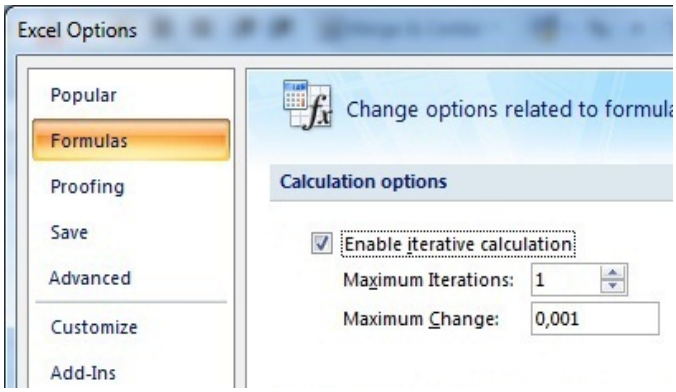


Figure 2: Setting of iterative calculation parameters in MS Excel

The item ”*Maximum Iterations*” specifies the maximum number of iterations, repetitions, which Excel provides in an iterative calculation. The item “*Maximum Change*” sets the accuracy of the iterative calculation - the value of the cell before and after the iteration is compared. If the absolute difference of the both values is smaller than the accuracy of the calculation, the iteration is stopped. The default value of “*Maximum Iterations*” is set to 100 and the default value of “*Maximum Change*” is set to 0.001.

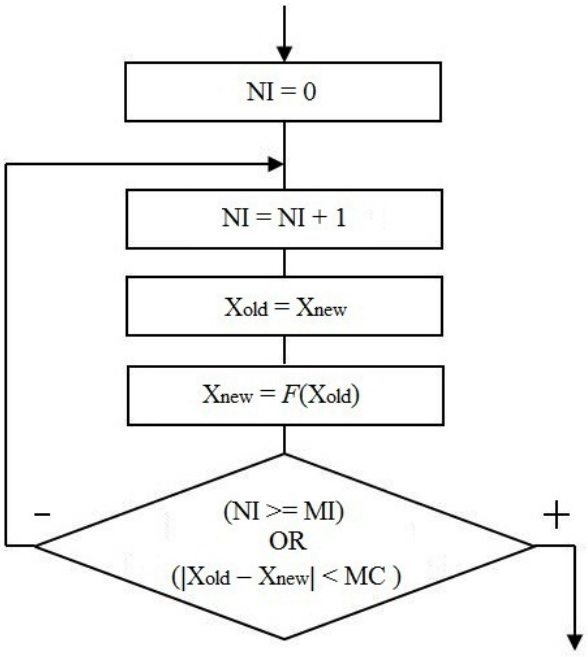


Figure 3: Flowchart of iterative calculation in MS Excel

The iterative calculation and its termination can be expressed in the form of the algorithm flowchart in Figure 3, where the following variables are used:

NI - the number of the already done iterations;

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Xold - the value of the cell before the iteration;
Xnew - the value of the cell after the iteration;
MI - the maximum iterations;
MC - the maximum change.

It is clear that the terminating condition is given either by the maximum of iterations (4) or by condition (3) – Hubálovská and Hubálovský (2013).

CASE STUDY – ANIMATION OF MOTION OF PROJECTILE ALONG BALLISTIC TRAJECTORY

In this case study the animation of motion of projectile along ballistic trajectory will be demonstrated. The animation is realized in two dimensional *XY* – scatter chart in MS Excel Spreadsheet.

Physical principle of motion along ballistic curve

Ballistic trajectory is trajectory of the flight projectile moving in the air. The main forces acting on the projectile are gravity, and air resistance. Gravity imparts a downward acceleration on the projectile, causing it to drop from the line of sight. Air resistance, decelerates the projectile with a force proportional to the square of the velocity. During flight, gravity and air resistance have a major impact on the path of the projectile, and must be accounted for when predicting how the projectile will travel.

Mathematical model

Before the principle of animation of the ballistic trajectory will be shown, the mathematical model of the problem has to be established.

The ballistic trajectory is given by equations of motion. The equations of motion in the *x*, resp. *y* directions are:

$$ma_x = -kv_x, \tag{5}$$

$$ma_y = -mg - kv_y, \tag{6}$$

where m is mass of the projectile, k is coefficient of the air resistance, a_x resp. a_y are accelerations, v_x resp. v_y are velocities and g is gravity acceleration.

The equations (5) and (6) can be solved either analytically or numerically. We will show in the paper numeric solution.

Numeric solution is based on splitting the trajectory of the ballistic motion to number of the small time elements dt. The solution is as follows:

$$t_{n+1} = t_n + dt, \tag{7}$$

$$(a_x)_n = -k(v_x^{\,2})_n, \tag{8}$$

$$(a_y)_n = -k(v_y^{\,2})_n - g, \tag{9}$$

$$(v_x)_{n+1} = (v_x)_n + (a_x)_n \mathrm{d}t, \tag{10}$$

$$(v_y)_{n+1} = (v_y)_n + (a_y)_n \mathrm{d}t, \tag{11}$$

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$$(x)_{n+1} = (x)_n + (v_x)_n \mathrm{d}t, \quad (12)$$

$$(y)_{n+1} = (y)_n + (v_y)_n \mathrm{d}t, \quad (13)$$

The initial conditions are:

$$(v_x)_0 = v_0 \cos\alpha, \quad (14)$$

$$(v_y)_0 = v_0 \sin\alpha, \quad (15)$$

$$(x)_0 = 0, \quad (16)$$

$$(y)_0 = h, \quad (17)$$

where v_0 is initial velocity of the projectile shoot, α is angle of the shoot and h is initial height of the shoot.

Simulation model - Setting of parameters and formulas for iterative recalculation

In the following text the dynamic animation of the ballistic trajectory in MS Excel two dimensional *XY* – scatter chart will be shown.

Main parameter responsible for iterative recalculation is time *t*. The trajectory will be drawn step by step from time *t* = 0 with the time increment d*t*.

The value of the time *t* is saved in cell `D2`. Simultaneously the circular reference formula `= D2 + D10` is entered into cell `D2`. This formula expresses that the value of time in `D2` after one iterative recalculation step increases by the increment time d*t* value entered in cell `D10` - iteration (animation) step.

Iterative recalculation starts by pressing of **F9** key. The number of the iteration steps is set by the value of "*Maximum Iterations*". To make only one step of the iteration, defined by formula in cell `D2`, the value of "*Maximum Iterations*" has to be equal to 1, as is evident from the Figure 2.

By repeated pressings, eventually by holding down the key **F9**, the value of cell `D2` will step by step increase by the value of the animation step, value saved in cell `D10`.

If only the formula `= D2 + D10` was entered to the cell `D2`, the value of `D2` would after each iteration step still increase. It is therefore necessary to determine the *terminating condition*, i.e. *minimum* and *maximum* time limits.

Minimum time is *t* = 0 s. Maximum animation time t_{max} is given by time, when *y* coordinate of the projectile is less than 0.

This can be done by adding the following condition to formula in cell `D2`:

```
= IF (MIN($S:$S)<0;0;D2+D10).
```

This condition compares the values of *y* stored in rows of column `S`. If the condition is true (first *y* value is less than 0) the value of `D2` changes to the 0. Otherwise, the iterative calculation is carried out and the value of `D2` cells increases by the value of the iteration step (value of the cell `D10`). The situation is shown on the Figure 4.

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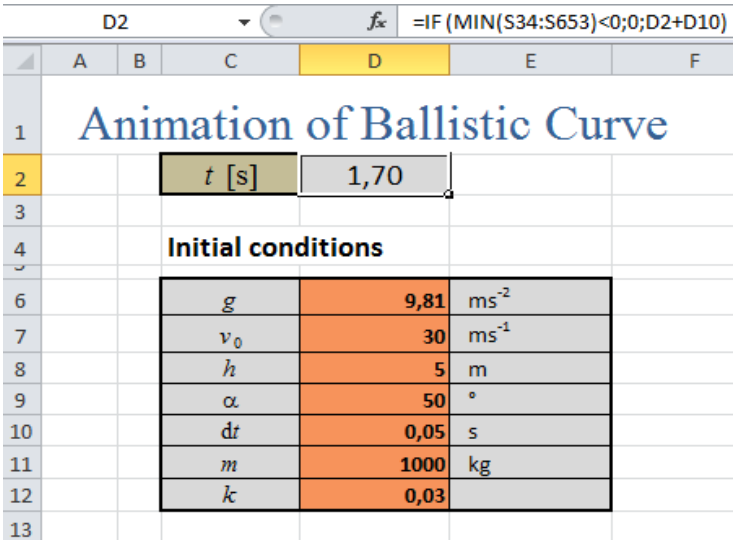


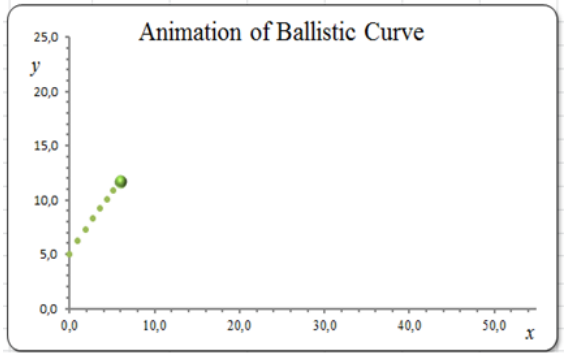
Figure 4: Solution of the iterative calculation of the time *t*

The iterative recalculation of time *t* is changed within the range from a minimum value (*t* = 0) to a maximum value (t_{max}) with the iteration step (the value of d*t* given in cell `D10`) by repeated pressings or by holding of key **F9**.

Animation - Creation of the XY scatter chart

The dynamic animation chart of the ballistic curve will be drawn in the interval $t \in \langle 0, t_{max} \rangle$. Into one of the columns (e.g. column `L`) the set of time increments *t* are saved.

The values of a_x, a_y, v_x, v_y, *x* and *y* are calculated based on formulas (7) – (13) – see Figure 5.



Source data

t	a_x	a_y	v_x	v_y	*x*	*y*
0,00			19,2836	22,9813	0,0000	5,0000
0,05	-17,3553	-30,4932	18,4159	21,4567	0,9642	6,1491
0,10	-15,6218	-28,0113	17,6348	20,0561	1,8850	7,2219
0,15	-14,1288	-25,8788	16,9283	18,7622	2,7667	8,2247
0,20	-12,8335	-24,0338	16,2867	17,5605	3,6131	9,1628
0,25	-11,7022	-22,4275	15,7015	16,4391	4,4275	10,0408
0,30	-10,7082	-21,0212	15,1661	15,3880	5,2125	10,8628
0,35	-9,8302	-19,7841	14,6746	14,3988	5,9708	11,6322

Figure 5: Dynamic animation of ballistic curve in *XY* scatter chart and source data

CONCLUSION

There are various approaches how to provide training and development of theoretically acquired knowledge in mathematics. A new way of the teaching / learning strategy by using the system approach was presented in the paper. The processes of creation of numerical solution, dynamic computer simulation model, visualization and animation have been presented step by step in the paper. The system approach can be set

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as the default paradigm for a wide integration of the principles of the algorithm development into education.

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First Outcomes of WP2 Research Carried Out Within the Framework of the IRNet Project – International Research Network

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Abstract

This paper, prepared by an international team of authors including specialists from different scientific areas, connected with ICT, e-learning, pedagogy, and other related disciplines, focuses on the objectives of the international project IRNet - International Research Network for the study and development of new tools and methods for advanced pedagogical science in the field of ICT instruments, e-learning and intercultural competences. The project is financed by the European Commission under the 7th Framework Programme, within the Marie Curie Actions International Research Staff Exchange Scheme. Grant Agreement No: PIRSES-GA-2013-612536; the duration of the project: 48 months1/01/2014 – 31/12/2017. In particular, the article describes a WP2: Analyses of legal, ethical, human, technical and social factors of ICT and e-learning development, and the state of intercultural competences in partner countries: Objectives, Tasks, and Deliverables. The second part of the paper includes data from preliminary research. During the study and analysis of global (international) and local (national) documents as well as university documents Table 1 was prepared which sets forth a comparison of legal, ethical, human, technical and social factors of ICT and e-learning development, and the state of intercultural competences in several partner countries, for example Poland, Ukraine, the Netherlands and Russia in the context of the IRNet project – International Research Network.

Keywords

E-learning. Legal, ethical, human, technical and social factors of ICT. IRNet - International Research Network Project.

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INTRODUCTION

On the eve of a new century, there is an unprecedented demand for and a great diversification in higher education, as well as an increased awareness of its vital importance for sociocultural and economic development, and for building the future, for which the younger generations will need to be equipped with new skills, knowledge and ideals. Higher education includes 'all types of studies, training or training for research at the post-secondary level, provided by universities or other educational establishments that are approved as institutions of higher education by the competent State authorities'. Everywhere higher education is faced with great challenges and difficulties related to financing, equity of conditions at access into and during the course of studies, improved staff development, skills-based training, enhancement and preservation of quality in teaching, research and services, relevance of programmes, employability of graduates, establishment of efficient co-operation agreements and equitable access to the benefits of international co-operation. At the same time, higher education is being challenged by new opportunities relating to technologies that are improving the ways in which knowledge can be produced, managed, disseminated, accessed and controlled. Equitable access to these technologies should be ensured at all levels of education systems (World Declaration on Higher Education).

IRNET PROJECT SUMMARY

IRNet - International Research Network for study and development of new tools and methods for advanced pedagogical science in the field of ICT instruments, e-learning and intercultural competences. Project financed by the European Commission under the 7th Framework Programme, within the Marie Curie Actions International Research Staff Exchange Scheme. Grant Agreement No: PIRSES-GA-2013-612536 Duration of the project: 48 months1/01/2014 – 31/12/2017.

Nowadays, we can observe a rapid transition of the knowledge society to the "society of global competence", in which both the global economy and the education systems are undergoing changes. It is evident that without an active implementation of innovative forms and methods of education, and above all, distance learning at all levels of education these objectives cannot be successfully achieved. At the same time we should identify the existing problem - the fact that e-learning methodology is not yet fully developed and specified, both within the EU and in Ukraine. Developing and implementation of the system designed to develop IT competences of contemporary specialist, in particular the future teachers, current teacher, leadership, based on the systematic use of selected Internet technologies, such as some LCMS systems (as Moodle), Massive Open Online Courses, "virtual classroom" technology, social media, other selected Web 2.0 and Web 3.0 technology positively contributes to the development of skills in the area of IT and intercultural competences. The IRNet project aims to set up a thematic multidisciplinary joint exchange programme dedicated to research and development of new tools for advanced pedagogical science in the field of ICT instruments, distance learning and intercultural competences in the EU (Poland, the Netherlands, Spain, Portugal, Slovakia) and Third Countries (Australia, Russia, Ukraine). The programme will strengthen existing

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collaboration and establish new scientific contacts through mutual secondments of researchers. The main objectives of the project are: 1. to exchange expertise and knowledge in the field of the innovative techniques of education between EU and Third Countries and suggest effective strategies of implementing new tools in their profession; 2. to analyse and evaluate social, economic, legal conditions, as well as methodologies and e-learning techniques being developed in the European and Third Countries involved.

The IRNet project aims to set up a thematic multidisciplinary joint exchange programme dedicated to development of new tools for advanced pedagogical science in the field of ICT instruments, distance learning and intercultural competences in the EU, Australia, Ukraine and Russia. The programme will strengthen existing collaboration between EU partners, and 2 third country institutions of higher education through mutual secondments of researchers.

Nowadays, we can observe a rapid transition of the knowledge society to the "society of global competence", in which both the global economy and the education systems are undergoing changes. It is evident; that without an active implementation of innovative forms and effective methods of education, and above all, distance learning at all levels of education these objectives cannot be successfully achieved. However, we can identify an existing problem that ICT techniques and e-learning methodology are not fully developed yet either within the EU or in Australia and in Ukraine. In this situation, an implementation of the system designed to develop ICT competences of contemporary specialists, in particularly current and future teachers, based on the systematic use of selected Internet technologies, such as some LCMS systems (as Moodle), Massive Open Online Courses, "virtual classroom" technology, social media, other selected Web 2.0 and Web 3.0 technology will positively contribute to the development of skills in the area of ICT and intercultural competences, other.

More detail conception of the project described in the Project application and on the project web-site (IRNet Project Application, www.irnet.us.edu.pl)

The main objectives of the project are as follows:

1. To evaluate teaching competences and to suggest effective strategies of implementing new innovative tools in the educational activity in the context of globalization of education.
2. To explore indicators of educational effectiveness in the EU and third countries involved in the project.
3. To exchange experiences, analyse and evaluate teaching competences in usage of innovative forms of education and suggest effective strategies of implementing innovative ICT tools in the education activity.
4. To analyse and evaluate social, economic, law and ethics conditions, as well as methodologies and models of e-learning techniques being developed in the European and third countries involved into the project.
5. To evaluate the effectiveness of the existing models/methodologies designed to provide e-learning and enhance intercultural awareness.
6. To develop a new model based on the current existing models/methodologies and literature review.

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7. To evaluate and present new models/methodologies for an effective remote collaborative work and improve Information technologies in Education Science in EU and third countries.
8. To actively transfer knowledge with a view to generating strategic impacts in the thematic research area.
9. To promote scientific discussion about the integrity of systems of education and work focusing on competence issues in the context of globalization of higher education.
10. Staff exchange between institutions in Europe (the Czech Republic, the Netherlands, Poland, Slovakia, Spain, Portugal) and third countries (Ukraine, Russia and Australia).
11. To strengthen existing collaborative research (e-learning methodology, web 2.0, web 3.0 technology analyse, intercultural competences, teacher skills in school of the future, social, human, IT, psychological, methodical, ethical, law factors, influence on some key competences developing) (IRNet Project Application, www.irnet.us.edu.pl).

METHODS

The planned scientific activities are divided into seven interconnected work packages (http://www.irnet.us.edu.pl/documents) in order to structure the work planned, of which five are based on joint researches of all the partners, one is focusing to dissemination of results (WP7) and one WP is designed to project management (WP1). Each of Work Packages is designed to one of main research activities of the project and aims to develop a new conceptual and methodological approach in the thematic research area. These will be also a basis of long term research collaboration promoting knowledge transfer between EU and third countries. The project seeks to use the synergies and complementarities of the 10 research teams to furnish a more accurate and holistic picture of the current state of universities. Each of these Work Packages is designed to produce specific outputs: workshops to discuss the results, a website, a working paper series to put the research results quickly into the public domain, and a book covering the scientific achievements. Overall, the work packages aim to widen an established research agenda and to develop a new conceptual and methodological approach. These will be the basis of a joint research application and long term research collaboration, which will assist in promoting and reflecting upon knowledge transfer between EU and non-EU countries.

WP2: analyses of different factors of ICT and of e-learning development in partner countries

We introduce the objectives and the tasks of the second work package in this chapter.

The overall goal of the WP2 is to anticipate the coming years when universities will face the need to work together, both in terms of student exchange and in terms of technological and infrastructural procedures for exchanging staff members and open online courseware material. The recent attention for MOOCs (Massive Open Online Courses) is only a small part of the solution. Much more vital are the compatibility of

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institutional policies, benchmarks for effectiveness and the mutual recognition of assessment characteristics.

Building on the leading work of the team the participants will engage in a critical review of the existing literature, legal documents, web sources, etc., drawing on contributions from a range of relevant disciplines (education, computer science, intercultural education, sociology, anthropology, political science) and analyse legal, ethical, human, technical, social factors of development ICT, e-learning and intercultural development in partner's countries. They will add new perspectives on the problem of understanding the higher education and developing some key competences - globalization nexus in different regional and national contexts.

This WP2 will be coordinated by UT (the Netherlands), exploiting their particular expertise in some key competences and education. It will advance existing knowledge by creating a synergy between UT's expertise with US, BGKU, DSTU expertise on legal, ethical and human factors of ICT development as well as psychological accomplishment of face-to-face and e-learning and teaching and sharing the latest blending teaching methods via technology in CU (Australia) and expertise of other universities.

The most important WP2 tasks (http://www.irnet.us.edu.pl/documents/wp2, 2014) include:

- Mapping and developing an account of factors involved in process of globalisation and regionalization in developing key competences, including their interests, scales of influence, and temporal horizons.
- Examining the role of higher education policy in globalisation processes (e.g. shifts from servicing to driving development of a knowledge society and from aid to e-learning as a means of competences' building) and the role played by higher education institutions and their projects as potential models for other world regions.
- Identifying the role of key international higher education institutions in policy developing of key competences and in new forms of international cooperation.
- Analysis of processes of competences development – e.g. processes operating simultaneously on different scales, contemporary trends and previous research.
- Researchers will engage in individual/joint-research in the visited institution. If it is in a city they happen to be researching they will be able to carry out fieldwork and/or archive research.
- Analysis of legal, ethical, human, techniques, social factors of Development ICT, e-learning and intercultural development in every partner's countries.

Researchers will be expected to take part in events, such as conferences, workshops and roundtables, particularly ones that deal specifically with their topic(s) of research, for example:

- Initial seminar in Poland in remote form (using Adobe Connect technology for videoconferences).
- Meeting for all project participants in Spain.
- Videoconferences and roundtable debate.

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- Meeting and Workshop (HSPU, Russia).
- Conferences DIVAI 2014 (Distance Learning in Applied Informatics) UKF (Slovak Republic); Conference "Innovations in higher education and dissemination of the initial results of the research on the law, ethical, human, technical, social factors of ICT developments, e-learning and intercultural developments in deferent countries" (DSTU, Ukraine), others.

Comparison of different factors of ICT and e-learning in several partner countries is carried out using such methods and tools compatible with the aims and tasks of WP2, as:

1) study and analysis of documents, 2) survey, 3) interview, 4) observation, 5) development of the subject dictionary, 6) research trip and visiting a partner university, 7) meeting, (video)conference, seminar, workshop, etc.

RESULTS

During the study and analysis of global (international) and local (national) documents as well as university documents tables were prepared which sets forth a comparison of legal, ethical, human, technical and social factors of ICT and e-learning development and the state of intercultural competences in several partner countries, for example Poland, Ukraine, the Netherlands and Russia in the context of the IRNet project – international scientific network.

Recommendation to the Committee of Ministers to pay particular attention to the ethical and social aspects related to basic skills in the use of ICT. In the Recommendation (2006/962/EC of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning), the European Parliament and the Council of the European Union (http://eurlex.europa.eu/, 2006) defined eight key competences that are needed by every person for self-realisation and personal development, for being an active citizen and for achieving full social potential. The digital competence is ranked fourth. Table 1 shows the comparison of legal factors and Table 2 shows the legal factors defined in documents published at the participated universities.

Table 1: Comparison of legal factors.

Factors	Poland	Ukraine	The Netherlands	Russia
ICT and e-learning in education	Standards of education. Preparing for the teaching profession (Law on Higher Education, ACT of 27 July 2005 Article 9c.)	National Qualifications Framework (Resolution of Cabinet of Ministers of Ukraine, 11 November 2011)	The Dutch State University system is characterized by free entrance for each student who graduated from the secondary school, provided that the needed subject courses have been covered. The targeted competences are	Decree of the Ministry of Education and Science of the Russian Federation dated 03.08.2012 № 583 "On monitoring the activities of federal government educational institutions of higher education" (http://www.edu.ru/db-mon/mo/Data/d_12/m583.html)

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			both academic and professional. Still the prescribed language for the bachelor stage is Dutch; Masters- and Ph.D. curricula are saturated with English at the moment.	
Could be distance learning officially used as a legal learning and teaching form and teaching at the high school? What are the conditions?	The number of hours in remote mode does not exceed 60 % of the total number of hours of classes. (Regulation of the Minister of Science and Higher Education of 9 May 2008)	Regulation of the Minister of Science and Higher Education of 30 April 2013	The use of media in Dutch Higher Education is encouraged as far as it contributes to flexibility and internationalisation. Step by step the ministry of higher education becomes aware that MOOCs are helpful to keep diversity in programs alive as not all specialties can be afforded by the limited number of universities staff members.	Federal law "About Education" The Law officially provides the possibility to use e-learning and distance learning technologies. Organizations engaged in educational activities are able to use e-learning and distance education technologies in the implementation of educational programs.

Table 2: Comparison of legal factors at universities participated in the project.

University of Silesia in Katowice	Borys Grinchenko Kyiv University	University of Twente in Enschede	Herzen State Pedagogical University of Russia
Decree No. 66/2012 formally allows one to teach up to 60% of classes in the remote mode.	Approval of the Regulation on e-learning courses in LMS Moodle, and special requirements for e-learning courses certification, 2012	The University of Twente has adopted the potential of MOOCs in a way that stimulates the further evolution of mediated learning, both on- and off-campus. Its goal is growing quality awareness at the level of teachers and curricular designers.	Development and implementation of primary and secondary distance education programs (Development program 2012–2015)
Increase in the number of e-learning courses, and greater activity in distance teaching. Organisation of lifelong learning courses and trainings – also in the form of e-learning in	Approval of the Regulation on professional development of teachers by creation of e-learning courses as compulsory for all teachers, availability of	Quite recently the board of governors at the university of Twente has expressed the explicit interest to undertake MOOCs as format for implementing fields of excellence.	Development of electronic educational resources aimed at remote support for various categories of students (pupils, students, students, professors, teachers,

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Polish and English – in the use of electronic databases for students, doctoral candidates and employees. Using and developing modern computer and information technologies for more individualised education in the form of e-learning and blended learning (Development Strategy 2012-2020).	an electronic course as necessary condition for receiving the title of associate professor and professor. Increase in the number of e-learning courses Using and developing information technologies for more individualised education in the form of e-learning and blended learning (Development Strategy 2013-2018). Decree on the Experiment of using mixed type of education in teaching masters programmes, 2013 Decree on the mandatory use of ELC in teaching correspondence department students, 2014	One of the challenges is to integrate social (pseudo) presence, constructivism, problem-based learning and social media. Prior to these mechanisms, there is a need to allow students to prove competence through unique, authentic learning achievements like design and societal problem solving, rather than just checking if the curricular components are mastered.	people with disabilities), including in foreign languages. Teachers' training in implementation of remote support for students with the use of electronic educational resources (Development program 2012–2015)

Recommendation to the Committee of Ministers places emphasis on paying particular attention to the ethical and social aspects related to basic skills in the use of ICT (Resolution, session Athens, Greece, 10-12 November 2003). Table 3 shows the comparison of ethical and social factors.

Table 3: Comparison of ethical and social factors.

University of Silesia in Katowice	Borys Grinchenko Kyiv University	University of Twente in Enschede	Herzen State Pedagogical University of Russia
Maintaining high ethical standards in research and compliance with the best practices code (Development Strategy 2012-2020). Implementation of a zero tolerance policy on plagiarism and other unethical behaviours (Development Strategy 2012-2020).	Adoption of corporate standards for teachers and students on ICT (Development Strategy 2013-2018). Implementation the project "corporate culture of the University," 2013, holding regular training sessions with teachers, students and staff on the question of Corporate Culture	Ethics and Technology has been formulated in curricula and project evaluation. Typical questions that emerged are: How can we see to it that newly emerging and converging technologies and infrastructures express our considered moral judgments and widely endorsed public values? How can we assess our technology in the light of public moral	Section 4.2. Social Effects. The program will make a significant contribution to the development of innovative educational system of the Russian Federation (Development program 2012 – 2015)

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		values like sustainability, user autonomy, safety, privacy, accountability, democracy and quality of life? What role should public actors play in decision making about technological risks in design? And how are our norms and values affected themselves by technological developments?	

Maintenance of its work program, as the main priority, learning foreign languages, in order to ensure that all people involved in educational systems will be able to effectively communicate in foreign languages and fully benefit from the increasing wealth of information and opportunities for contacts and exchange, to promote the training of teachers and teacher trainers in the use of information and communication technologies (ICT) for educational purposes (Resolution, session Athens, Greece, 10-12 November 2003). Table 4 shows the comparison of human and educational factors.

Table 4: Comparison of human and educational factors.

University of Silesia in Katowice	Borys Grinchenko Kyiv University	University of Twente in Enschede	Herzen State Pedagogical University of Russia
Individualised education in the form of e-learning and blended learning (Development Strategy 2012-2020).	Individualised education in the form of e-learning and blended learning (Development Strategy 2013-2018).	Internationalization and the Integration of International Students at the University of Twente has been researched by Silke Kucking in her Master Thesis.	Development of electronic educational resources aimed at remote support for various categories of students (pupils, students, students, professors, teachers, people with disabilities), including in foreign languages (Development program 2012 – 2015)

The Digital Agenda for Europe 2013-2014 (https://ec.europa.eu/digital-agenda/en/news/digital-do-list-new-digital-priorities-2013-2014) analyses and describes in particular 5) Entrepreneurship and digital jobs and skills, and in this documents it is stressed that "The Commission signals that by 2015 700,000 to 1 million ICT jobs will not be filled in Europe, due to lack of skilled personnel. Additional action is needed to boost the overall number and the employability and mobility of ICT experts. Therefore the Commission will launch a 'Grand Coalition on Digital Skills and Jobs'. Table 5 shows the comparison of technical factors.

Table 5: Comparison of technical factors.

University of Silesia in Katowice	Borys Grinchenko Kyiv University	University of Twente in Enschede	Herzen State Pedagogical University of Russia
Using and developing	Using and developing	The Uses and	Monitoring of federal

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modern computer and information technologies for more individualised education in the form of e-learning and blended learning; (Development Strategy 2012-2020). Making the University of Silesia's infrastructure available for events important for the Region and Country (Development Strategy 2012-2020).	modern computer and information technologies for more individualised education in the form of e-learning and blended learning; (Development Strategy 2013-2018).	Gratification Theory has led many initiatives on Media in the Learning and Teaching to the optimum of evolution rather than revolution. Media can be seen as catalytic rather than disruptive.	institutions of higher education is carried out to measure a number of indicators, in particular § 5.2. "The availability of information and communication education": number of PCs within the local networks with the Internet access, the channel capacity, the availability of special software".

To support the development of research on the educational use of information and communication technologies (ICT) in all subjects included in the curriculum (Resolution, session Athens, Greece, 10-12 November 2003), other. Table 6 shows the scientific aspects of factors.

Table 6: Scientific aspects of factors.

University of Silesia in Katowice	Borys Grinchenko Kyiv University	University of Twente in Enschede	Herzen State Pedagogical University of Russia
Cooperation under international research and educational projects and scientific networks (Development Strategy 2012-2020).	Cooperation under international research and educational projects and scientific networks (Development Strategy 2013-2018).	The University of Twente has embedded its internationalisation policies in a multitude of consortia and student associations.	The informatization Council of Herzen State Pedagogical University of Russia is a joint advisory and scientific advisory body of the University, developing recommendations and suggestions for solving problems of informatization in accordance with the program of development of the university, and for improving the functioning and development of innovative University through the use of modern computer technology. (Temporal Regulations)

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DISCUSSION

The authors of this paper have extensive research experience as well as a track record of previous publications within the framework of the subject of the described research (Kommers et al. (2014) Smyrnova-Trybulska (2007, 2010, 2013), Morze (2013a, 2013b, 2013c, 2013d), Noskova (2013), Pavlova (2012), Yakovleva (2013)). The global, regional and local aspects of the situation concerning the evolution and development of the educational policy in European and third countries are changing simultaneously. We can observe a reduction in differences in education systems in European and third countries thanks to such programme and projects as Bologna process, 7 Framework Programme, Erasmus etc. However, differences still remain and one of the aims of our research consortium is to explore indicators of educational effectiveness in the EU and third countries involved in the project and factors influencing this. In the previous chapter 'Results' we have presented the first outcomes of wp2 research carried out within the framework of the IRNet project – International Research Network - study and analyses of documents. Below we present one of the surveys, intended to be conducted in the coming months in all the partner universities. Received outcomes could help us to understand the current situation concerning educational policy and effectiveness in the consortium countries; these will be compared with earlier research outcomes and will support the development of more adequate research directions and project methodology.

One of the surveys, intended for university authorities and academic teachers, reads as follows:

1) What do you think of the official national educational policy, pursued by the Ministry of Education and Ministry of Science and Higher Education concerning using ICT and e-learning in higher education?

Excellent □ Very good □ Good □ Satisfactory □ Poor □ Other

2) Which factors most influence and characterize the educational policy, pursued by the Ministry of Education and Ministry of Science and Higher Education concerning using ICT and e-learning in higher education (in scale 1-5, 1-min, 5-max)?

Legal (in scale 1-5) □ Ethical (in scale 1-5) □ Human (in scale 1-5) □ Technical (in scale 1-5) □ Social (in scale 1-5) □ Other

3) Which factors most influence and characterize the educational policy, pursued by the Ministry of Education and Ministry of Science and Higher Education concerning developing multi- and intercultural competences (in scale 1-5, 1-min, 5-max)?

Legal (in scale 1-5) □ Ethical (in scale 1-5) □ Human (in scale 1-5) □ Technical (in scale 1-5) □ Social (in scale 1-5) □ Other

4) Do you think that globalization of information and educational environment and standardization of formal educational systems is a positive trend in the world higher education system?

□ Yes □ No

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5) Do you think that globalization of information and educational environment and standardization of formal educational systems is a positive trend in your national higher education system?

 Yes No

6) Should the government policy provide a system of training in ICT and e-learning for teachers?

- Certainly should
- it is the task of the educational institution
- teachers must improve their skills themselves
- other
- Should a policy in the field of e-learning resources be pursued at the state level?
- Certainly should
- it is the task of the educational institutions association
- it is the task of the educational institution itself
- other

8) Should the risks of the global information environment influencing the consciousness of the growing person (child, adolescent) be considered at the state level?

- Certainly should
- Should not, because it limits the Internet freedom
- Other

9) To what extent does the law regulate the use of e-learning in higher education?

- There are state regulations
- There are institutional regulations
- There are no precise regulations
- Other
- Do the teacher activity regulations involve the need of professional activities not only in the official language?
- Teaching is carried out only in the state language
- Teachers should use the English language in the professional activities
- Other

CONCLUSION

In this paper the authors presented the objectives of the international project **IRNet - International Research Network for study and development of new tools and methods for advanced pedagogical science in the field of ICT instruments, e-learning and intercultural competences as well as** WP 2: Analyses of legal, ethical, human, technical and social factors of ICT and e-learning development and the state of intercultural competences in partner countries: Objectives, Tasks, Deliverables. The second part of the

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paper includes data from preliminary research. During the study and analysis of global (international) and local (national) documents as well as university documents Table 2 was prepared which sets forth a Comparison of legal, ethical, human, technical and social factors of ICT and e-learning development and the state of intercultural competences in several partner countries, for example Poland, Ukraine, the Netherlands and Russia in the context of the IRNet project – International Research Network.

The international team of researchers from The University of Silesia in Katowice (US, Poland, Beneficiary 1 (Coordinator)), University of Twente (UT, The Netherlands (Beneficiary 2)), University of Extremadura (UEx, Spain (Beneficiary 3)), Constantine the Philosopher University in Nitra (UKF, Slovak Republic, Beneficiary 4), Lisbon Lusíada University (LU, Portugal, Beneficiary 5), University of Ostrava (OU, Czech Republic, Beneficiary 6), Curtin University in Perth (CU, Australia, Partner 1), Borys Grinchenko Kyiv University (BGKU, Ukraine, Partner2), Dniprodzerzhinsk State Technical University (DSTU, Ukraine, Partner 3), Herzen State Pedagogical University of Russia, St. Petersburg (HSPU, Russian Federation, Partner 4) will be continuing the study and research in the framework of the Project Application, according to the project scheduler, and in near future, they will publish subsequent papers and manuscripts in the conference proceeding as well as well in the scientific journal and monograph.

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Teaching Information Systems for Students at Business Programs: Possibilities of E-Learning Environment

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Abstract

Abilities to use and manage modern information technologies (IT) effectively are becoming very important competences for managers. They need to understand the role that information systems play within organizations, their impact on business processes, costs and benefits. Therefore, it is absolutely necessary to include IT courses in business study programs. This article deals with the problems of creating electronic course Introduction to Information Systems for business students. The main idea in the preparation of the course was to explain the reasons why acquire information systems, how to define the requirements and how to manage the whole process. However, as we have in the course also students in the field of public administration, we had to include also topic of e-government and geographic information systems. Preparing the course we set four research questions that will be addressed in this article; how the students will evaluate the course, how the students will evaluate projects, how many self-tests will students pass before the exam, and what will the relation be between self-tests success and final exam success.

Keywords

Information systems. E-learning. Business administration. Teaching.

INTRODUCTION

The fundamental objective of most businesses is to maximize profits and gain a competitive advantage. This goal is as old as the business environment but the instruments are changing. One such instrument is the adoption of information systems within the company. Information systems can help a company make adequate use of its data, increase productivity and bring innovation - new services and products, new markets, new business methods, and even new industries (McFarlan, 1984), (Porter, 1996), (Tanriverdi, 2005).

Currently, there are popular Enterprise resources planning (ERP) systems that permit the integration of information technology (IT) into all processes in the company (Mabert, Soni, and Venkataramanan, 2003), (Botta-Genoulaz and Millet, 2006). ERP systems are the major managerial tool and technology that combine knowledge from different fields e.g. information technology, operations management, marketing, organizational behavior,

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data management and human resources fields (Sarkis and Sundarraj, 2003). They support effective sharing of information along a company value chain in order to achieve operating efficiency with an emphasis on usability (Hub and Zatloukal, 2009). ERP packages offer a workflow engine to generate automated workflows according to business rules defined by management. Approval matrices allows information and documents to be routed to operational users for transaction handling, and to managers and directors for review and approval (Law and Ngai, 2007), (James, Russell, and Seibert, 2002).

Involvement of information systems in business operations is not just a problem of technology, but also it is management problem. Managers, as the people responsible for process setting, should have a basic idea of what possibilities the IT offers and how to use it in order to help the company in gaining a competitive advantage. They need to manage and apply IT effectively to support accomplishment of their mission objectives. They must understand the information technology to the extent that they are able to distinguish when the business is successful / unsuccessful itself and what is affected by the information system. Senior manager (CIO) may not understand the details, but they should encourage the adoption of the technology and estimate its effects (Willcocks and Sykes, 2000), (Sedlák, et. al, 2011). Moreover, CIO must manage IS expenditures to ensure they are getting value for money. General managers need to understand the actual--as well as the potential--role that IS assumes within organizations. To realize this potential, general managers must create an IS infrastructure, including IS management, IS staff, hardware, software, data, and processes (Tralvex and Sauter, 2003).

Managers have to gain some basic knowledge from the IT domain in order to ensure this ability. According to Tralvex and Sauter, managers have to develop the following IS competencies:

- align their IS strategy with a business strategy to ensure that current investments lead to business value,
- develop processes for scanning the environment for new technologies to ensure that future investments add to business-value,
- set IS priorities (this is critical because user requests for new systems have an average backlog of 4 years),
- develop an internal balanced-score card to assess IS performance in terms of costs and service,
- benchmark IS performance with high performers to determine best IS practices,
- develop a sourcing strategy to minimize production and transaction costs while still maintaining excellent service levels.

Some of these skills can be acquired only in practice, but others can be learned at school. Therefore, many business schools put into their programs courses in information systems. Some schools have only one general course dedicated to information technologies (usually Management Information Systems) while other schools have more subjects (Databases, Decision Support Systems, Business Intelligence and so on). In all cases, however, education is focused on the problem, how to prepare students for the responsibility of acquiring information system, or a system integration.

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Educational background

Course Introduction to Information Systems is taught at University of Pardubice, Faculty of Economics and Administration for many years. It is part of curricula of business administration and public administration programs. Particularly, four different study programs have this course incorporated into their bachelor degree study. Every year, this course passes 200-250 full-time students and 70-100 distance learners.

Course is taught in the spring semester of the second year, which means that students have already gained some experience with management, finance, accounting and marketing classes. In terms of IT courses, all students passed one compulsory course (Data Processing in Excel) and only three study programs passed compulsory course (Introduction to algorithms) introducing flowchart and process thinking. Unfortunately Databases course was left optional making this course unattractive. Only small amount of students undertake this course.

Teaching distance students in this course is based on the model of blended learning. During the semester are scheduled two meetings lasting six hours together. Fundamental study material was text book in paper form. Last year we were given the opportunity to participate in European grant on innovation of management model in distance learning, thanks to which we were able to rebuild this course in e-learning environment Moodle 2.5. The following chapters describe how we have progressed and to what results this transformation led.

METHODOLOGY OF RESEARCH

Creation of electronic course is a challenging activity in order to prepare materials, which will bring benefits to students, especially with the course like this. Information systems are not really popular among non-technical students. Students at business administration programs assume that they will never have to deal with the issue of information systems and expect someone from IT department to be responsible for. But they have to understand that if managers let the decision about system specification up to IT people, the system will not support the processes. Experiences with students and also new trends that penetrate into IT domain led us to innovate not just form of a course, but also its content.

The main idea in the preparation of the course was to explain the reasons why acquire information systems, how to define the requirements and how to manage the process. Mainly, the definition of requirements phase seemed important. Definition of requirements is challenging not just for the customer who must have at least a basic idea of what he wants, but also for the analyst, who must understand the functioning of processes in the organization and find common ground with a customer. At this point we had essential approach and started to search for quality sources of information.

Information system course for managers is taught at many schools around the world. Syllabus and course materials (text books, case studies, projects etc.) vary but there can be found similar aspects. Here we bring the list of Management information system books that we used as an inspiration when rebuilding our course.

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- Corporate Information Strategy and Management: Text and Cases (Applegate, Austin, and McFarlan, 2007)
- Business Information Systems: Technology, Development and Management for the E-Business (Bocij, Greasley, and Hickie, 2008)
- Management Information Systems: Managing the Digital Firm (Laudon, Laudon, 2011)
- Management information systems: Solving business problems with information technology (Post, 2012)
- Principles of Information Systems: A Managerial Approach (Stair and Reynolds, 2007)
- Strategic Information Management: Challenges and Strategies in Managing Information Systems (Galliers and Leidner, 2009)

After many revisions we had ten lessons, in which students learn basic information about information systems and pass all stages in the IS life cycle focusing on the user-centric view. However, as we have in the course also students in the field of public administration, we included in the syllabus topic of e-government and geographic information systems.

E-learning environment

E-learning environment offers many opportunities for both teachers and students. Many articles have already been drafted on this topic therefore we will highlight only those reasons that motivated us to create electronic course.

- Study materials – materials in paper form quickly become outdated. Teachers are forced to make new editions in order to stay up to date. Electronic materials facilitate availability and reduce costs for students to purchase study materials.
- Using e-learning in blended learning allows investing hours of meetings into dialogue with students and presenting their views.
- Learning can be individualized and tailored to the specific needs of students.
- Self-tests and tasks for particular lectures can be accessible at any time. Students can control their progress.
- Exam test should be prepared from questions that are known from self-tests. We believe that the aim of final exams should not be showing the student what he/she does not know. Instead we need a tool helping students to obtain the required knowledge. This can be achieved by establishing broad set of questions that cover the entire content of the subject taught. Those questions should not be concealed in contrary it is good to make them available to students.

As a learning platform was chosen Moodle in version 2.5, which represents a unique open source tool, equivalent to commercial tools. This tool is based on the theory of constructivism, which brings into practice. With a wide community of developers and enthusiastic users, new components are constantly being developed (Forum, Chat, Choice, Test, Survey, Journal, Wiki, etc.) that teachers can use in the course. It is up to the teacher how he/she will use these modules and how to take the best from activities which comprise the course. Learning platform Moodle can be used in different scenarios of online teaching - such as a support for full time students with tasks and tests, free

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discussion environment, full distance learning course with multimedia interactive components, etc. For each such scenario fits a certain set of modules used.

Model of our course is depicted in figure 1. Elements that are common for all chapters (building blocks) are placed in the middle of the picture and tasks that are specific for particular chapter are shown in bubbles.

Fundamental e-material is a Chapter text, mostly fifteen to twenty pages long. This text does not vary from ordinary study material except that we emphasize the role of customer. Importance of e-learning environment, however, lies in the use of other elements that help the student to understand the issue, its meaning and possible use for practice. Very useful proved to be Study guide. This is the introductory part, written in non-formal language with the intent to take students' attention and explain what to expect in each chapter. It is also important to highlight here the pitfalls.

Each chapter also covers self-test with 10-25 questions. Students have the possibility to take each test any times as they want. Analysis of results of self-tests will be addressed in the next chapter.

The last part of the common content, we would like to highlight, are the questions and tasks. This part does not contain key since the correct answers can be found right in the Chapter text.

Additional questions with the key are presented in 5 chapters. Content of these e-materials cover questions for reflection, consideration of any system they know well, or finding examples from practice. Therefore the key does not show the only correct solution, but instead provides a sample solution or the source with information.

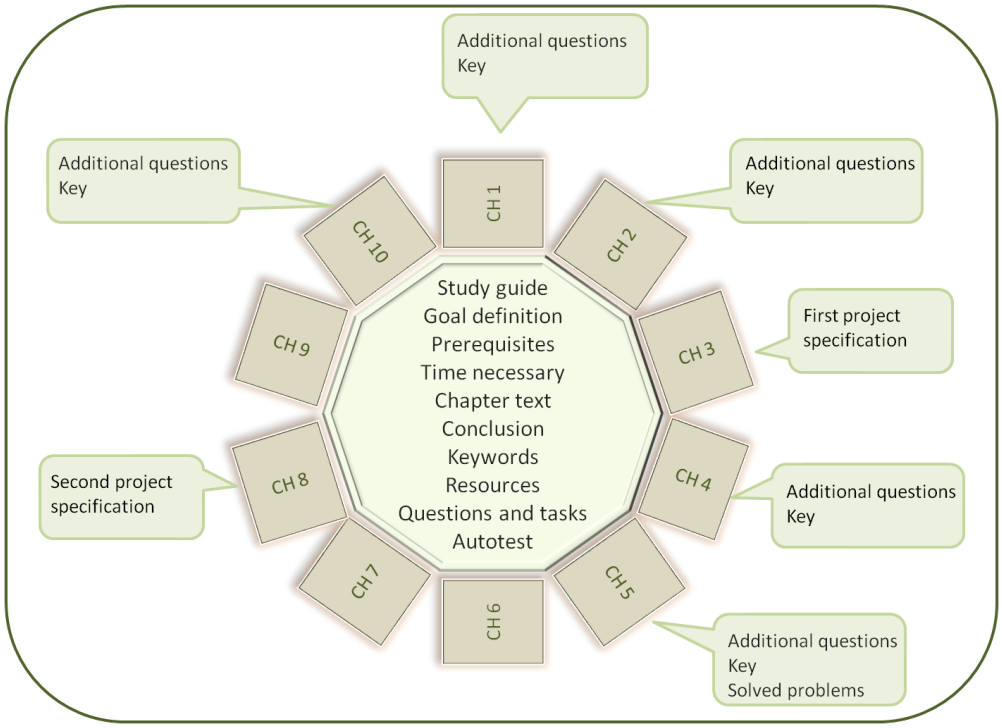


Figure 1: Model of e-learning environment

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The important part of this e-learning environment is project based learning. The experience of teachers confirms that project based learning is an effective and enjoyable way to learn. Learning by doing gives students the opportunity to actively solve a problem and not to be only the passive recipient of information. In our course, we have two projects each of them based on a different domain. First project is aimed at business administration. Students are expected to deliver process model of their (fictional or real) firm with functional requirements on information system. Tool used in this project is the program Adonis. Second project is aimed at public administration. Systems that are very useful in this branch are geographic information systems. Students, after introduction to software application ArcExplorer, undertake tasks, which show them the functionality and usability of the program.

Interactive activities

Interactive activities incorporated into the e-learning course serve as a motivation factor and help for students. At the same time they bring an element of communication to students at distance learning program who do not have many opportunities to discuss their problems with peers or teacher. In our course we used these activities:

- Student forum – is aimed at enhancing communication among students. Students have the possibility to discuss problems with projects, questions arising from study material and so on. Although the forum is prepared for student's discussion, if there is no answer for some period (two days), the teacher takes the initiative.
- Tests – each chapter is accompanied with self-test (named Autotest). This activity let the student verify that the student has understood the topic.
- Questionnaire – questionnaire was used to obtain feedback from students about the quality of the course.
- Database – database activity is used here to select a topic in the first correspondence task. Students have to choose for which company they will prepare the workflow and information system requirements. This company has to be briefly described (field of activity, size). If the given company already exists in the database, then the student can not choose the same company. This activity does not need a teacher to monitor whether themes are the same, because this control is done by student at the time of entry into the database.
- Student dictionary – students are asked to prepare explanation of one key word used in the study material. This activity is evaluated.
- Teacher evaluation of projects – teacher evaluates submitted projects with written assessment. If the project does not meet all the requirements, then it is returned for revision, including observations and comments. There is no limit to how many times students can rework the project. The aim is to show all students how deal with the task and bring them to a successful completion of the task.
- Student evaluation of project – students were asked to describe problems they faced doing the project, or any other insights.

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RESULTS

Creation of e-learning course was accompanied by a variety of problems but finally the course was done and we defined 4 research questions that were answered after the first completion of the course (spring 2013):

- how the students will evaluate the course,
- how the students will evaluate projects,
- how many self-tests will students pass before the exam,
- what will be the relation between self-tests success and final exam success.

Answers to our questions, we saw at the end of the semester. Answer to the summary of overall satisfaction, we have gained through anonymous questionnaire with five questions. Students were given scale of one to five with the same meaning as class classification (1 the best, 5 the worst). Only question 5 open question with the option to add a comment.

Table 1: Overall satisfaction with the course

Questions	**Rating**
How do you rate overall clarity of the course?	1,63
How do you rate the contribution of its content?	1,84
How do you rate interactivity of the course?	1
How do you rate the benefits of interactive and communication elements for your studies?	1,84
Did you miss some course topic? Found an error? Do you have some beneficial insights on how to improve the course?	Mostly no, some misspelling errors, one positive reflection.

The surprising result is the evaluation of the course in terms of interactivity. Although the course is assessed positively as interactive, the contribution of these elements is not rated as excellent. Probably students underestimate the importance of these elements.

Second question considered evaluation of projects. Students wrote their opinion directly into their projects. Mostly their answers concluded that projects were demanding but interesting. For the first project we have complains about installation of program Adonis that could be difficult for someone and also about language barrier (the program is in English. Second project was evaluated as easier with no particular complains.

Third and fourth questions both consider the impact of self-tests on students learning. Third question is focused on students' willingness to prepare for the exam while the answer to fourth question will show if it is beneficial to take self-tests.

To answer third question we had to get a record of the students' activity. From the graph at figure 2 is clear that majority of students passed 8 tests. At first glance, this seems surprising, but from the perspective of the student it is deliberate action. After completion of eight tests, the student can assume that he/she already knows enough to pass without unnecessary effort. However, if a student completely omits two chapters at the self-testing and then gets one of them at the final exam, then he/she leaves empty-handed.

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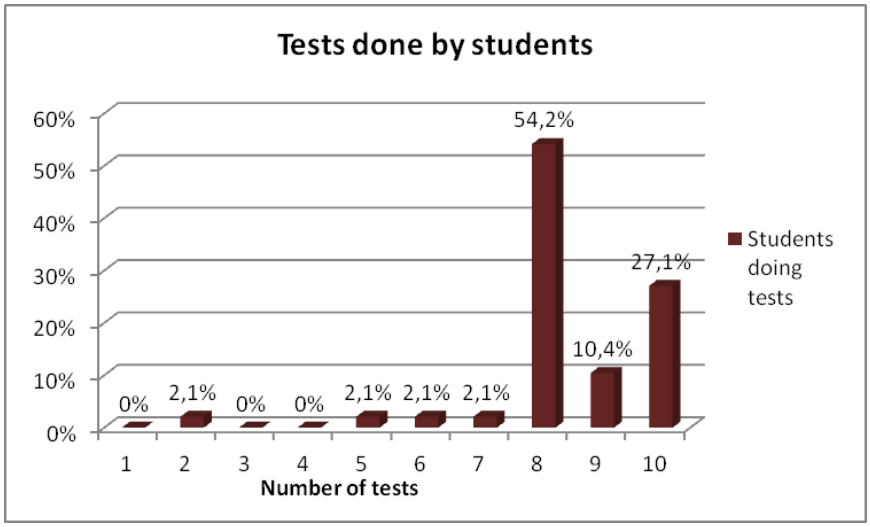


Figure 2: Number of tests done by students

That brings us to the fourth question, whether there is any correlation between success in self-test, and final exam. Final exam consists of two parts; test and oral exam. In the test there are 10 questions from self-tests, one per chapter. This part takes only 10 minutes. Only students with the score higher than 65% are accepted to the oral exam. In the oral exam students toss number of chapter from which they are asked questions. Figure 3 shows the quite surprising results. Success at the first part of the exam (test) is much higher than at oral exam.

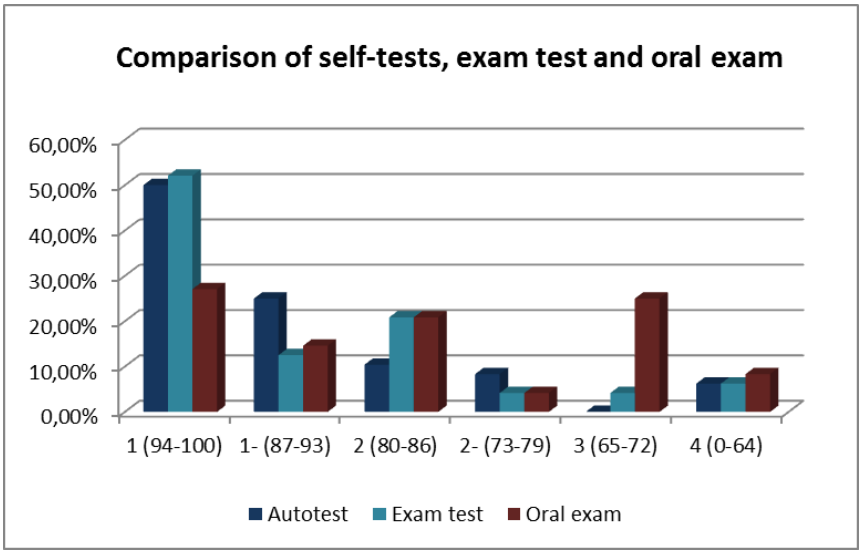


Figure 3: Correlation between self-tests, exam test and oral exam

After detailed review of results we found that grade one obtained only students with score 100% however having 100% at the test does not mean excellent grades. On the contrary we found cases where students with high test score did not pass. These results show what we have witnessed in the exam. Sometimes students have learned by heart, but when asked to explain the issue with their own words or give an example they had a problem.

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CONCLUSION

Presented project brought a lot of information and inspiration for the next period. Our expectations regarding improvement in student performance and students satisfaction were met only in some respects. The greatest success was achieved in the average grade obtained in the exam in comparison to spring 2012. This measure improved from 2.27 to 2.09.

After interviews with students we got the two way feedback according to quality of the course. Students who have experienced lessons before upgrading the course (those who did not pass last year) appreciated the change. Students who did not have this experience were not really impressed.

During the preparation of the course we put emphasis on self-test preparation, because we expected that it significantly improve student preparedness. Unfortunately we must conclude that the result is not such straightforward. Self-tests helped students who prepared thoroughly in order not to feel afraid of exam. However students who believed that only the knowledge of tests will be sufficient to do the exam were disappointed.

The last reflexion considers communication in the course. Students were given the possibility to discuss in the student forum with colleagues and also with the teacher; nevertheless they did not use this channel frequently. Instead they used social networks or servers specialized on student issues like Primat. Using these channels, students were able to discuss freely without fear of being ridiculous.

For next years we plan to focus mainly on two issues; self-testing and first project targeted on information system planning. Considering self-tests we plan expand the number of questions that will help students with learning this subject. First project proved to be useful but students had problems with installation of the program so now we try to arrange server installation with remote access. Second problem concerning the project was language barrier. All supporting materials (texts, videos, podcasts) are in English. This year we will prepare our own materials in Czech language.

ACKNOWLEDGEMENT

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Reliability Analysis of Test Items in Pedagogical Experiment

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Abstract

The problem in teaching Discrete Math is first of all insufficient motivation of students for the study of mathematics. Students often learn by memorizing without knowing the content of lectures. Such acquired knowledge is used by students during an examination, but they do not realize that the knowledge will be necessary also in their future study. According to this fact, author of this paper has decided to realize pedagogical experiment by which he wanted to compare knowledge of two different groups of students. Author is describing a draft and implementation of pedagogical experiment. Pedagogical experiment has been implemented at the Informatics Department, Faculty of Natural Science, Constantine the Philosopher University in Nitra. Before the experiment it was necessary to make content analysis of subject Discrete Mathematics, current situation of teaching analysis, verification of simple thematic units necessity of subject Discrete Mathematics for individual subjects of study program Applied Informatics/Bachelor study, structure proposal and methodology development of e-courses creation. In compliance with qualitative and quantitative indicators it was necessary to evaluate the benefits of such study materials and methodology for Discrete Mathematics teaching development. Within the experiment, the author created two comparable groups of students (control, experimental). The control group took part on teaching process in present courses and experimental group proceed by newly proposed structure of e-courses. Both groups took control test (pre-test) from Discrete Mathematics. Analysis of suspicious items was made before the testing. According to tasks averages the biggest problem students had with questions B3, B5, C1, C2. We can see that the majority of tasks are positively correlated, except for the task A2, B1, B2, B3, B4, C1. These tasks, following the above results appear to be suspicious. Moreover, the task A2 has no significant correlation with any other task. Task A4, B2, B3 and C4 do not correlate with total scores and after their removal the reliability coefficient has increased. After finishing both terms (winter and summer) students took part on final test (post-test).

Keywords

Discrete mathematics. Pedagogical experiment. E-course.

INTRODUCTION

The research method is generally defined as the process or processes which are working with in research. The main research methods may include: observation, scaling,

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questionnaire, interview, textual analysis, experiment and others (Gavora, 2001). Within each research method could be created a specific research tool that must have two basic properties - validity and reliability. Validity is the research tool ability to identify what was intended to detect and reliability is accuracy, reliability of research tool (Gavora, 2010). For the verification of the designed procedures pedagogical experiment realized at the Department of Informatics of the Faculty of Natural Sciences, Constantine the Philosopher University (UKF) in Nitra was used as the research method. The experiment was preceded by the content analysis of the subject Discrete Math and the current status of teaching the subject at the Department of Informatics, Faculty of Natural sciences, UKF in Nitra. According to (Gavora, 2010) the essence of the experimental method is depicted by the following scheme (Figure 1):

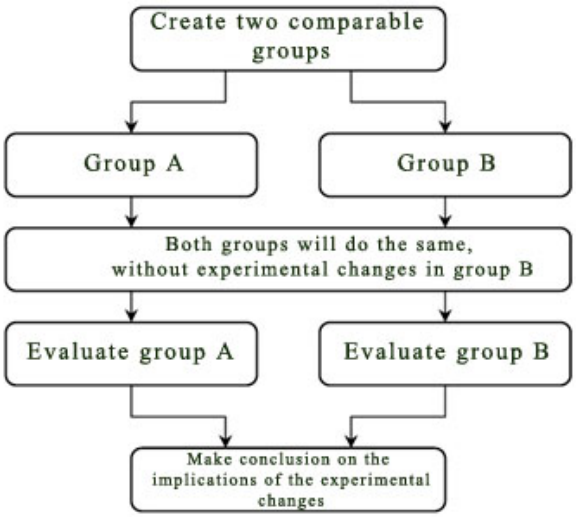


Figure 1: The scheme illustrating the essence of the experimental method

From the figure it is clear that in each experiment at least two groups of people, which work in various conditions must be formed. These conditions are checked by the experimenter (or his fellow workers) and their impact in both groups is evaluated at the end of the experiment. In experimental method, experimental change is marked as *independent variable*. The consequence of the impact of the independent variable is called *dependent variable*. In this experiment independent variable is represented by two planes: teaching using newly created e-learning course and teaching in progress in the original e-learning course. Dependent variable, which we shall experimentally verify, will form the level of knowledge (this one will be measured by test) (Turčáni and Kuna, 2012).

PREPARATION OF THE EXPERIMENT

Preparation of the experiment was divided into several consecutive steps. The realization of experiment took place itself in academic year 2011/2012 at the Constantine the Philosopher University in Nitra. In winter semester students passed the subject DM1 and in the summer semester the subject DM2. Both experimental and reference groups were formed by students of the first year of bachelors study programme Applied informatics. For the sake of personal and organization provision the numbers of students in both experimental and reference groups were divided into 54 students (reference

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group) and 32 students (experimental group). I tis necessary to state that experimenter directly did not participate in teaching in any of the groups included in the experiment (it was not possible on the personal and organization grounds).

For teachers in control and experimental group were prepared complete materials (initial and final tests for students, questionnaire), with informing them of experiment conditions (not to inform students they are participating on experiment), final tests, experimental group should use new e-course (the form could be chase by the will and options). Supervision in groups during the initial testing ensured experimenter. Both teachers which took part on the experiment were interviewed to detect their opinion for using Information and communication technologies in teaching Discrete Mathematics, as well as using interactive, multimedia elements within teaching process by e-course. Content of Discrete Mathematics 1 and Discrete Mathematics 2 went through a significant change. Next we will present recommended experiment running, which was developed to respect the experiences of both teacher. Then, we will continue with pre-test analysis (initial test) and post-test (final test), which were the key base for us to compare the information obtained (Balogh and Koprda, 2012; Turčáni and Kuna, 2012).

Characterization of control group and experimental group

The total number of students in the control and experimental group, who were involved in the experiment in academic year 2011/2012 was 134.

Control group

The control group consisted of 91 students (of which 15 were women and 76 were men) who were divided into five groups (students had to be separated into groups by reason of capacity training). Using the original e-course the teacher had exercised over 10 thematic units. The teacher had seven years of experience and had been teaching Discrete Mathematic for seven years.

Experimental group

The experimental group consisted of 43 students (of which 5 were women and 38 were men) who were divided into two groups. Number of thematic units remained unchanged from the original course. Content of thematic units was reallocated. What has considerably changed is the structure of the course. We rearranged the thematic units of subjects DM1 and DM2 so that thematic units of subjects of technical and systemic nature continually referred to them. Among these subjects we can include Architecture of computers (AP), Operating systems (OS), Computer nets (PS). Thematic units, from an analysis of the questionnaire, which the teacher assigned the highest weight ratio, are in a course supplemented by interactive multimedia elements. Author addresses himself to given field further in article (Kuna and Turčáni, 2012). When new e-courses were proposed, we took use of linear and branch teaching programmes.

When teaching within experiment, the teacher used newly prepared e-course. Layout of thematic units in Discrete Mathematics 1 is as follows:

- Lesson 1: Introduction to logic
- Lesson 2: Boolean algebra.
- Lesson 3: Divisibility relation and its properties.
- Lesson 4: Greatest common divisor, least common multiple, Euclid's algorithm.

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- Lesson 5: Diophantine equations.
- Lesson 6: Criteria for divisibility.
- Lesson 7: Concept of set.
- Lesson 8: Binary relation and relation on the set.
- Lesson 9: Function as a special case of relation. Mappings.
- Lesson 10: A countable and uncountable set.

Layout of thematic units in Discrete Mathematics 2 is as follows:

- Lesson 1: The basic concepts of combinatorics, binomial theorem.
- Lesson 2: Introduction to graph theory.
- Lesson 3: Connectivity of graphs. Walks in graph.
- Lesson 4: Testing graph´s connectivity.
- Lesson 5: Distance between two vertices in a graph
- Lesson 6: Trees and spanning trees.
- Lesson 7: Eulerian graphs
- Lesson 8: Applications of Eulerian graphs
- Lesson 9: Hamiltonian graphs.
- Lesson 10: Applications of Hamiltonian graphs

The teacher has fifteen years of experience and has been teaching Discrete Mathematics for ten years.

Plan of experiment

Appropriate classification of interactive, multimedia elements into simple thematic units can create an environment that will help students to understand the issue better. They help the same way also by training learned information. It´s obvious, that the teaching process in control groups will run using original e-course, without use of interactive, multimedia elements. The subject content is divided into thematic units matching the length of existing term. The teachers had during teaching process the possibility to adapt the number of real thematic units according to their own deliberation (in accordance with student´s rate of understanding, level of their knowledge, unexpectedly circumstances). The process of knowledge discovery could be an alternative to this experimental plan, especially educational data mining (Munk and Drlik, 2014). We can analyse the log file of the virtual learning environment, which contains information on accesses to the activities of e-courses, and the student does not know that he is the object of our survey (Munk, Kapusta and Svec, 2010; Munk, Drlik, Kapusta et al., 2013).

Pre-test – Initial test

Students took the pre-test on the first lesson of Discrete Mathematics. The purpose of it was to find out two facts. The first one, what is the knowledge level of students coming from high schools. The second one was to find out, if the control and experimental group are comparable with initial knowledge. We were interested in three main areas. The first area was *Sets – basic relations and concept, sets operations (Figure 2, question's A1-A5).* The second area was *Statements and their truth value, methods of evidence (Figure 2, question's B1-B5).* The last third area was *Number sets and number theory (Figure 2, question's C1-C5)*. Each of the area has had five examples. In accordance with the objective

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we have set up various test tasks. These tasks were taken from publication High school mathematics in tests 1 (Ľ. Burjanová, I. Viskupová, 2003). Before using the pre-test, we made simple pre-test items reliability analysis.

Descriptive characteristics score of individual test tasks are visualized (Figure 2). According to tasks averages the biggest problem students had with questions B3, B5, C1, C2.

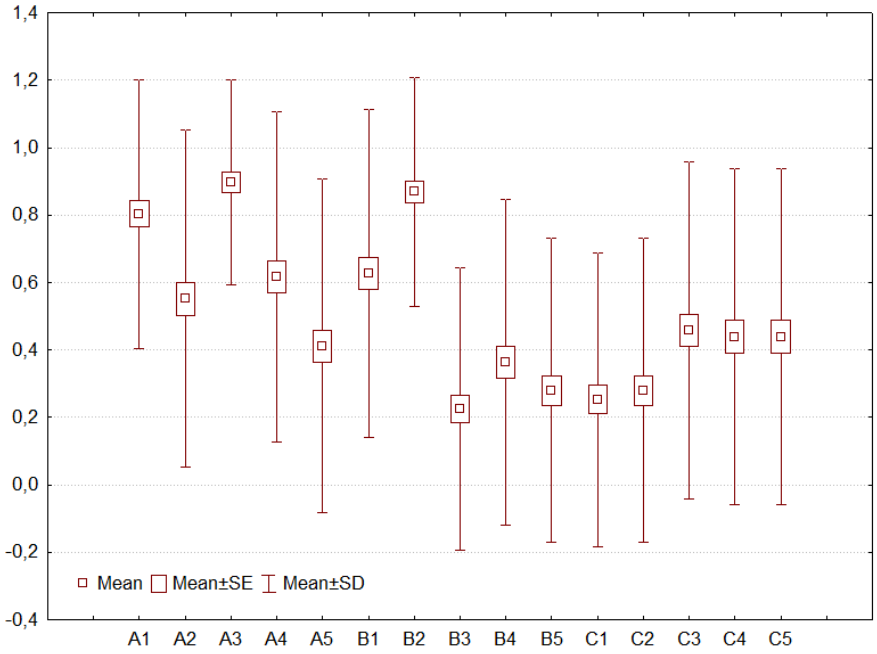


Figure 2: Box graf - visualization of the descriptive characteristics

From the following correlation matrix (Table 1), we can identify suspicious items.

Table 1: Correlation matrix

	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5
A1	1,00	-0,07	0,22	0,09	0,03	0,10	0,09	0,04	0,13	0,20	0,07	0,15	-0,02	0,06	0,25
A2	-0,07	1,00	0,07	-0,02	0,10	0,12	0,10	0,08	0,06	0,14	0,09	0,10	0,04	0,04	0,04
A3	0,22	0,07	1,00	-0,08	-0,03	0,06	-0,04	-0,04	0,13	0,07	-0,02	0,01	-0,12	0,05	0,24
A4	0,09	-0,02	-0,08	1,00	0,07	0,07	0,04	-0,27	0,12	0,28	0,06	0,02	0,03	-0,19	0,08
A5	0,03	0,10	-0,03	0,07	1,00	0,17	0,16	0,10	0,08	0,07	0,17	0,20	0,26	0,06	0,10
B1	0,10	0,12	0,06	0,07	0,17	1,00	0,04	0,14	0,10	0,10	0,14	0,14	0,21	-0,02	0,02
B2	0,09	0,10	-0,04	0,04	0,16	0,04	1,00	-0,06	0,12	0,00	0,10	-0,07	0,13	-0,22	-0,10
B3	0,04	0,08	-0,04	-0,27	0,10	0,14	-0,06	1,00	-0,08	-0,04	0,10	0,11	0,05	0,02	-0,11
B4	0,13	0,06	0,13	0,12	0,08	0,10	0,12	-0,08	1,00	0,18	0,14	0,05	0,24	-0,01	0,15
B5	0,20	0,14	0,07	0,28	0,07	0,10	0,00	-0,04	0,18	1,00	0,02	0,31	0,09	0,08	0,12
C1	0,07	0,09	-0,02	0,06	0,17	0,14	0,10	0,10	0,14	0,02	1,00	0,07	0,16	0,22	0,05
C2	0,15	0,10	0,01	0,02	0,20	0,14	-0,07	0,11	0,05	0,31	0,07	1,00	0,01	-0,01	0,03
C3	-0,02	0,04	-0,12	0,03	0,26	0,21	0,13	0,05	0,24	0,09	0,16	0,01	1,00	0,21	0,28
C4	0,06	0,04	0,05	-0,19	0,06	-0,02	-0,22	0,02	-0,01	0,08	0,22	-0,01	0,21	1,00	0,28
C5	0,25	0,04	0,24	0,08	0,10	0,02	-0,10	-0,11	0,15	0,12	0,05	0,03	0,28	0,28	1,00

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From the matrix, we can see that the majority of tasks are positively correlated, except for the task A2, B1, B2, B3, B4, C1. These tasks, following the above results appear to be suspicious. Moreover, the task A2 has no significant correlation with any other task.

In the following Table 2 is presented summary statistics for the total test score.

Table 2: Statistics tasks summary

Number of items in scale: 15	
Number of valid cases: 107	
Mean: 7,514018692	**Sum: 804,00000000**
Standard Deviation: 2,530435439	**Variance: 6,403103509**
Minimum: 2,000000000	**Maximum: 14,000000000**
Cronbach's alpha: 0,554185157	**Standardized alpha: 0,543016408**
Average Inter-Item Correlation: 0,074072872	

Reliability coefficient of 0.55 (55%) indicates the proportion of the sum of the tasks scores variability for the overall variability of the test. Both forecasts (Cronbach's alpha and Standardized alpha) are not very different, so that means, that individual items have the same variability. Low average correlation between tasks suggests that after removing some of the tasks we could increase the reliability of the test (Munková and Munk, 2010).

Table 3: Test statistics after removing the respective task

	Mean if deleted	Var. If deleted	StDv. If deleted	Itm-Totl correl.	Alpha if deleted
A1	6,710280	5,719801	2,391611	0,245147	0,530058
A2	6,962617	5,699537	2,387370	0,166911	0,545046
A3	6,616822	6,105511	2,470933	0,096955	0,553051
A4	6,897196	5,961393	2,441597	0,061295	0,566421
A5	7,102804	5,400646	2,323929	0,306296	0,514566
B1	6,887850	5,501441	2,345515	0,267772	0,523296
B2	6,644860	6,135557	2,477006	0,056256	0,559388
B3	7,289720	6,149707	2,479860	0,009457	0,571133
B4	7,149533	5,510350	2,347414	0,266104	0,523713
B5	7,233645	5,468774	2,338541	0,320213	0,513625
C1	7,261682	5,595074	2,365391	0,272297	0,523819
C2	7,233645	5,674382	2,382096	0,218279	0,534036
C3	7,056075	5,342650	2,311417	0,326664	0,509693
C4	7,074766	5,807494	2,409874	0,121010	0,554739
C5	7,074766	5,452354	2,335028	0,278116	0,520727

As it´s visible from Table 3 task A4, B2, B3 and C4 do not correlate with total scores and after their removal the reliability coefficient has increased.

Students had for working out the pre-test one class (90 minutes). At the beginning we paid attention to instruct them how to work out the questions and gave them an administrative instruction. In accordance with this fact, they have only 80 minutes of pure time for working out the questions. Pre-test consisted of 15 questions. It was given to

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control group in print version. For experimental group was prepared an electronic form, which is a part of proposed e-course. Tasks for control as well as experimental group were the same. The correct answers had to be marked or encircled from given options. Some students didn´t take part on initial and final test during experiment (healthy problems, finishing or study interruption), therefore the number of students in control and experimental group didn´t match that in sample description. For remaining the objectivity and relevance of the results we took into account only results of students which took part on pre-test, post-test 1 and post-test 2. Table 4 shows number of students, which take part on simple tests in control and experimental group. Also the final number of those, who took part on all three tests. (Klocoková, Munk 2011; Klocoková, 2011)

Table 4: Number of students participating on the experiment

	Pretest	Posttest 1	Posttest 2	Final number of students
Control group	72	58	59	54
Experimental group	35	32	39	32
Total	107	90	98	86

From the reason of results objectivity and reliability just the final number of students was relevant for the experiment interpretation, since only these students passed all tests (Zahorec, Haskova, Munk, et al. 2013).

Post-test – Output test

Students took part on post-test 1 after finishing all thematic units from Discrete Mathematics 1 during examination at the end of first year winter term. They took part on post-test 2 again after finishing all thematic units from Discrete Mathematics 2 at the end of first year summer term. The main aim of both post-test 1 and post-test 2 was to verify student´s knowledge of simple thematic units from DM1 and DM2.

Post-test 1 was part of the tests, so students had enough time for preparation. Students had for working out the questions 90 minutes again. Their pure time for working out after instructions was 80 minutes as before. Post-test 1 was in printed version and consisted of 6 exercises without a possibility to choose an answer. Additional calculation had to be placed on the paper. We prepared two equivalent versions (A, B) containing the same exercises with different numeric values.

As well as post-test 1, also post-test 2 was part of the tests. Therefore students knew about the test in advance and had enough time for preparation. Also for working out the questions students had 90 minutes. Their pure time for working out after instructions was 80 minutes as before. Post-test 2 was likewise in printed version and consisted of 5 exercises without a possibility to choose an answer. Additional calculation had to be placed on the paper. We prepared two equivalent versions (A, B) containing the same exercises with different numeric values.

The results of post-test 1 and 2 were part of tests evaluation. So students were forced to prepare conscientiously and this motivated them to have the best results.

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CONCLUSION

Author of this paper realized a pedagogical experiment by which he wanted to compare knowledge of two different groups of students from Discrete Mathematics. Author is describing a draft and implementation of pedagogical experiment. Pedagogical experiment has been implemented at the Informatics Department, Faculty of National Science, Constantine the Philosopher University in Nitra. Author paid attention to identification of suspicious items in pre-test. According to tasks averages the biggest problem students had with questions B3, B5, C1, C2. We can see that the majority of tasks are positively correlated, except for the task A2, B1, B2, B3, B4, C1. These tasks, following the above results appear to be suspicious. Moreover, the task A2 has no significant correlation with any other task. As it´s visible from Table 3 task A4, B2, B3 and C4 do not correlate with total scores and after their removal the reliability coefficient has increased. The results of post-test 1 and 2 were part of tests evaluation. So students were forced to prepare conscientiously and this motivated them to have the best results. In fine of the experiment we statistically evaluate simple tests, questionnaires and processed research findings.

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E-learning as a Tool to Enhance Teaching Effectiveness

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Abstract

The study introduces empiric research done at the Faculty of Education of University Hradec Králové, Czech Republic. The subject of research was finding of e-learning efficiency of the courses in Learning Manangement System Moodle environment in the course of Didactics of the subjects on nature and society in the study programme Teaching profession for primary school. Evaluation of e-learning efficiency was carried out by means of pedagogical experiment both by traditional finding of the differences in an increased knowledge of the students of the experimental and control group and by analysis of self reflection of the reached competences. Operationalisation of the competences from the area of didactics of the subjects on nature and society and on its base a new course in Learning Management System Moodle was created for the purpose of pedagogical experiment. On the base of results from the experiment higher efficiency of teaching with the support of e-learning was proved.The students in experimental group reached statistically higher score in knowledge test than the students of control group. The obtained competences were also higher evaluated than in control group.

Keywords

Elementary school. Efficiency. E-learning. Moodle. Reflexe kompetences.

INTRODUCTION

In the Czech Republic took place an extensive transformation of education at all levels of school system at present. One of the start points, on which are intentions both the Czech Republic and other advanced states in the area of innovation constructed, is the report of the International commission of UNESCO Education for the 21st century Learning is the hidden wealth (Delors, 1998). It is introduced in this report that education in the whole course of life is founded on 4 pillars. It is a case of pillars, which are the base for forming educational curriculum and characterize how the education should be interpreted:

1. Learn to recognize, i.e. to learn to connect enough wide general knowledge with the detailed knowledge of the branch, benefit from the educational opportunities in the course of life. Learn to teach.

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2. Learn how to act, i.e. to master the working competences, get over different situations and work in teams, learn how to act in conditions of different social and working activities.

3. Learn to live in collective – i.e. to develop understanding for other people and accept the idea of mutual dependence, master the conflicts – in the sense of respect to values of pluralisms and mutual understanding.

4. Learn to exist, i.e. develop own personality and ability to deal with greater autonomy, independent judgement and personal responsibility, utilize personal potential.

New orientation of education in the Czech Republic should correspond with above introduced four pillars of education. It represents especially mastering of the method how to learn, how to utilize new information and communication technologies, how to avoid overloading with shallow information, how to learn to elaborate the information and turn it in knowledge, how to apply the obtained knowledge, how to learn to think critically and evaluate the information, how to work in teams and independly, how adequately react on different opinions, how to understand the mutual connections, how to solve problems and act on the base of independent judgement, how to accept personal responsibility, etc.

The new conception of curriculum on the base of these principles of education puts a stress on the key competences, mastering of the attitudes and values, reinforcement of teaching integration and inter subject relations, with greater extent of differentiation and application of new topics. With regard to the transformation of basic education in the Czech Republic and accepting of the key document of the Framework educational programme for the basic education. Even innovation of students´ preparation at Pedagogical faculty of University of Hradec Králové occurred. It was approached to the innovation parallely with utilizing the results of following described research. In this way even the syllabus of Curriculum and instructions of the subject Nature and society was innovated in both of the content and methodical part.

RESEARCH PROJECT

At restructuring of the content of the subject Curriculum and instructions it was started both from the newest trends in general didactics and from Framework educational programme. In Framework educational programme, the key competences, educational areas and awaited outputs are defined. The subjects on nature and society correspond with these documents concerning the educational area Man and his world. This area contains 5 basic topics, which mingle all the time at the first level of general education. The topics are as follows:

- The place, where we live
- People and time
- Variety of nature
- People around us
- Man and his health

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The thematic circles were determined for the content of above named subject (course) and separate circles of the demanded competences were assigned, which the students should obtain (Tab.1). It includes the competences of future teachers concerning the teaching of the educational area Man and his world.

Tab. 1 Operationalised competences, which the students of teaching profession for the 1st level of elementary school in the subject Curriculum and instructions of the subject on nature and society, should obtain.

Thematic field	**Awaited competences of the student**
Conception of subjects on nature and society	He/she orients in alternative educational programmes He/she is able to submit a survey of the conception of the subjects on nature and society in UE states
Educational area Man and his world	He/she orients in the Framework educational programme for the elementary education He/she knows the cross-section Framework educational programme topics. He/she knows the expected outputs of given educational area for separate periods. He/she knows the fundamental topics of educational area. He/she has a knowledge of facts about fundamental subject matter.
Key competences and their development in the subjects on nature and society	He/she can explain the conception key competence. He/she can characterize separate key competences. He/she knows methods how to develop the key competences in concrete topic.
Projects	He/she can manage to explain the principles and aims of project teaching. He/she can manage to propose stimulating environment for proposition of teaching projects. He/she can manage to elaborate teacher's activity in separate parts of teaching project.
Didactic analysis of subject matter	He/she understands the principle of didactic analysis of subject matter. He/she is able to carry out didactic analysis of subject matter of given topic. He/she is able to determine the basic subject matter, fundamental concepts and their relations.
Teaching method, organizational form of teaching	He/she can explain the concepts of teaching method and organizational forms of teaching. He/she can characterize fundamental teaching methods, which are most often used in the subjects on nature and society. He/she can explain the concept of activating methods. He/she can explain on the examples from the subjects on nature and society application of the selective activating methods of teaching. He/she can chose suitable methods of teaching for the given topic. He/she can evaluate suitability of application of concrete teaching method for given topic.
Material didactic means	He/she is able to explain the concept of material didactic means. He/she knows how to chose the most suitable material didactic means for the subjects on nature and society for the concrete topic. He/she knows how to use material didactic means (teaching aids and didactic technique) in teaching of subjects on nature and society (overhead projector, programmes for interactive black board, own teaching means, teaching programmes, etc.).
Worksheets	He/she can name basic rules for creating worksheets. He/she knows how to use these rules in creating the worksheets. He/she can create worksheet for given topic.

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Evaluation in the Subjects on nature and society	He/she knows general ways of evaluation. He/she can select suitable ways of evaluation for the subjects on nature and society. He/she can work with criteria for different types of activities and aims (Košťálová, Miková, Stang, 2008).

Reflex meditation is aimed at understanding of own theoretical and practical outputs (Buchtelová, 2000). Emphasis is put in the frame educational programme for elementary scholl for pupils to get specific competences. The fact, to which measure the pupils can utilize the obtained competences, is mostly evaluated by other person (teacher, parents, test, practice). Future teachers could not rely only on evaluation by surrouding factors. Self estimation of skills plays an important role in professional life of teacher (Čáp, 2001, Petty, 1996). It was the reason, why in our empiric inquiry was used even questionnaire of self reflection of competences (reflection of own competences). Mentioned questionnaire was aimed at how the students evaluated their entrance and output knowledge and skills. This evaluation was called self reflection of competences.

On the base of operationalised competences, which the students of teaching profession should obtain in the subject Didactics of the subject nature and society, a proposal of innovation of the content, method and means of teaching was carried out. For increased effectiveness of teaching of subject a special e-learning course in Moodle (environment used at University Hradec Králové) was formed.

As a base for determination of effectiveness of educational process was used the model of education production D. M. Windham (1988), who works with the pedagogical concept of educational outputs. Similarly Donald L. Kirkpatrick evaluated efficiency of teaching by forming a model, which contains 4 levels of evaluation (Kirkpatrick, 1998):

- Reaction notes, how the students react on teaching, how they are satisfied, which type of reminders they have to the teaching organization, etc.
- Learning measures of the obtained knowledge, i.e. changes in the knowledge, skills, habits and attitudes of the learning students.
- Behaviour – catches measure of changes and influencing of students behaviour at study and in activities connected with learning (Transfer of Training).
- Results present efficiency of learning, which is demonstrated in the organization of student's learning, in self reflexion, etc.

Benton; Cashin, Kansas (2012) introduce aim efficiency (What is the main aim of learning?), subjective (How computer helps to separate subjects of educational process?) perceptual (How the computer help in the course of learning?) resultative (How the learning supported by computer helps for life?) and expensive (What are the costs on accessibility of modern, experimental approaches in learning?), when the state reached and ideal is compared from different points of view.

Zlámalová (2004) determines learning efficiency according to:

- Learning results obtained by comparison of reached aims with declared or different forms of study.
- Statement of students.

In actual experiment cognitive properties (acquired knowledge – didactic knowledge test) and cognitive-affective properties (self reflexion of competences – questionnaire)

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were evaluated. Self reflexion questionnaire came from the fact, that in frame educational programmes for elementary and secondary schools emphasis is put on certain competences, which the students should obtain. To which measures the students could show these competences, is usually evaluated by somebody else (teacher, parents, test, practice). Future teacher could not relay only on evaluation by surrounding factors. An important role plays skilfulness of self evaluation in the professional life of the teacher (Petty, 1996, Čáp, Mareš, 2001). From these reasons so called questionnaire of competences reflexion was used for the empiric research. The mentioned questionnaire investigated, how the students evaluated their entrance and obtained output skills and knowledge. This evaluation was called reflexion of competences

The subject Didactics of the subjects on nature and society is aimed at the development and application of knowledge and skills obtained in the subject of general base of teacher study "General didactics". The students will familiarize in detail with the content of the educational area Man and his world, with the methods, organizational forms, material didactic means, ways of evaluation and possibilities of exploitation of information and communication technologies, which are suitable for this educational area.

Direct teaching of the subject Didactic of the subjects on nature and society is carried out at the realization of pedagogical experiment in the form of lectures (1 lesson a week) and seminaries (2 lessons a week). Interpretation, discussion, demonstration, microteachning and independent work were used as a main teaching methods. The students studied individually or in the groups of two or three students for the seminar. They fulfilled parallely separate tasks (e.g. concept of the subjects on nature and society in alternative educational programmes, in educational programmes of other states, they applied the assigned teaching methods on given topics, passed microscenes, prepared worksheets and mind maps on given topic, etc.).

Aims and hypothesis of research

The research was aimed at the possibilities of using e-learning as a support to traditional university instruction. The main aims were following:

- To find out the difference in efficiency of university instruction with the support of e-learning and traditional presentation of university instruction.
- To find out and describe the change in self reflexion of competences of the students after passing the university instruction with the support of e-learning and without the e-learning support.

It was empiric investigation, if the suitable using of e-learning in the university instruction has a positive influence on an increase of students´ knowledge and if it leads to the change of the reflexion of own self competences of students. The following hypotheses were formulated:

H1: *The students passing the university instruction with the support of e-learning reach in the knowledge test higher level of knowledge (they obtain higher number of points) than the students passing the traditional university instruction without the e-learning support.*

H2: *In the students passing the university instruction with the support of e-learning the reflexion of own acquired competences evaluated (with the help of Likert scale) was*

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better at the end of university instruction than in the students passing traditional university instruction without the e-learning support.

Research methods and sample

Fundamental research method was a pedagogical experiment. Didactic test and questionnaire were a part of this experiment. At the beginning of university instruction (semester) the students passed knowledge didactic test (pretest) and subsequently they filled up the questionnaire, concerning reflexion of their competences. At the end of the university instruction (semester) this method was repeated, the same knowledge didactic test as at the beginning was given to the students and the same questionnaire, which reflected their acquired competences. The students passed a posttest from the reached knowledge and the questionnaire on reflexion of their competences.

The research sample was formed by the students of the 3rd year of study branch Teaching profession for the 1st level of elementary school of Pedagogical Faculty, University Hradec Králové, which in academic year 2012/2013 took part in the university instruction of the subject Didactics of the subjects on nature and society. The research set was formed by 96 students. It was case of stratification choice, the students were divided in two groups – an experimental (48 students) and control one (48 students). Dividing into groups was done by random sorting to groups in LMS Moodle frame.

The students output obtained after the university instruction with the support of e-learning in cognitive area (mapping, understanding and application of the information) and its comparison with the output of the students reached after the traditional way of university instruction without the support of e-learning was investigated. Further the object of the research was reflexion of competences, which the students gained after passing the subject Didactics of the subjects on nature and society.

RESEARCH RESULTS

At the beginning of the experiment statistical analysis of statistical significance of the difference between the outputs in the pretest of the students included in experimental and control group Nil hypothesis was formulated.

H0: *There is not a statistical difference between the outputs, reached by the students included in the control group (passing the traditional university instruction without the support of e-leaning) and students included in experimental group (passing the university instruction with the e-learning support).*

It was proved that there is not a statistically significant difference between the control and experimental group in the mean of obtained points and we could say that statistical equivalent of the selected groups was proved.

Further the separate hypotheses introduced above were tested. For testing itself statistical hypotheses were determined:

H01: *There is not any statistically significant difference between the mean number of the points in the knowledge test reached by the students in the experimental group and the mean number of points in the knowledge test reached by the students in the control group.*

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HA1: *There is statistically significant difference between the mean number of the points in the knowledge test reached by the students in the experimental group and the mean number of points in the knowledge test reached by the students in the control group.*

H02: *There is not any statistically significant difference between the mean values of reflexion of competences of the students of the experimental group and the mean evaluation of the competence reflexion in the students of the control group.*

HA2 *There is statistically significant difference between reflexions of competences in the students in the experimental group and the control group.*

Tab. 2 The results of testing

Hypothesis	T-value	Z-value	Decision
H01	5,6791	4,9112	rejected
H02	5,7375	4,7040	rejected

Hypothesis H01 was rejected, accepting of the alternative hypothesis means that the level of students´ knowledge, who took part in the university instruction with the support of e-learning differs from the level of students´ knowledge, who passed the university instruction without the support of e-learning (according to the mean score in the test – higher). We could suppose that the reason of the level difference of knowledge were the following facts:

- Study by means of virtual study environment LMS Moodle put high demands on the independent work of the students (the students were pressed to submit the seminary work and fulfilled the control test in given time limit). At this way of work the data for the credit were clear. The students gradually got used that the fixed date could not be avoided and step by step it made them to prepare systematically for the university instruction in the course of the whole semester.
- Theoretical source of work for the university instruction was prepared for the students in the experimental group (the author of the course elaborated distinctly the given problems “instead the students”). In spite to it the students of the control group had at their disposal textbooks and professional (scientific) literature for self study (the given problem they should elaborate themselves).

Hypothesis H02 was rejected. We accept the alternative hypothesis, the statistically difference between the control and experimental group in reflexion of the competences in the subject Didactics of the subject on nature and society is confirmed. This result could be explained as follows: The students of the experimental group continuously elaborated the given tasks during the semester and moreover they had possibility to verify their knowledge in control tests. They immediately received the feedback. On the base of this feeback the students could estimated their weak points and at the same time they could verify, which topics they mastered on the required level. They obtained higher certainty in given problems and it reflected in their output questionnaire of reflexion of their competences.

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CONCLUSION

The study with the support of e-learning (by the means of virtual study environment - LMS Moodle) showed to be very effective, as it, among other, put a great demand on independent work of the students. The students gradually got used to the new way of study and started systematically prepared for the university instructions in the course of the whole semester.

As concerns reflexion of competences, which informs about measure of certainty of students in given problem, even in this case study with e-learning shows better result. The students of the experimental group continuously elaborated the given tasks during the semester and moreover they had possibility to verify their knowledge in the control tests. They obtained the feedback immediately and on its base the students could reveal their weak points in time and simultaneously they could verify, which topic they mastered on the required level.

The aim of the research study was to find out if the suitable use of e-learning in the university instruction has a positive influence on the increase of students´ knowledge and if it leads to an increase of the reflexion of own competences. We miss information about this problem – what were the results?

The students of control and experimental group showed comparable level (both in pretest of knowledge and in entrance questionnaire of reflection of competences no statistically difference between both groups of students was found). Two basic hypotheses were tested, concerning the changes in the students´ knowledge and in reflexion of competences. Statistically significant difference between the experimental and control group was found , which was in favour of the experimental group.

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Teachers´ Skills Improvement to Use Computer into Health Education in the Republic of Mozambique

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Abstract

In The Republic of Mozambique, there is an urgent need to improve the capacity of the network of human resources placed into training to adequately respond to the country's identified shortages and training needs. In this paper a study related to teacher training to use computer into health education classes in the Republic of Mozambique is presented. It was developed an educational program in health training institutions in 11 provinces, 15 health training institutions. The program focused on the improvement of teachers´ skills to use computer into their classes according to their needs. To collect data were applied questionnaires, interviews and pedagogical materials' analysis elaborated by teachers during the program. According to the results teachers showed a huge variety of difficult to manipulate the computer. But the outcomes revealed the potential to use computer to produce pedagogical materials locally contributing positively to reduce costs of education to reach all the provinces in the country and also the process of decentralization by the Ministry of Health to increasing the autonomy of these health training institutions.

Keywords

Health education. ICT in education. Media literacy. Teacher training.

INTRODUCTION

Nowadays an important task of Health Education is become classes more relevant to students, more easily learned and remembered, in general more reflective of the actual practice of health. It is suggested that students need to develop and/or improve skills in dealing with controversial issues as they prepare to participate in a democratic society.

Teacher training centres used to be based on old technologies as books and writing activities. But now the new technologies offer a wide potential to be explored since the end of 20th and beginning the 21st century. It seems there is no doubt about the improvement of education based on new technologies (UNESCO, 2010).

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In contemporary democratic societies, lay citizen needs to understand the nature of scientific knowledge and practice, in order to participate effectively in policy decisions, and to interpret the meaning of new scientific claims which affect their lives (Sandoval, 2005).

In this sense, the media literacy is recognized as an essential area to promote critical view for citizens. To promote a democratic society in which citizens are able to consume critically the mass media but also to express themselves by this media as producers. Media literacy is an important part of education for this society, and it cannot be denied (UNESCO, 2010).

> "*Current advance in information technologies and propagation of new digital media and learning environments stipulate the increasing importance of media literacy, which is today recognized almost universally as one of the key competences in the educational system (UNESCO, 2010, p. 5).*"

Learning in context seems to role an important contribution in students understanding of health education. Because when students are engaged in context it makes their learning more meaningful.

> *"Media literacy is the capacity to access, analyse and evaluate the power of the images, sounds and messages with which we are faced everyday and which play an important role in contemporary culture. It includes the individual capacity to communicate using the media competently (UNESCO, 2010, p. 5)."*

How the potential born by the ICTs can improve access and quality of education appears at a very opportune moment. The 21st century based on a technological civilisation based on the digitalisation of information and a media culture organised around the media and its convergence, and that it is subjected to an extremely rapid process of civilising evolution.

Bingimlas (2009) found, in a literature review, several advantages of using ICTs and several barriers to the successful integration of ICTs in teaching and learning classes. It was pointed out that "While new technologies can help teachers enhance their pedagogical practice, they can also assist students in their learning." (p. 236). Cited by Bingimlas (2009), Grabe and Grabe (2007) claim that technologies can play a role in students' skills, motivation and knowledge and can be used to present information to students and help them to complete learning tasks.

Becta (2004) organized the barriers into categories: teacher-level barriers (individual), such as lack of confidence, lack of time and resistance to change and also in school-level barriers (institutional), such as lack of effective training in solving technical problems and lack of access to resources. Accordingly with the purpose of this study it will be discussed here the approach of training. The lack of effective training is the most frequently referred barrier in literature to the integration of ICT in education.

In Mozambique, there is an urgent need to improve the capacity of the network of human resources placed into training to adequately respond to the country's identified shortages and training needs. Beyond the cost, the major constraint for the increase of human resources is the capacity to train new workers. For this reason, one of the main focus areas of the Human Resources Development Plan 2008-2015 (PNDRH) is to improve

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the capacity of the training institutions under the Ministry of Health. Currently there are 15 training Institution of health that are located in all provinces of the country.The situational analysis identified a shortage of qualified staff to teach the courses of the training institutions and centers (Ministry of Health, National Directorate of Human Resources) National Plan for Health Human Resources Development (NPHHRD) 2008-2015, Maputo-Mozambique)

Pedagogical materials used into the classes by teachers of the health training institutions are centralized into the Ministry of Health, so it is expected that after the process of decentralization these training institute of health would be able to organize by themselves. The impact of technologies is changing the institutions.

To support this change, it was designed an educational program about 30 hours related to Media literacy in Health Education. This program aimed to improve the teacher´s skills in using different media into the classroom at training institute of health in The Republic of Mozambique.

The project was based on the use of ICT to enhance the pedagogical teachers' skills to improve their classes in the Health training centres. These centres used to receive some computers from different non-governmental organizations to improve the quality of education. But the main problem is that they just received these materials but in general there is no training to use it. Sometimes there are some technical training courses to manipulate the material but nothing related to the pedagogical use of the computer into the classes. In this sense, the Ministry of Health of the Republic of Mozambique (MISAU), supported by Japan International Cooperation Agency (JICA) and Faculty of education – University of São Paulo (FE-USP) developed a project related to methodology of teaching to use ICT tools in health education as a part of the project to strengthening of technical and pedagogical skills of teachers from training institute of health (FORSA-MZ). The project aimed to support teachers to elaborate their own pedagogical materials according to their needs. To produce these materials were used basic equipments as personal computer and a digital photographic camera. This program was developed in 15 different training institute of health.

Firstly it was discussed the step to produce comics, how to organize ideas to express information to be used according to their needs after this activity the participants were requested to elaborate the comic in paper and later to use the computer to produce the comic. The third activity was to elaborate photo novels, also according to their needs. Prepare the storyboard on paper, and later the scenarios to take pictures necessary to tell the narrative of this storyboard. After that using the computer, produce the photo novels. Even they had access to personal computer and laptop, most of them had difficult to manipulate these equipments. They were initially oriented about the software utilization, scenarios' choice, characters, balloon's insertion and external images captions to help in their stories (narrative) composition. They were as well oriented about the comics chart's language, narrative texts made outside of the balloons, characters speech, kind of balloons, charts design.

For example, to prepare the comics they were requested to add callouts using the world editor by windows system, but the majority of them never had used this function. Basically they just knew to open a file, type and save it almost nothing more than this. So it

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was necessary to spend more time to teach and help them how to create a table using word to add picture and callouts to prepare the photo novels.

In some Mozambican provinces teachers had difficulties to save files in external memory drive. So it was necessary to discuss previously basic instructions to use the word editor to later start to discuss the pedagogical use of this equipment.

METHODS

To collect data's were applied a pre and post questionnaire, interviews and analysis of comics and photo novels produced by teachers during the training. The data's were analysed according to content analysis (Bardin, 1977). We choose this qualitative approach which according Lüdke and André (1986) allow us to use the natural setting as primary source data, i.e. the teacher enrolled in a training program.

According to Bogdan and Biklen (1997), the use of interviews is the best approaching tool to study people that share a particular feature. What they share between them will be revealed when they talk about their perspectives rather than when they are watched during their activities.

RESULTS

According to some reports from teachers they start to recognize the importance the importance of pedagogical training to use the equipment. Just to have access to computer can not improve the quality of education. It is necessary to improve the technical skills of teachers to support them in using the computer in a pedagogical approach in their classes.

"*I never had any kind of training since I was graduated in nurse, I need pedagogical training*"

"*We need some support after training, to help us when we have difficult, as tutoring process*"

Some examples of comics and photo novels are presented to discuss these results.



Figure 1: Comics produced in Cuamba' Province in Mozambique (Pollution of Muanda´s river).

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According to some materials it is possible to notice the local needs. In this figure 1 it is presented a narrative about to problems related to consume polluted water, risk to drink water from river without any clean proceeding.

This habits can cause diarrheal or cholera, and in the figure 2 there is a photo novel produced by a different teacher with a related issue. But we can notice the problem still the same, consume of inappropriate water. All of the productions were related to problems of inappropriate water' consume.



Figure 2: Comics produced in Cuamba' Province in Mozambique (Precautions about Cholera).

It is clear that for these teachers, from this centre, the main problem is the focus of contamination of river´s water as in the figure 3. These results show how important is the process of production of pedagogical material occurs locally. It is not possible to keep the production process centralized into the ministry of health.

The results presented indicate that after the training these teachers are able to produce their own materials in each health training centre according to the reality of each province.

To implement the ICT in health education is necessary that teachers fell confident about the domain in using this ICT tools. In this sense, the training developed with these teachers had presented positive results as it was pointed out by them.

"*Now, I can elaborate my materials to each class. If I do not have any material about one subject I can produce it*"

"*So it is not so complicated, with a basic computer we can do a lot of things. But we need some support from ministry, because if we have problems or difficult we can ask some help*"

"*We need to be monitored after this training to help us when we forget how to use the software we need some help or someone to call for clarification*"

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Figure 3: Comics produced in Cuamba' Province in Mozambique (Water treatment).



Figure 4: Comics produced in Cuamba' Province in Mozambique (Diarrheal transmission).

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DISCUSSION

Based on the outcomes we can observe a huge variety of products, the comics produced reports different realities while in some provinces the main issues was about drinkable water in other was about some epidemic as diarrheal and cholera. It was point out they can recognize their local ethnical characteristics in these materials based on pictures and videos.

Another positive aspect is related to the costs of production. For Mozambique to produce pedagogical materials with low costs and more appropriate to their needs is an essential achievement.

According to our analysis the comics can contribute as well to the development of other abilities such as coherence and cohesion – by a text construction; summarization and objective capacities by resuming a dialog in a balloon; utilization of different languages by adopting symbols, signs or images to transmit the information; development of creativity, ideas, thoughts and concepts; besides the development of the reading and writing (Santana and Arroio, 2008).

Stories are used every day as a way of making sense of and communicating events in the world (Avraamidou and Osborne, 2008).

It can be noticed on this production some difficult to express their ideas. But also some of them had difficult in typing accents for words. For some it could be a simple task, but when you are requested to elaborate pedagogical materials this task is crucial. So it shows how important is to associate pedagogical and technical training when computer are available for teachers.

In other hand if they do not know how to use the computer they will not be able to explore the potential of this tool in a way to help them to improve the quality of the education. Because they are not able to use the computer how they would be able to teach the students to use it.

When completely explored, words and illustrations have an enormous power to tell stories and to transmit messages. The students participate actively by using their imagination to fill out the spaces between the pictures (Rota & Izquierdo, 2003).

According to Wertsch (1998), the cultural tools can mediate the learning processes by appropriation of social and cultural elements in where they are used as a comprehension and meaning mechanism of signification. In this manner comics while cultural tool allows the comprehension of meanings and also the elaboration of others which belongs to a particular social group.

The results showed that the decentralization of pedagogical tools production was really important achievement form this educational program. The autonomy of teachers to elaborate their own materials according to their local demands was pointed out as a very positive contribution from this training course. Another positive point was the engagement of these teachers in preparing their classes, they felt as authors. Before this training they used to apply the classes prepared by the Ministry of Health and now after the training they are elaborating according to their local needs. The media literacy is supporting them to develop their autonomy.

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According to Schank and Berman (2002), a story is a "structured, coherent retelling of an experience or a fictional account of an experience... and that in some sense, all stories can be considered didactic in nature, in that they are intended to teach or convey something to the listener" (p. 288), in this case these teacher are using the comics to tell about inappropriate water that is an emergent issue in health education subjects for Mozambique.

Comics and photo novels can make students to think about health content in different approach which these tools can introduce scientific issues in a visual entertaining way (Radoo, 2006) by the visual appeal of the images. On this way learning health could be more interesting instead of just memorizing the subjects to get success doing exams.

CONCLUSION

According to our results we can notice that narratives supported by ICTs can be used to support teachers with some elements that provide interactive experiences for them. We believe that the ICTs in health education are able to communicate content issues to the students or community in a motivational way.

But it is clear that teachers should be supported to produce their own pedagogical materials according to their real needs. On this way to promote their autonomy to prepare these materials seems to be really important. Another important point is that health teacher should be prepared to manage with the production of narratives, as we could see some of them had some difficulties.

The teacher's imagination was stimulated by the ICT as a cultural tool to mediate the process of fiction creation. Besides the teaching health sciences, prepare students to communicate is essential. They must be able to communicate orally and in a written form also. Both skills require practice, and thus, the health science curricula should provide opportunities for settings in which speaking and writing skills can be enhanced by ICTs.

We believe that we were able to soften the naïve vision that these resources can only make classes more pleasant, and so we think that the training had a positive impact and we hope to have contributed to make them more reflexive when using ICT in health education.

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Fostering Higher-Order Thinking Skills within an Online Learning Environment

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Abstract

In the era of Web 2.0, new technological tools with promising educational potential emerged. Digital technology is changing the way people solve problems, communicate as well as think and learn. This fact has to be taken into serious account prior to designing a learning scenario. In this study, a pedagogy-driven approach to designing two collaborative learning scenarios within an online learning environment was applied. Through sharing knowledge via asynchronous discussion forums and creating a common glossary of new terms, we wanted students to train their higher-order thinking skills. The qualitative analysis of the learning scenarios' implementations implied that the collaborative nature of the learning activities was engaging and beneficial for the learning process. However, the overall quality of students' products was low, probably due to the fact, that students lacked the experience with this type of assignments. To help students to overcome the difficulties with exact formulating of their ideas, structuring their answers and using the terminology properly, teachers should prepare more opportunities for training these competences in various contexts and modifications.

Keywords

Collaborative learning. Discussion forum. Glossary. Higher-order thinking skills. Web 2.0.

INTRODUCTION

In the era of Web 2.0, new technological tools with promising educational potential emerged. User-driven online applications that enable interaction, collaboration and sharing constitute a life-long learning platform that is opened for everyone. Digital technology is changing the way people solve problems, communicate as well as think and learn. This fact has to be taken into serious account prior to designing a learning scenario. As formulated by Oblingers (2005), we also pose the following questions about the actual trends:

Who are our learners?

Today's students perceive the use of computers, Internet, cell phones, and other digital tools as integral parts of their lives. They have never known life without digital technology. Prensky (2001) described this generation of learners as "digital natives" – native speakers of the digital language of computers. They have also been named as "Net

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Generation" (Oblinger and Oblinger, 2005) or "New Millennium Learners" (Redecker et al., 2009). Some generalized characteristics of new millennium learners synthesising the observations made on today's learners in various research studies are given by Redecker et al. (2009). Table 1 shows them classified into several categories.

Table 1: Characteristics of new generation of learners.

Category	Strengths	Weaknesses
Digital literacy	technologically savvy, having practical knowledge of digital technology, multiple media literate, mobile, connected, always on	shallow understanding of technology
Personal attitudes	achievement-oriented, pragmatic, determined, hopeful, engaged, creative, expressive	focused on grades
Social attitudes	social, interactive, open to sharing	egocentric
Working attitudes	experiential, immediate, skilled at multitasking	impatient, distracted, surface oriented, having lack of critical skills
Cognitive patterns	non-linear, visual	less textual, discontinuous, distracted, cognitive overload

What learning activities are most engaging for learners?

Our students are experiential learners, thus they prefer constructive - learning by doing - activities rather than assimilating knowledge from validated sources like books or lectures. They learn well when they work on meaningful problems and their learning outcomes are useful to them. However, as they are characterized as impatient, they easily become distracted if an activity is too slow, not interactive and provide not enough active stimuli. According to their social attitudes, learners prefer community oriented activities - team projects, competitions, games. They appreciate learning methods based on peer-to-peer interactions, when they learn each from other by sharing knowledge and remixing ideas. New generation of learners is very achievement oriented. They call for strict rules and like to know procedures leading to the goal. Their preference is for scheduled activities with fixed rules and defined rewards rather than activities with free, ambiguous course.

Are there ways to use IT to make learning more successful?

Nowadays, our students consider for granted, that they have online access to all significant information about the attended courses including study materials, educational software etc. They like and use the possibility to contact teachers via e-mail or in discussion forums. Their assignments are usually submitted and evaluated within the online environment. The learning management systems like Moodle provide the social computing tools for collaborating, contents creating and sharing and so make the social constructivism strategy applicable even in large-scaled groups and distance courses that completely omit the personal contact of participants (Dougiamas and Taylor, 2003). Nevertheless, the individual forms of learning activities are still more frequent within the blended learning contexts.

In (Homola and Kubincová, 2009), the methodology for application of Web 2.0 and its tools in organized education is discussed. Blogs, wikis, social networking and tagging, media sharing, podcasting, online social gaming etc. were applied in higher education, in

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various fields and levels of study. The reported benefits include: promoting the topic's attractivity and students' motivation, increased quality of learning, practicing skills such as critical and analytical thinking, collaboration, teamwork, professional presentation and communication.

There are many successful examples of online learning communities that might be inspirational for educational practitioners at schools. Members of such learning communities share common interests and interact via tools of Web 2.0. For instance, the Scratch portal documents a unique example of world-wide learning community of mostly young programmers with millions of interactive projects shared to learn from, evaluate, comment and remix. The Scratch programmers may also use the online collaborative programming environment (Hill and Monroy-Hernández, 2013). In massive open online courses that are becoming more and more popular, thousands of learners are involved in collaborative learning activities via discussion forums, peer-reviewing assignments etc. (Huang et al., 2014). In such communities participants are contributing to each other's learning. Some of them may be seen experts to other novices in the community, being novices to other experts at the same time. In (Rohlíková et al., 2012), a positive experience with online courses for lecturers in further education is reported with analysis of multiple methods used to promote active learning.

When aiming to enhance educational process by using specific technology, two alternative approaches of researchers might be noticed. In the pedagogy-driven approach, the learning process with its objectives and learning activities being pursued is considered to be much more important than the assisting technology behind it. On contrary, the technology-driven approach pays more attention to the technological component of the investigated learning scenario. In this study, we decided for the pedagogy-driven approach. Therefore, we were initially interested in qualities and learning preferences of our students in order to project such learning activities that would optimize their strengths and minimize their weaknesses.

The purpose of this study was to develop innovative learning activities (for students attending courses on programming) that would

- be engaging for students,
- enable students to learn the way that is typical for an online learning community (based on knowledge sharing, communication and collaboration),
- contribute to students' higher-order thinking skills (conceptual thinking, critical thinking).

METHODS

Our methodology draws on designed-based research strategy (Sandoval, 2004). To understand the learning process better, we always try to design, implement and analyse the proposed learning scenarios repeatedly in multiple iterations. Such in-depth analysis of interventions realized in authentic educational contexts provide essential feedback while developing new learning scenarios and learning theories. In the following sections, two learning activities are presented as for their design and implementation. All students' contributions saved within the online environment were analysed carefully. During the

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classroom part of the 2nd activity, the teacher's records from her participatory observation were the significant source of information.

Sharing Knowledge with Classmates

For community of computer programmers (software developers), it is typical to seek and provide information online, using official documentation, tutorials and specialized online forums or participate in open-source projects. To become a successful learner as well as a productive member of the community, one has to be able to judge the quality of information sources correctly and to share her/his ideas and professional experience with others comprehensibly. To foster these competences that are essential for life-long learning, we included a forum-based learning activity in an advanced programming course on Java technology. This course (Programming 3) is attended by undergraduate students of applied informatics (2nd year of study) and it is taught in a blended manner. The e-learning activities (e. g. online assignments, tests, discussion forums) are meant to complement the face to face instruction and are managed using a Moodle course. When considering the new learning scenario, we had 3 starting points in mind:

- Students have difficulties with explaining their ideas and solutions using the proper terminology and formal notation. We have been recognizing this repeatedly throughout the recent years in submitted assignments, bachelor theses as well as during oral examinations.
- Students tend to spend less time by studying in favour of producing; they search for quick answers, not willing to analyse and compare more information sources in detail.
- In the online environment, every student presents his/her contribution in public, so we anticipate the higher quality of students' contributions. By reading contributions of classmates, students are likely to learn about new topics. By asking to evaluate other contributions, students gain the opportunity to reflect critically on what they have read.

The learning scenario: a theoretical view

The proposed learning scenario comprises 2 phases, the 1st phase takes 2 weeks, and the 2nd phase takes 1 week. At first, students are asked to choose one of the 5 discussion threads started by a teacher in an asynchronous discussion forum. Each of the teacher's initial postings is published in the name of a virtual person and intentionally concerned with topic that is interesting but new to students (was not mentioned in lectures throughout the semester). Students should find and study relevant sources (Java API, tutorials, or books) before posting their answers (writing a short coherent text to explain the issue, giving a good example etc.). They are encouraged to pay attention to the quality of their postings so they would be valuable for others. During the 2nd phase, students are asked to read all the answers posted by classmates carefully so they could vote for a best contribution in every single discussion thread. They are also free to reply to postings when identifying an error or some misconception of the author. In order to emphasize the importance of the learning activity and promote the motivation, active participation of students is graded (5 points for one's own contribution, 5 points for reading and

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evaluating the postings of others). The assigned points represent a significant part of the student's final assessment (20 % of the total score).

Implementation issues

The proposed learning scenario (as described above) was realized in winter semester 2013 with 14 active participants. During the 1st phase, the discussion forum was set to the so-called Q & A format to give all students equal chance to contribute with original answers. In a Q & A forum, one can read others' postings only after contributing with her/his own answer first. To implement the 2nd phase effectively, this distinctive property of Q & A forums was cancelled and everybody could read and comment everything such as in a standard discussion forum. Students could highlight the selected posting by assigning a point to it. After experiencing some problems while realizing previous iterations of the learning scenario (with 2 groups of 26 and 29 participants in winter semester 2012), we decided to strictly separate the contributing phase from the evaluation phase. Several students (surprisingly, in both cases the ones with best final assessment) did not wait with their evaluation until the whole group finishes with contributions, apparently read the evaluated contributions superficially or even did not read the postings at all (the evidence came from the analysis of logs). After fulfilling the goal, students tended to lose interest in the learning activity's further progress. The relatively low quality of student's contributions in previous years led to the idea of increasing the weight of the learning activity's assessment from 10% to 20%. To better understand the behavioural patterns of participants, the subscription to discussion forum was banned. We found this simple restriction helpful for identifying students' returns to forum as a result of their intrinsic motivation. In all iterations, the learning activity was realized during the last month of the semester, so students could utilize also the knowledge acquired within the actual course. Another supportive argument could be the fact that the activity of students naturally rises at the end of the semester.

Collaborative Glossary

The second learning scenario is aimed at fostering students' ability to explain the exact meaning of terms. As was pointed out in the introduction section, the new generation of learners is often characterized as impatient, distracted, and not looking for exhaustive answers. Due to information overload students often consider all acquired information to be equal not assessing their quality. Building glossary is such type of learning activity that can improve students' working skills by shifting their working attitudes to more precise and detailed information processing.

The learning scenario: a theoretical view

At first, students are tasked to collaborate on building common glossary of key terms of programming language that they have learned during regular lessons. The learning scenario is arranged into four consecutive phases repeated iteratively while inserting new terms to the online glossary. The learning scenario starts with a classroom activity focused on getting programming experience through hands-on exercises. Students solve carefully chosen problems, which require the application of new programming techniques and new elements of the programming language. The practical experience gained during the 1st phase forms the basis for the constructivist learning process. The 2nd phase takes place at

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home. Students have to choose one of the new terms and try to define its precise meaning verbally by writing the definition into the online glossary. During the next face to face lesson (the 3rd phase), a discussion about the inserted terms follows. Discussion is initiated and moderated by a teacher. The discussion phase is focused on joint evaluation of contributions' quality. Next, students should use the information implied by the discussion to correct, refine or comment the entries in the glossary (the 4th phase). By reading and commenting the definitions of classmates, students are improving the overall quality of the common product.

Implementation issues

The learning scenario was implemented with 8 students in winter semester 2013 within the course for prospective informatics teachers (Children's Development Environments). This course is elective and dedicated to programming in Imagine Logo. The participation was compulsory and set as a precondition for completing the course successfully. Also for this subject, an e-learning course in Moodle was created to supplement the face to face instruction. As Moodle contains a specialized module that directly supports the collaborative making of glossaries, we just used its functionalities. In the so-called Glossary module, one can create and administrate the list of definitions as well as comment and categorise the contents comfortably. The anticipated result of the students' joint effort was an artefact that might be useful for the whole community of involved participants.

RESULTS

The quantitative data saved via the build-in logging service of the learning management system contain useful information about students' presence in the online environment. In (Lovászová and Palmárová, 2012), we used the educational data mining-like strategy (namely the log's analysis) to identify behavioural patterns of students who were involved in a similar forum-based learning activity. However, in this study, we were focused more on qualitative analysis of students' work as well as the teachers' (researchers') observations recorded during the experiments. In each of the cases, we examined the same aspects of the learning scenarios (Table 2).

Table 2: Evaluation of experiments – the addressed questions.

	Aspects of interest	Questions to answer
1	Engagement	Did the learning scenario promote active learning?
2	Cognitive load	Did the learning scenario provide students with tasks that were demanding enough and required the application of higher-order thinking skills?
3	Collaboration	Did students benefit from the collaborative nature of the learning scenario?
4	Anticipated behaviour	Did some unexpected or unwanted phenomenon arise during the learning activity?
5	Quality of contributions	What was the quality of students' contributions?
6	Teacher's role	If any, what kind of teacher's intervention was needed?

In the following sections, main results of the experimental implementation of suggested learning scenarios are summarized, one at a time.

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Sharing Knowledge with Classmates

(1) *Yes*. All 14 participants joined both phases of the learning activity in time. 3 students posted even more than the one compulsory contribution (2, 3 and 5). Students were free to choose a discussion thread in which they would like to contribute. The average number of contributions per discussion thread was 4,2, students showed their interest in all published topics almost equally (regular expressions, exceptions, localization, compressing and decompressing of data, serialization of objects). For every student, there were 20 postings of other students to read.

(2) *Yes.* The contents of students' postings indicate that most of the students were not familiar with the topic to discuss, so they needed time for preparation of answers. None of the students posted the answer immediately after reading the initial questions, we noticed more returns to forum before the final act of posting (2,7 times in average, counting just the first viewing log per day). The only one student, who posted several minutes after entering the forum for the first time, copied the first sentence from the well-known online source (Java API documentation) leaving the hyperlink to it. It is very likely, that he spent the elapsed time by searching the very first answer via the search engine.

(3) As students had to select the best contribution in every single discussion thread, they were likely to learn about new topics by reading the postings. However, we did not perform any post-tests to measure the actual learning outcome. We assume that the comparison of classmates' postings that varied a lot as for their quality, provided students with beneficial learning experience putting them in the role of a critical arbiter. We noticed, that students did return to their discussion threads after posting their answers at least one more time (the average number was 2,7). Two female participants were visiting the forum on daily basis (9 and 13 times), probably to check the new postings in their discussion thread as the access to other threads had not been permitted until the 1st phase's deadline. After selecting the best contributions, 2 students did not return back to the forum any more. Other 12 students were probably interested in global results of the learning activity as well as the teacher's evaluation of contributions, the average number of post-evaluation returns reached 2,6.

(4) During the 2nd phase of the learning activity, we wanted students to comment each other's postings. Students did not use this opportunity at all.

(5) When evaluating the quality of written contributions, we decided to classify them to 4 categories by assigning an integer code to it (0 = no information value, 1 = low quality, 2 = medium quality, 3 = high quality). The average quality of contributions resulted in 2,1. In each discussion thread, just one high quality answer occurred. In total, 4 contributions were evaluated as being of low quality, the rest (12) represents the medium quality contributions. For instance, in discussion thread that was focused on regular expressions, a high quality answer would be structured as follows: explanation of the formal term, few fitting examples of regular expressions and their applications in practise, short overview of the related Java classes or a sample commented source code illustrating the fundamental usage in a meaningful context. According to the contents of the analysed answers, 3 main weaknesses of students were identified. At first, it seems to be difficult for them, to select a good example for illustrating new concepts or procedures. Secondly, they tend to write the answer as a commented source code rather than a well-structured essay. The comments provided by students are often insufficient; the source code is too long, having

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a poor format or not being tested. After comparing the evaluation of students with the teacher's categorization of contributions, we found out that in 32,9% of cases, a high quality contribution was chosen. 58,6% of points were assigned to medium quality contributions. The low quality answers were chosen 6 times by 6 different students. During the 2nd phase, students could not see the number of points assigned to contributions by their colleagues, so the evaluation process was independent. Complete results of evaluation were made visible to all participants later, after ending the 2nd phase.

(6) Besides giving the initial instructions (in both, verbal and written forms) and setting the topics for discussion threads, the teacher did not join the forum actively, nor communicated with students in person about the forum. After closing the 2nd phase, the teacher additionally evaluated all posted contributions by assigning extra points (1, 2 or 3) in order to express an expert's opinion. In this way, students could compare their decision with the teacher's one.

Collaborative Glossary

(1) *Yes*. The conception of the learning activity pursued by students supported the constructivist way of learning. A student constructs her/his knowledge on the basis of the prior experience and interactions with other learners. She/he did not study the ready-made materials, but was actively involved to the creation of the course's contents. Instead of consuming the facts, students were challenged to think of the meaning of the concepts and use the related terminology correctly.

(2) *Yes*. General concepts are constructed as abstractions of the subjective experience with the concrete instances (natural concepts) or by understanding the formal definition (artificial concepts). While creating the glossary, students were working with both, the natural and the artificial concepts. The glossary entries were created as natural concepts originating from the programming experience. This part of the learning activity is likely to foster the abstract thinking. Evaluating the entries of classmates contributes to students' analytical and critical thinking. In this case, students work with artificial concepts – definitions.

(3) *Yes*. The efficiency of learning is likely to be enhanced by sharing the entries while working on a common product. However, we found the joint discussion realized during the 3rd phase of the learning activity most beneficial. The moderated discussion helped students to distinguish right and wrong definitions and sample examples.

(4) *Yes*. We assumed higher level of intrinsic motivation from students. The number of entries in the glossary could be much higher. In average, there were 3 entries made by each of the 7 students. One student did not contribute during the homework phase at all, though he was rather active during the classroom discussion.

(5) The quality of written contributions was low. In the following list, we categorise the students' mistakes that were identified while analysing their entries:

- *Preconceptions, naive formulations*: Most of the definitions reflected some, but not all of the concept's substantial characteristics. Preconcepts are considered to be an inherent phase within the constructivist learning process. The understanding of concepts gets deeper and more precise over time in correlation with further experience.

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- *Misconceptions, wrong formulations:* Some definitions contained statements that were untrue. This revealed the wrong understanding of the concept or difficulties with expressing the ideas. The most surprising were the syntactic errors in Logo statements as those can be avoided quickly by testing the output of the sample programming code in action.
- *Alternative views*: These contributions could be evaluated as correct, though they were not systematic and so may have negative influence on constructing of the conceptual framework.
- *Formal imperfections*: Students often did not stick to the formal rules of formatting and structuring in their entries. The common product lacked the desired uniformity.

(6) The teacher had to guide the students throughout the whole learning activity. First, she was the author of the programming tasks to introduce the new concepts in an appropriate way and specified the formal conventions for editing the entries in the glossary by publishing the very first entry as a sample. Without the classroom discussion about the first tries and errors of students that was moderated by a teacher, the outcomes of the learning activity would be probably unsatisfactory.

DISCUSSION

Both of the presented learning scenarios were motivated by observations of students' performances in subjects focused on computer programming. As the generalized characteristics of a new generation learner suggests, the students do have difficulties with critical thinking and intrinsic motivation for deeper understanding of concepts. We anticipated that the public presentation of contributions in a written form would lead to the higher quality of students' work. This assumption was not confirmed. Although the students were actively participating, the lack of experience with this type of assignments has manifested. Students seemed to be satisfied with their answers, or the answers of classmates, as they did not feel the need to comment even the obviously wrong entries in the glossary or some really poor explanations in the forum. This minimalistic contributing strategy of students could be explained also with the fact, that they still prefer the face to face communication with their classmates and that the tasks were rather demanding for them.

The social constructivist attributes of the investigated learning scenarios enriched the students' learning process most likely in 2 ways: Firstly, students were involved in learning activities of a collaborative nature that are typical for online learning communities. Secondly, during a face to face discussion or by comparing their own evaluation of contributions with the expert's one, each student could recognize the differences produced by the shallow and the complex approaches to the topic. For teachers, the learning activities, that make every student to produce and share her/his contribution in a permanent online repository, may serve as an effective diagnostic tool. The results gained from the analysed iterations of the learning scenarios based on using the Glossary and the Forum modules in action strengthen our belief that such learning activities are meaningful and have potential to foster the higher-order thinking skills. To help students to overcome the difficulties with exact formulating of their ideas, structuring their answers and using

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the terminology properly, teachers should prepare more opportunities for training these competences in various contexts and modifications. As evidenced by experiments, the overall results of the collaboration are likely to be better if the motivation of students would be higher. The optimal rules for assessing students' level of engagement in the proposed collaborative learning scenarios should be investigated in more detail as well.

ACKNOWLEDGEMENT

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Modern ICT Based Teaching and Learning Support Systems and Solutions in Higher Education Practice

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Abstract

In Hungarian and international practice, many attempts and sets of example can be found as a direct or indirect use of the latest ICT (Information and Communication Technologies) in the teaching-learning process. With the support of Web 2.0 and e-learning 2.0 new education informatics methods have been published, often reshaping significantly the learning environment with new media instruments (Forgó, 2011). This way we shall get all the way to digital pedagogy 2.0 and its latest developments. The Web 3.0 as a line of continuation goes rather beyond the scope of existing technologies, and in addition to previous services promotes intelligent orientation in large data sets, reveals primacy of distributed mobile technologies and connectivity options as well as provides a among the first a space for new technologies such as artificial intelligence. The education system is trying to follow the new environment, the new roles, the digital generation's attitude, and the challenges of constant changes, as indicated by several international and Hungarian community forums. (For example Forum of Innovative Teachers). However, due to the development of multi-dimensional background variables adequate education / learning methodology recipes solutions are not available just yet. The research is looking for questions arising from this situation, searching for learning ways and habits of the digital generation as well as for the latest tools of digital communication and in order to achieve a more efficient outcome, it seeks methodological and technological support on base of higher education.

Keywords

Information and Communications Technology. Electronic and mobile learning environment. Micro content. Digital communications. 3D. Social networks.

INTRODUCTION

The main feature of the information society is that the information has become a primary value. Because of economic globalization and corporate governance crisis the main engine of information society is computer technology and the rapid development of telecommunications, its most important stages are the spread of personal computers and the emergence of broadband networks, its symbolic technological innovations are the Internet and mobile phones. As the result of this rapid development no area of life can avoid the application of information technology. It also involves important social changes: the rate of employment in the information sector thrives dramatically, telework and life-

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long learning becomes possible and necessary the same time. As a result, the development of digital literacy and the dissemination of information infrastructure may appear as primary strategic objective. The same time, living in the information society, people may face many previously unknown problems such as unlimited quantity, but various quality of available information in need of proper assessment, filtering and processing or the protection of privacy over control of economic or political powers(Ollé; Papp; Lévai; Tóth-Mózer; Virányi, 2013). This effects the environment of the society. The nature of work is changing, the changes are related to the individual learning processes, attitudes, developed learning habits, or the altered teacher and student roles (Szűts, 2013).

We often refer to our accelerated world and we face the an information overflow while equipped with gadgets. As in other spheres of life, of course, education does not remain the same in the ICT-based world. In the Internet era, electronic learning environments, that is all functions-organizing learning content management interfaces related to learning are more and more being built into the formal education system is (Benedek, 2013).

A good example is the Moodle (Modular Object-Oriented Dynamic Learning Environment) system used and Budapest University of Technology. The system is used by millions worldwide and in addition it is rapidly being deployed into public education. In the meaning of pedagogical tasks and principles a less mature, but in the practice already adopted at ELTE (Eötvös Lóránd University) is a virtual learning environment where users of a virtual campus learn real content, while the students can participate in a virtual classroom from their homes as well.

According to today's research surveys, the Y-and Z-digital generation members who at present and near future form group of students prefer more informal forms of learning which are not closely related to the educational institutions.

"Similar to Moodle systems such as the Iliad or the OLAT (Online Learning and Training), it is traceable, who logged in, and what amount of time spent on the surface, and what activity did he show in the system. But this is still a too bound framework for most young people" (Molnár, 2012). On similar principle as Moodle works the EDX, a system born as collaboration of Harvard and MIT (Massachusetts Institute of Technology), or OpenLearn created at one of the distance learning the citadel, the Open University. The three websites have in common that only one registration is required to access quality content, where in addition to the name and e-mail address no other information is required about us.

TYPICAL HUNGARIAN AND INTERNATIONAL ICT PRACTICES

The most up to date national and international ICT solutions shows the following trends regarding teaching and learning.

- As a result of interpenetration, network access is not available for almost everybody. We may say the digital gap has ceased to exist, in international comparison in particular.
- The majority of new developments strongly relies on this extended access such as web 2.0 services.

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- The focus of progressive ICT development and use is shifting towards mobile tools.
- Integrated, complex ICT tools and systems are becoming organic parts of everyday life and learning at an increasing pace.
- Regarding ICT generations, the perfection of existing generations is the prevailing trend instead of introducing new generation inventions.
- In today's world of technological enhancements and supported systems the developments are increasingly pointing towards the free, open, and integrated systems.
- Regarding web 2.0 contents, portal management is increasingly less dependent on software engineering skills. Instead, the more simple and user friendly CMSs (Content Management System) are becoming increasingly popular. LMS (Learning Management System) is a software package to implement and support teaching and learning programmes and courses, facilitate the uniform management of courses and participants (students) and to support the entire teaching process (Kommers, 2010).
- LCMSs also support the development of curricula and e-learning based, interactive multimedia courses.
- Besides the the man-machine relation the importance of machine-to-machine interaction increases in learning forms.
- CMS is the abbreviation of Content Management System. It was developed at the same as PHP and it is based on the application of PHP and SQL engines. As its use is quite simple, users not possessing technical qualifications or programming knowledge are also able to apply it to edit websites or electronic publications and publish online. These frameworks may be customized, modified, extended and structured online in use (Paulsen, 2002).

In Hungary, the most widely used CMS systems are Drupal – http://drupal.hu, Joomla – http://joomla.org.hu, Moodle – http://moodle.org, Wordpress – http://word-press.hu and Olat – www.olat.org. They may be divided into classes according to the following criteria:

- open source or proprietary software
- programming language (php/.NET asp)
- simple or modular framework system with or without functional plugins
- According to EU practice, the following protocols and framework systems have been introduced and applied in relation to the web 2.0 model (see Fig. 1.) As shown by the figure, content management systems are supported by a specific content development tool (CCT – Content Creator Toolkit). In addition to learning management systems, another one specifically supporting students is also included (SMS – Student Management System). Administrative and statistical tasks are managed by a separate financial and accounting system (AS – Accounting System) (Klimes; Balogh, 2010).

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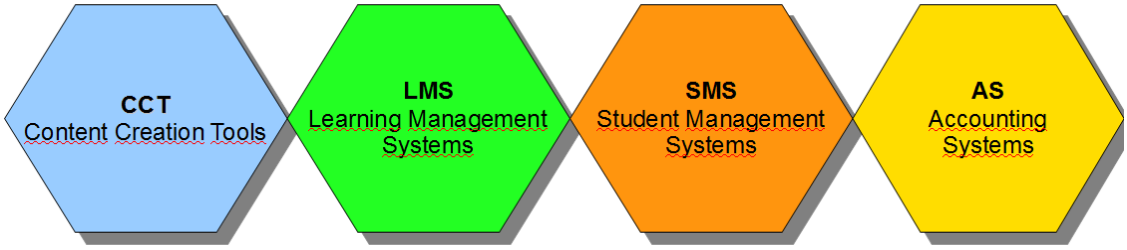


Fig. 1: Web 2.0 systems in the EU, source: own edited photo

- An increasing number of network based ICT solutions are used in education with special regard to learning environments and social or collaborative engines (like ELGG, the open source social networking engine).

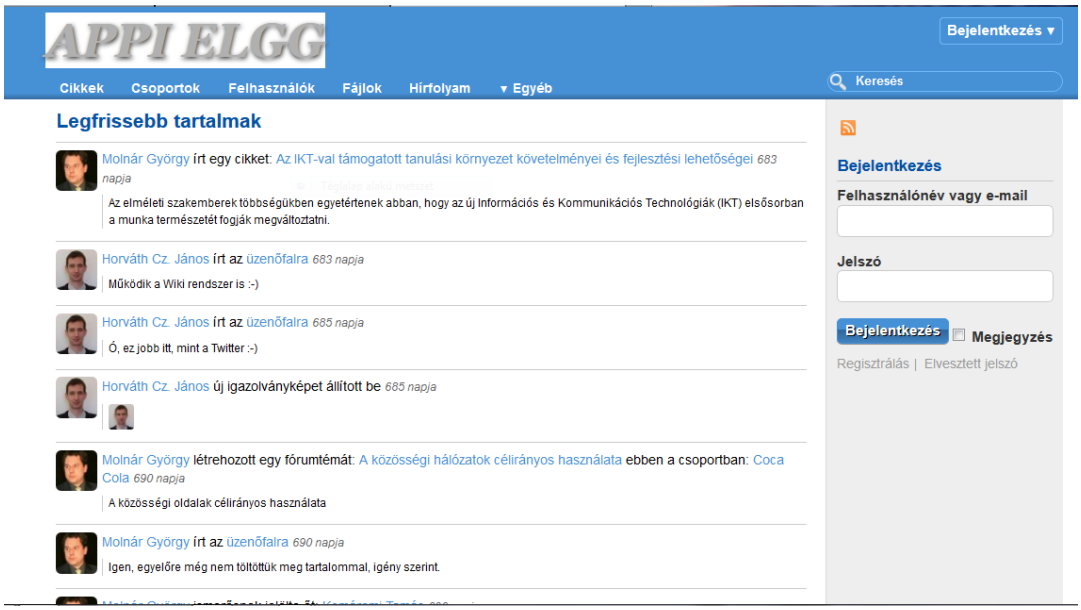


Fig. 2: The social portal of APPI ELGG, source: own photo

- In addition to real, traditional educational environments, virtual classrooms and learning environments promoting atypical learning forms also play an increasingly important role at micro and mezzo levels. Such a system for example is Second Life where we can learn via our avatars or Ning, where a virtual classroom is accessible by means of an online platform (Castells, 2005).
- Information, which represents the foundation of knowledge based society is available in such a sophisticated form and represents such a load for society that justify the increasing importance of visual representation forms (Infographics) in understanding and processing large volumes of information (Molnár, 2012).

From the web 2.0 applications available worldwide, the number of first generation ones (web 1.0 applications) is decreasing as opposed to web 2.0 portals with significant growth trends. These latter ones also facilitate interactivity in addition to editing contents. The general features of web 1.0 tools are listed below.

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- Content provider services: textual, visual (photos, graphics, figures) audio and video contents
- Contents published on data storage devices (CD supplements, USB drives, DVDs)
- Internet (web) based contents: hyperlinks, HTML 4.0, HTML5.0 on static websites

General features of web 2.0 tools:

- Web 2.0 is an IT medium where users organize and manage contents together
- The owner of the portal only provides the IT framework without restricting contents
- Organized bottom up (from users towards groups like blog communities, forums)
- Service oriented, characterized by service development
- Relativistic management of personal data; data security problems are typical where the personal, social and business data of users may be acquired by third parties (Buda, 2010).

The next section lists those of the 100 most popular web 2.0 applications that are currently in use and essential for independent learning (Forgó, 2011).

- Twitter (microblog tool)
- YouTube (video share)
- Google Documents (administrative teamwork tool)
- Delicious (social bookmarking site)
- SlideShare (presentation storage)
- Skype (instant messaging / VoIP)
- Google Reader (RSS / feed reader)
- WordPress (blog tool)
- Facebook (social network)
- Moodle (LMS system)
- Prezi (presentation software)
- Google (search tool)

In addition to web 2.0 portals, web 3.0 applications should also be mentioned here. This is not a new feature at all, even though we have not even been fully familiarized ourselves with all the web 2.0 functions. The web 3.0 generation means contents, commerce, community and context are all personalized and combined with vertical search. The simplified formula for web 3.0 is Web 3.0 = (4C + P + VS) (http://longhand.hu/web2/web-30.php).

EMPIRICAL ASSESSMENT RESEARCH OF ICT ATTITUDE AND DIGITAL COMPETENCES

Characteristics of the study and the circumstances

The survey took place between 2013. September 10 and 25 with the involvement of individual units within the BKV (Budapest Transport Company) and MÁV (Hungarian State

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Railways). The study questionnaire was made with the Google form designer and form sheet. The introductory survey questions were supposed to explore the sociological characteristics of individual respondents, they enquired about equipment requirements, use of knowledge, and assessed the capability of the application of the modern distance education methods. 73 people attended the anonymous data reporting. Of these, 64 worked at BKV and 9 were employees of the MÁV. Target segment of the study included all selected, as employees engaged in intellectual work or work in lower and middle management at their workplace.

The assessment was made with the respondents involved. Accordingly, the results revealed can only be locally representative. Representativeness in a general sense, cannot be applied nationally to the identified characteristics in other companies, or only with significant restrictions to the interpreted data. Isomorphic representativeness therefore replaced with the homomorphic approach. In order for the results to be interpreted in other areas in connection with other companies, in the following we intend to establish characteristic of the sample rate of 95 % confidence intervals. In case of companies with these characteristics which fall within the confidence intervals, the results can be accepted without reservation (the survey is representative). The greater differences can be observed for a particular company, the more necessary is for the results to be taken as approximates.

The main objective of the survey was to explore defined parameters for the two fundamental elements. In this context, therefore, among the target population we studied the knowledge potential of digital learning tools, services and knowledge management levels, personal learning characteristics and habits, as well as the respondent's attitude during the learning course. Our processing method in addition to simple descriptive statistical methods included also multivariate analytical methods (cluster, factor analysis, multidimensional scaling) procedures as well. Due to space limitations of the article we didn’t present full analysis but used graphs and dendograms and summarized the results in the text.

For example, and for the sake of argumentation of analysis carried out we reported the results using a dendrogram, where one can see the distinctive curl clusters. Based on the data conversation, phone calls and e-mail separate from the other communication method. According to this interpretation this attitude is linked to frequency and preference. On this basis, we can state that on this level the through the framework type of communication seems to be spreading.

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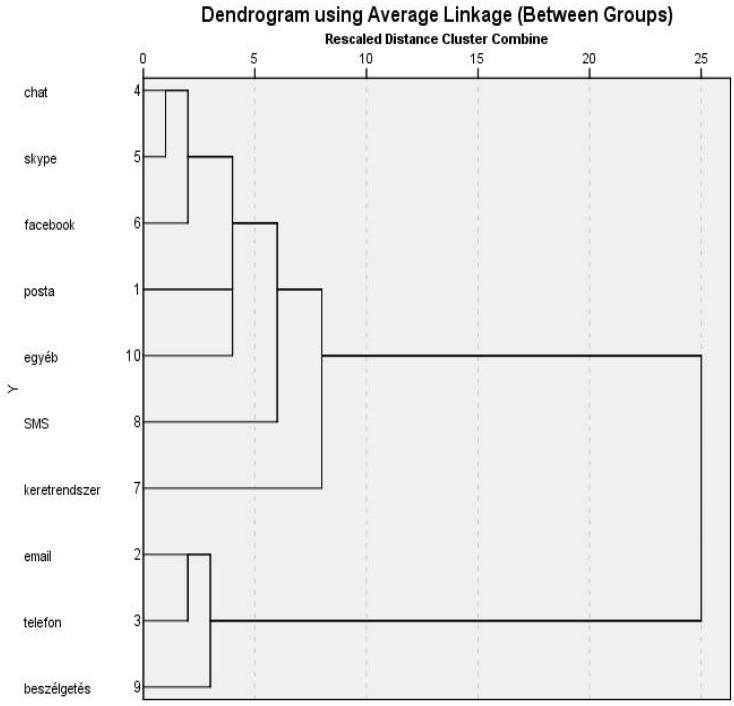


Fig. 3: Dendogram, source: own photo

The results of the survey is used in the context

In respect of communications modes used the 3 spaces of communication do not differ. Both in business, workplace and private communication of e-mail, telephone calls and personal conversation (negotiation) is dominant. Also, all three spaces are limited area of SMS expression. The traditional mailing, chatting, Skype and Facebook use and communication using framework is negligible.

In terms of means of communication the 3 spaces are very similar to one another, smaller (but significant) differences may discovered between them. All of them feature primary orality (exclusive of any devices), desktop computer (with the exception of private communications, where laptop and smartphone are increasingly taking over the role). The use of the traditional postal services are increasingly pushed to the background, the IP phone, video phone, tablet, notebook and netbook is not widespread.

In corporate training based on e-learning 86% of employees would participate, 44% of them study with desktop (not mobile) computer. The majority (82%) would use their own devices, but there is a significant proportion of those (22%) who would learn with tablet provided by their company. The further training could take 2 hours a week for an average respondent, but every 9th respondent would learn 5 hours a week, one in six would dedicate less than an hour a week.

In respondent segments the most noticeable difference is between the sexes. Women use more varied forms and tools of communication, but in case of some higher priced means generally men are early adopters. In terms of education there were significantly less differences, but it can be said that the more educated use a wider spectrum of modes and instruments. Analysis from the position taken in company show that only a few differences can be seen. Generally speaking, the lower-level level employees use bigger

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variety of tools to communicate. The rest of the analysis did not show significant differences.

Among the respondents the awareness of the teachers' group in forms and means of communication is significantly higher than among the others. The use these means in different spaces (work, private, etc) is both higher than the use of others, and the spectrum is wider too.

Testing latent variables clarify that with minor differences in both test target groups (private sector, public education) in all communications arena personal conversations, e-mailing and phone calls are the crucial method, while the primary orality, a desktop computer and phone (mostly traditional version) are the tools most often used. Between the two spheres there are a number of minor differences that can be revealed, but in whole they do not affect the high degree of similarity.

NEW POSSIBILITIES IN THE ICT ENVIRONMENT OF THE FUTURE

Further options for innovation are represented by current and future applications such as Second Life, 3D Desktop, integrating Leonar3Do measuring practicals into the Classroom Response System, incorporating videos and educational videos into the educational process and Kinect-based sensory solutions.

The development illustrated by the picture below solves the problem represented by the lack of space in 2D displays for the numerous modern applications. In the near future, 3D operating systems may be introduced via the 3D desktop system.



Fig. 4: 3D Desktop, source: own photo

An obvious development direction for all the solutions discussed in the previous sections regardless of their contents is creating and using 3D presentations in education, relying on prezi.com (see Fig. 23). The 3D texture is prepared by the editor of a 3D software (e.g. Blender) and the content rendered from the 3D frames are composed into a video based flash format. The output is the presentation that may be presented by means of a media player at lectures (e.g. Windows Media Player Classic). The presentation may also be projected frame by frame where the routes between individual 3D elements can

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be visualized or selected frames may be projected without showing the ones between (Molnár, 2011).

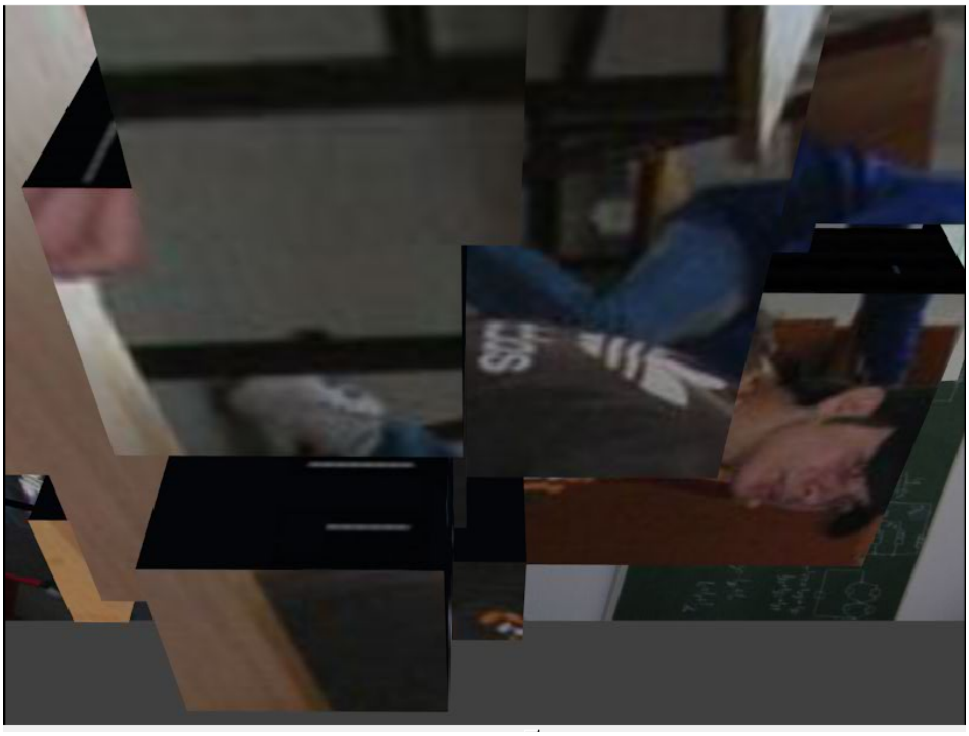


Fig. 5: 3D presentation, source: own photo

CONCLUSION

Based on past experience in higher education and empirical studies conducted it is confirmed that it is not only a particular application or program, but also function is an essential element in new ICT supported electronic world. These are often characterized as incomplete instrumental systems, with basic functions only to support mostly digital immigrants'/natives' toolkits.

The main feature of these areas is that there are no established pragmatic regulatory systems (Facebook, SlideShare, Pinterest). The results of the research showed a number of innovative good practices. These all take into account adaptation to students' learning habits involved in higher education, they attitudes toward new student role, and last but not least, adapt to the expectations that are incorporated into the next teaching, culture methodologies. On the basis of the survey carried out, the result show the most preferred learning methods, forms, learning time spent, their through-the-day distribution, as well as the parameters of the ICD based communication tools. Due to the results we can predict behavioral culture of the target group.

As a continuation of the research it would be useful to differentiate and analyse the specific clusters and factors.

This paper essentially discusses the various dimensions of the new ICT environment from both theoretical and practical aspects. By introducing the reader with the ideas of previous articles including novelties and their practical relevance, the author hopes to

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have contributed to a change of attitude in these fields. In addition to the national and international trends in teaching and learning presented here, technical and methodological specifications, case studies and actual examples are also offered to the reader, providing added value to educational science and shifting the focus within it to the interdisciplinary approach and the development directions defined by it, always considering education techniques and methodology. Adapting the micro and meso methods described in the educational process may serve as a starting point for marking out the track for future educational development in addition to supporting innovation.

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Computer Aided Teaching Topic "The Rainbow Formation" in Subject Computer Simulation in Physics at High Schools

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Abstract

One of the most important tasks in teaching of mathematics and science is to use a suitable method for understanding and developing of theoretically acquired knowledge. The author has found during the teaching in subject Computer Simulation in Physic at study program Physical Measurement and Computer Science that the possible method is modelling and computer simulation of the physical phenomena in MS Excel Spreadsheet and MS Excel Chart. The paper focuses to the theory of modelling, simulation and demonstrates creation of the computer simulation model of the rainbow function in MS Excel.

Keywords

Animation. Computer simulation. Mathematical modelling. System approach. Visualization.

INTRODUCTION

The Departments of Physics and Department of Informatics, Faculty of Science University of Hradec Králové have accredited study program *Physical Measurement and Computer Science*. The mission of the program is to teach the student how to apply mathematical modelling and computer simulation. *Modelling and Simulation* (M&S) has become an important way of solving problems (see e.g. Hubálovský, Milková and Pražák, 2010).

The results of the research published in Hubálovský (2011), Hubálovský (2012) and Hubálovský (2013) confirm that using the methods Modelling and Simulation can positively support learning of Science in distance form of study.

The teacher responsible for subject *Computer Simulation in Physics* developed procedure enhancing the traditional high schools physics curriculum by the topic "The rainbow formation" (Halliday – Resnick – Walker, 1997) using the methods of modelling and simulation. The paper presents case study of the process of breaking down into a worksheet that connects classical experiment with a simple numerical model of the reflection of sunlight, i.e. a mix of visible monochromatic light with different wavelengths on tiny spherical drops. This model uses geometric and trigonometric functions and Snell's

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law for deriving the rainbow function and its modelling and computer simulation using a spreadsheet.

Teachers of physics sometimes ask if it wasn't wiser to modulate the traditional contents of the high school physics when the information and communication technologies might support and enlarge the possibilities of the traditional lectures very significantly. One of the appropriate fields of physics for that is certainly optics. Most of the textbooks come very quickly from the basic principles, such as principles of reflection and refraction, to the mirror and lens display and finally to rather sophisticated optical devices such as various types of telescopes and microscopes. Even the founders of optics were fascinated by the natural phenomenon of light dispersion in a raindrop – i.e. a rainbow. Among these founders were such figures of the 17th century physics as Isaac Newton, Christiaan Huygens, or the first significant Czech physicist Jan Marcus Marci.

THEORY OF MODELLING AND SIMULATION IN EDUCATION

Scientific modelling and computer simulation are the terms which are closely related. From the education point of view the method of M&S can be used in different fields of high school studies – see e.g. Hubalovsky (2012):

- In the field of sciences education - in case of models and simulations of science processes and phenomena;
- In the technical education - in case of the process control of machines and simple robots;
- In the humanities and social studies - in case of the processes and phenomena associated with this issue;
- In management studies - in case of the management processes and quality control processes.

Modelling

Based on Hubalovska and Hubalovsky (2013) the main goal of modelling is describing the behaviour of the physical phenomenon as part of the reality. The first step in the process of computer simulation is creation of conceptual model of the studied real system. Conceptual model can be represented in different way. The most used representations are:

Mathematical equitations establishes mathematical model of the studied real system. The model can be obtained either theoretically based on basic physical properties of the system, or numerically by means of the measured values. Determination of parameters of theoretical model developed from empirical data is called system identification.

Scatter charts (scatter plot) is a type of mathematical diagram using Cartesian coordinates to display values for two variables for a set of data in 2D types of the chart. The scatter plot takes two sets scalar variables and uses them for two axes in 2D space. Time depending variables create dynamic scatter chart representing time depending conceptual model of the dependency of system outputs on its inputs.

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Simulation

The concept of modelling is closely related to the concept of computer simulation. Simulation can be understood as process of executing the model. Simulation enables representation of the modeled real system or real process and its behavior in real time by means of computer. The simulation enables also visualization and editing of the model.

A typical simulation model can be written both through specialized programming languages that were designed specifically for the requirements of simulations, or the simulation model can be created in standard programming languages.

From the above considerations, it is clear that simulation is a process that runs on the computer. In some publications, therefore, can be found the term "computer simulation". It generally is valid that computer simulation is a computer-implemented method used for exploring, testing, numerical solution and analysis of properties of the mathematical models that describe the behaviour of the physical phenomenon and which cannot be solved using standard analytical tools and that has to be solved numerically - see e.g. Hubálovský (2011) or Balogh, Turčáni and Buriánová (2010).

Case study of the computer simulation of *rainbow function* in MS Excel is presented in the paper.

From *educational point of view* the simulation, simulation model and visualization of simulation results on the screen help students better understanding the basic features of the processes and systems and develop their intuition. It is also essential that the teaching by means of simulation is much cheaper and faster than the teaching carried by real experiment. In some cases providing the real experiment cannot be feasible.

MATHEMATICAL MODEL OF THE RAINBOW FUNCTION

Why hasn't the high school physics dealt with the rainbow formation? The construction of the rainbow function is not difficult but the study of the function process and the determination of its extreme position of the individual colour spectrum demand knowledge of higher mathematics, in concrete terms the calculation of the derivation of a function. However, if the spreadsheet is used, there is no need for examining the function analytically. Instead we calculate the sufficient number of function amount with the help of the spreadsheet and we draw curves of the rainbow function for individual colours of the spectrum as the graphs of functions. We use proper dynamic geometry to facilitate the understanding of the phenomenon by our students and to demonstrate them that when a rainbow is formed by dual refraction on the air-water boundary there exists a certain boundary angle inside a small spherical raindrop and one or two reflections (formation of a primary and secondary rainbow).

Introductory classical experiment can be done as entry motivation with tools commonly available in the school science lab. We need spherical glass flask, water, rack and white drawing paper which serves as a focusing screen. Little limitation is the need of natural sunlight that reaches into the classroom through an open window. Sunlight goes into the glass bulb filled with water, which represents model of raindrop. Sunlight refracts on the flask surface, then is reflected from the inner side of the flask, and once again during exit out of the flask, exactly as sunbeams on the raindrops during creation of the

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natural rainbow. Protruding rays reaches classroom wall, which is in the shade. Because for different wavelengths of light water has a different refractive index, draws incident rays on the focusing screen - drawing board, attached to the wall with adhesive tape - the solar spectrum decomposed into colour bands that correspond individual monochromatic components of the light itself. See figure 1.

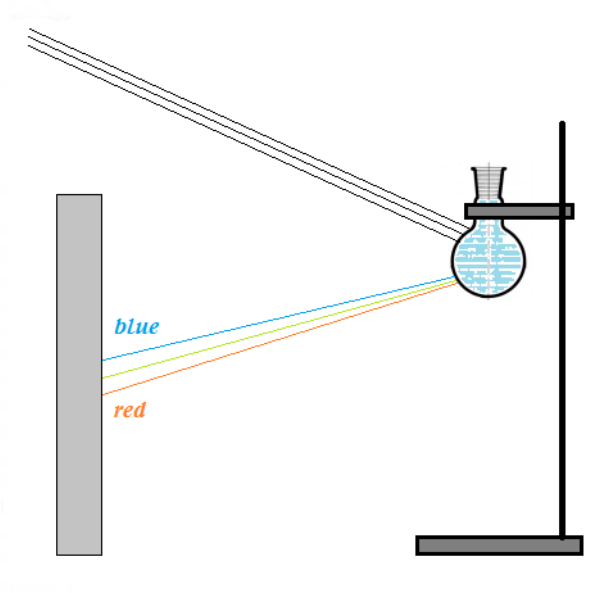


Figure 1: Introductory experiment

Derivation of the rainbow function

Before starting the derivation, let's review the student's knowledge of mathematics and physics. It is sufficient for students to know the principle of reflection and refraction of light. In reflection and refraction the reflected (refracted) ray remains in the plane of impact. The plane of impact is determined by two straight lines – an impact ray and a perpendicular to the optical boundary in the place of impact. Moreover for the reflection is valid that angle of reflection is equal to the angle of impact – i.e. $\alpha = \alpha'$. For refraction is valid that the proportion of the sine of angle of impact to the sine of angle of refraction is equal to the relative index of refraction, i.e.

$$\frac{\sin\alpha}{\sin\beta} = n \qquad (1)$$

This principle is often called Snell's law by its founder, Dutch mathematician and physician Willebrord Snell van Royen. It is also necessary to know the sine function and the inverse function (arcus sine). And furthermore to know that the sum of the inner angles of triangle is always 180º, in tetragon it is 360º, in pentagon it is 540º, and that the correspondent top angles are equal.

With the use of the figure 2 it is relatively easy to derive right formula for rainbow function.

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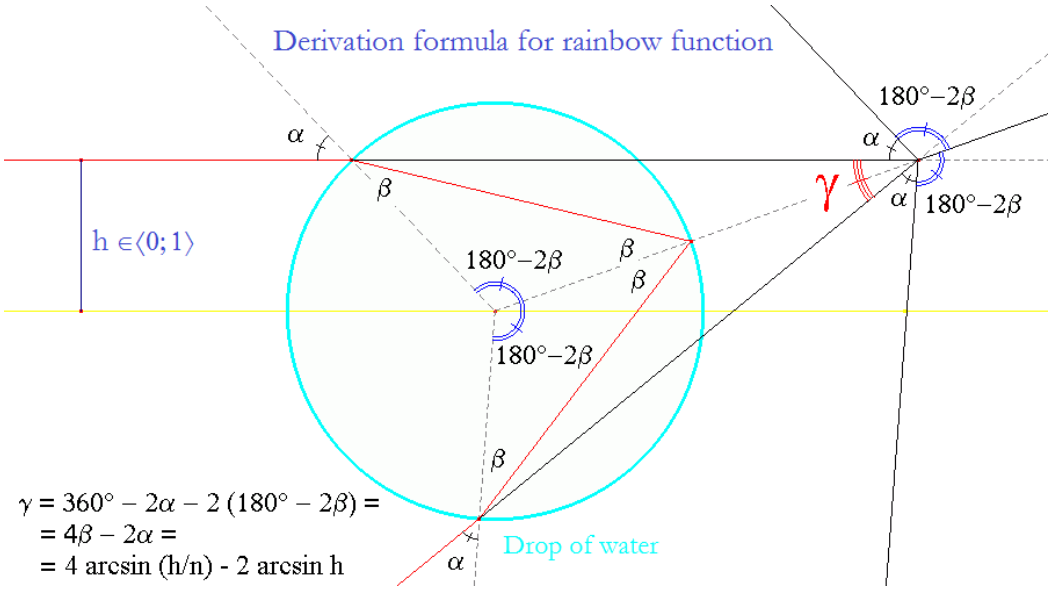


Figure 2: Derivation formula for rainbow function

Because sum of angles in right top corner in figure 2 is the full angle, so we can write:

$$\alpha + \gamma + \alpha + 180° - 2\beta + 180° - 2\beta = 360° \tag{2}$$

$$2\alpha - 4\beta + \gamma + 360° = 360° \tag{3}$$

$$\gamma = 4\beta - 2\alpha. \tag{4}$$

Angle *α* is the angle of incidence, so sin *α* = *h*, therefore *α* = arc sin *h*. Similarly angle *β* is the angle of refraction, so sin *α* = *n* sin *β*, therefore *h* = *n* sin *β* and $\sin\beta = \frac{h}{n}$, therefore $\beta = \arcsin\frac{h}{n}$.

That for the resulting angle of refraction γ on a drop of water is valid this relation:

$$\gamma = 360° - 2\alpha - 2(180° - 2\beta) = 4\beta - 2\alpha \tag{5}$$

$$\gamma = 4\arcsin\left(\frac{h}{n}\right) - 2\arcsin(h) \tag{6}$$

where *h* is a relative distance of the dropping ray from the parallel ray crossing the centre of the drop (the real number from 0 to 1). The *n* is the relative index of refraction for the transition of the ray from air to water. Because the absolute index of air refraction is normally very close to 1 (1.00026), it is possible to substitute the absolute index of the water refraction for *n*.

Derivation of the second rainbow function

Some of the students may have noticed that sometimes there can be seen two rainbow arcs in the sky. The second, which we haven't mentioned yet, can be occasionally

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seen outside the primary arc and it is a little thinner and its colours are in the opposite order than in the primary arc. It is called a secondary rainbow. When the secondary rainbow is formed, the light is not reflected only once but twice actually. The situation is shown on the figure 3.

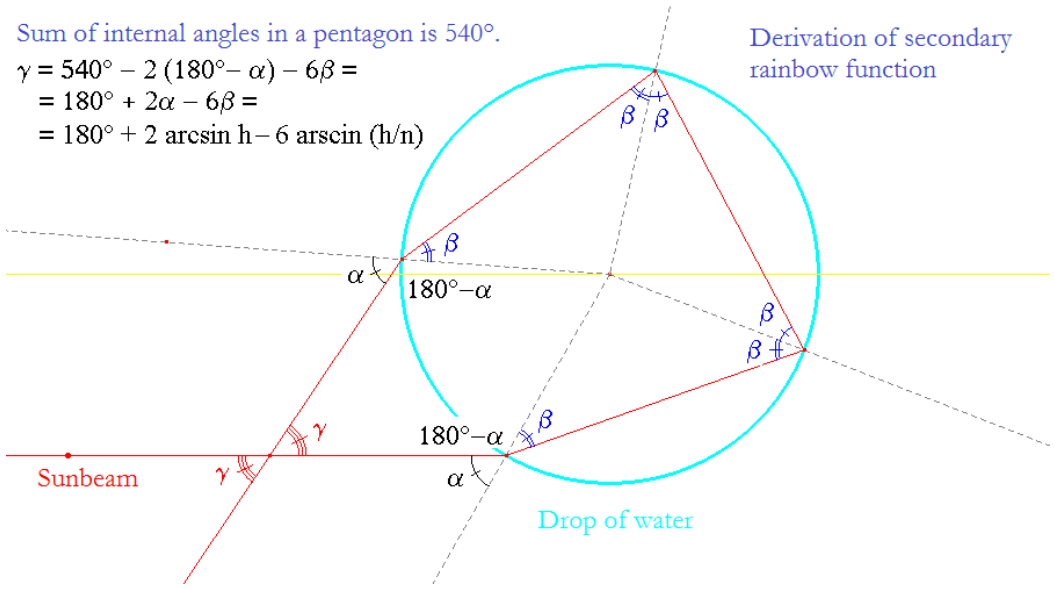


Figure 3: Derivation formula for the secondary rainbow function

We can similarly derive a formula for a rainbow function of the secondary rainbow, sum of the internal angles in a pentagon is 540°.

$$\gamma = 540° - 2(180° - \alpha) - 6\beta = 180° + 2\alpha - 6\beta \tag{7}$$

$$\gamma = 180° + 2\arcsin(h) - 6\arcsin\left(\frac{h}{n}\right) \tag{8}$$

COMPUTER SIMULATION OF THE RAINBOW FUNCTIONS

Even more illustrative than a static picture is animation, which cannot be put into this article but it is possible to display it on the internet website in the Java applet image (Musílek, 2011). The picture is constructed in an appropriate environment such as Cabri Geometry II or GeoGebra. The most difficult part of the construction is application of Snell's law. It precisely models the refraction of a ray of light to perpendicular in the moment of entering water from air and vice versa, i.e. from the raindrop back to the air. However, the refraction principle is very easy to construct by axial symmetry. The geometrical model has dual usage from the didactic point of view. The completed model is shown to the students with a lower level of mathematic knowledge and physical intuition to examine its characteristics and to understand correctly the essence of the phenomenon. To more talented students it is given a task to construct the model so that they have to combine their knowledge of physics, geometry and skills of using special software – a geometry notebook.

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In the following the computer simulation of the rainbow functions in MS Excel Spreadsheet an MS Chart will be presented.

Computer simulation of the rainbow function in MS Excel

Let's look at the rainbow function γ as to a real function of one real variable h (see equitation (6)), where index of refraction n that depends on a wave length (and also on the colour) of the dropping light is a parameter. The process of function for three different amounts of refraction index n_R = 1.330 (red light), n_G = 1. 334 (green light), and n_B = 1.337 (blue light) can be calculated and depicted as a function type X-Y in the spreadsheet.

Construction of the simulation model in MS Excel is as follows:

- The set of the independent variable h from 0 to 1 with the step of 0.01 is saved in the column `A` of the MS Excel Spreadsheet. This column is titled as ***h*** in the bookmark "Formula" by the function "Define title…".
- The columns `B`, `C` and `D` are titled ***RED***, ***GREEN*** and ***BLUE***. The values of indexes of refraction for red, green and blue colour are saved in the cells of row `2` and corresponding columns, e.g. `B2`, `C2`, `D2`. These cells are titled ***n***.
- Then the formula `=(4*ARCSIN(h/n)-2*(ARCSIN(h))*180/PI()` can be written to the cell `B4`. Then the formula can be copied to the right and down to the whole area of the output values.
- Simulation model is represented by *X-Y* chart of dependencies ***RED***, ***GREEN*** and ***BLUE*** values on corresponding independent variable ***h***.

Simulation model is shown on the figure 4.

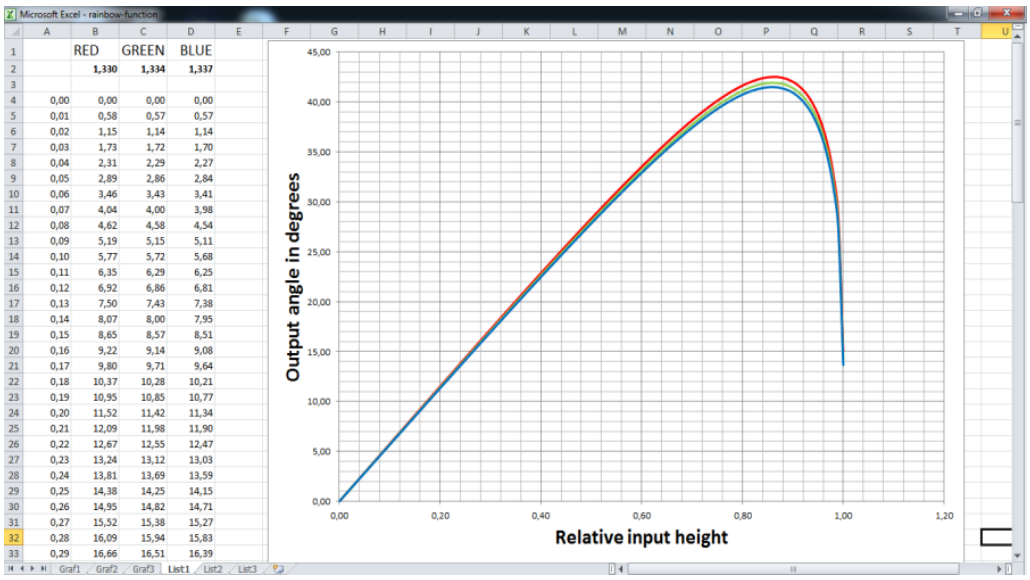


Figure 4: Calculation and display of rainbow function

It is clear from the graph that the maximal angle of the light reflection on raindrops is 42.5º. It occurs in the red light and for the relative inputting height 0.86. In the same inputting height we get 41.9º for the green light and 41.5º for the blue light. And this is the explanation of dispersion of the solar light to the colour spectrum and the formation of the beautiful atmospheric phenomenon that is called rainbow. The places that we can see in

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the parallel view with the solar rays under the certain angle crate an imaginary circle. Because a rainbow can be seen only when looking at a rainy screen in the sky, it has most often shape of a circle arc. We can see the arc with the Sun behind us and the rainy screen in front of us. If it rains only in the part of the sky in front of us, we can see only a part of the arc and the rainbow is touching the horizon only in one side or it doesn't touch it anywhere. Because all the light is reflecting on drops of water under the smaller angles, or under the limit angle, the inside area under the rainbow arc is lighter than the area outside the arc.

Computer simulation of the primary and secondary rainbow in MS Excel

Let's look at the second rainbow function *y* as to a real function of one real variable *h* (see equitation (8)), where indexes of refraction *n* and construction of the simulation model are the same or similar as mentioned in previous subsection. The simulation models of the primary and secondary rainbows are shown on the figure 5.

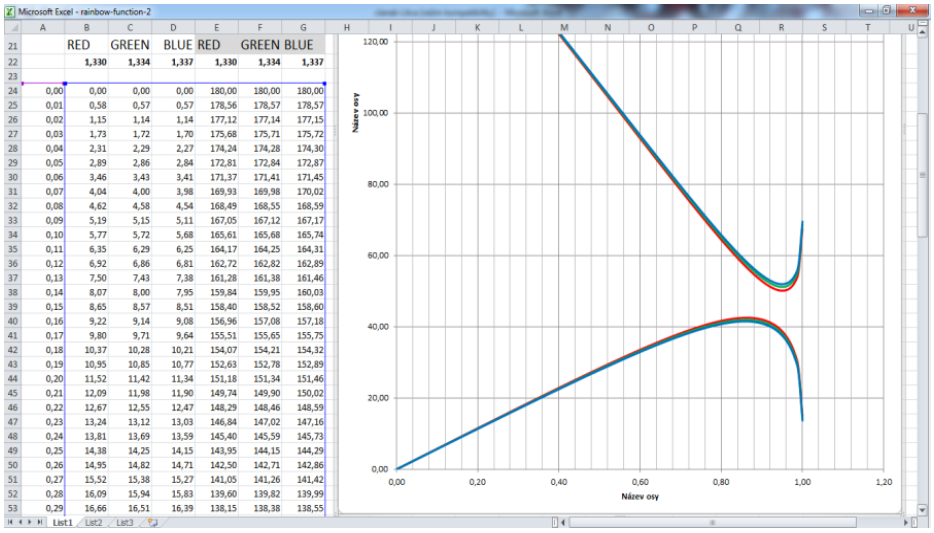


Figure 4: Calculation and display of both rainbow functions (primary and secondary)

When looking at a chart for the rainbow function, we can see that the extreme of the secondary rainbow function arises in the relative entering height 0.95 and reaches amount of 50.1º for red light, 51.2º for green light, and 51.9º for blue light. There has to be a good visibility because the secondary rainbow is always less bright and less contrastive than the primary rainbow. If we watch both rainbows, the dark Alexander's arc is clearly visible.

CONCLUSION

The presented case study of the creation of mathematical model, numerical solution and computer simulation were examined during the learning of high students in the subject Computer simulation in Physics. The results of pedagogical research (Musílek, 2013) has support the hypothesis that high students of distance form of study who have completed the experimental teaching of the topic "The rainbow formation" understand optical phenomena better than students who did not pass this teaching. The similar results can be found in Hubálovský (2013) and Hubálovský and Šedivý (2011).

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E-learning and Motivation for Learning Physics at School: The Case of Generations Y and Z

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Abstract

The article deals with e-learning, the impact of virtual and real activities for tenth formers' motivation for learning physics of different generations Y and generations Z. According to the sociologists' classification persons born in 1977-1994 belong to generation Y whereas the ones born in 1995-2012 belong to generation Z. Generation Z is associated with technologies and sometimes is even equated to technologies. The problem statement is formulated by the following question: how do e-learning and inquiry-based learning impact the motivation for learning Physics of the learners of generations Y and generations Z? The purpose of study is to reveal the effects of e-learning and inquiry on the motivation for learning Physics of learners of generations Y and generations Z. The method of study is as follows. The secondary correlative analysis of the results of national research and qualitative research has been conducted. The secondary analysis of national research (2004 and 2008) data revealed the impact of Inquiry-based and computer related activity on the motivation for learning Physics of generation Y learners. The correlation between the motivation for learning Physics of generation Y learners and the use of the computer in afterschool activities (e-communication, computer games, e-learning and e-creative leisure) has been analysed. The qualitative analysis is focusing on the problem of performing laboratory work, the hands-on dimension, the sense of reality and applying theory in practice. The qualitative analysis of the motivation for learning Physics of generation Z learners reveals the role of real and virtual laboratory work.

Keywords

Motivation for learning physics. Generation Y. Generation Z. E-learning. Inquiry-based learning.

INTRODUCTION

Science is an important component of our European cultural heritage. A paradoxical situation has developed in the conditions of technological development when fewer and fewer learners take interest in natural sciences or choose studies of natural sciences. 'Yet in recent times fewer young people seem to be interested in science and technical subjects. Why is this?' (Osborne & Dillon, 2008).

A positive approach to the studies of natural sciences is encouraged by the inquiry-based learning. H. Banchi and R. Bell (2008) define four levels of the inquiry-based learning activity performed by a learner: confirmation inquiry, structured inquiry, guided

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inquiry and open enquiry. Inquiry-based learning is affected by application of information and communication technologies.

On the other hand the phenomenon of inquiry-based learning is impacted not only by technologies but also by changing generations. According to the sociologists' classification persons born in 1977-1994 belong to generation Y whereas the ones born in 1995-2012 belong to generation Z (McCrindle & Wolfinger, 2010). Currently learners of generation Z attend comprehensive school. The relationship of generation Z with technologies has been precisely defined by A. Cross-Bystrom (2010): 'Generation Z *is* technology'. The statement presupposes a very close relationship with technologies since the generation itself is equalled to technologies. Californian psychologist L. D. Rosen (2012) raises a question about what teachers know about young people who spend entire hours with the computer in different social networks. L. D. Rosen's question can be restated as follows: what do teachers know about the motivation of learners of generation Z to study natural sciences and how is it affected by e-learning?

The problem of motivation for learning Physics was also important for generation Y leaners: 'A German student at lower and upper secondary level regard Physics as very difficult to learn, very abstract and dominated by male students' (Fisher & Horstendal, 1997, p.411).

According to sociologists the future of the science of Physics depends on learners belonging to generation Z. The significance of the science of Physics is doubtless; however, there is much concern about learners' interest in Physics. The discussed situation highlights *a scientific problem* which is formulated as a question*:* how do e-learning and inquiry-based learning impact the motivation for learning Physics of the learners of generations Y and generations Z?

The object of the research is the motivation for learning Physics of learners.

The aim of the research is to reveal the effects of e-learning and inquiry on the motivation for learning Physics of learners of generations Y and Z.

The objectives of the research are as follows:

1. How do real physical experiments influence the motivation for learning Physics of generation Y learner?
2. How does e-learning affect the motivation for learning Physics of generation Y learner?
3. What is the attitude of generation Z learner towards real and virtual physical labs and their role for motivation to learn Physics?

THEORY BACKGRAUND

Educational psychology has identified two classifications of motivation: intrinsic and extrinsic. Extrinsic motivation is motivation to perform and succeed for the sake of accomplishing a specific result or outcome. Intrinsic motivation arises from a desire to learn a topic due to its inherent interests, for self-fulfilment, enjoyment and to achieve a mastery of the subject. The topics that are relevant to students' lives foster intrinsic motivation (Brozo, 2005). Autonomy-supportive teacher behaviour can be effective in

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fostering intrinsic motivation in students (Reeve & Jang, 2006). Suitable level of task difficulty is important for intrinsic motivation (Margolis & McCabe, 2006). The autonomy in the learning process plays a positive role for the developing of intrinsic motivation (Reeve & Jang, 2006). The different level of experimental activities (confirmation inquiry, structured inquiry, guided inquiry and open enquiry) provides different level of learning activities autonomy. The small autonomy occurs in confirmation inquiry, bigger autonomy – in structured inquiry, guided inquiry and biggest autonomy – in open enquiry.

The physics labs can be real or virtual. There are various ways of defining virtual labs. It can be defined as a computer program that allows student to run simulated experiments via the web or as a stand-alone application. A virtual lab could be a set of simulations put together (Examples are applets, flash base demos, animations) (Bajpai, 2013). The scientific literature reveals many features of virtual labs: tools are less time-consuming, more flexible, clean, rapid, safe, and that they open up for types of experimentation that otherwise might not be possible for students to engage in (Dalgarno & Lee, 2010; Petersson, Andersson & Säljö, 2013).

There is a discussion about the role of real and virtual labs in education. It is argued that there is no simple answer to the dilemma which laboratory is the best for students. All types of laboratories offer certain advantages. The balanced mixture of real and virtual labs should be offered to students as both forms of activity have unique properties that are needed to promote deeper conceptual understanding (Jaakkola & Nurmi, 2008; Winn et al., 2006).

In recent years a large number of virtual labs have been produced. Research shows that modern interactive laboratory experiments increase motivation when students enter interactive laboratories from mobile phone/computer/etc (Zacharia & Olympiou, 2010; Changeiywo, Wambugu *&* Wachanga, 2011; Oidov, Tortogtokh & Purevdagva, 2012). The virtual environment is attractive if operations carried out in virtual labs by some students are observed by other students (Ince, Kirbaslar, Yolcu at all., 2014). The virtual labs are attractive because students can easily use working methods that resemble methodologies practiced by scientists such as observation, developing hypotheses explaining observations and testing these hypotheses using given datasets (Petersson, Andersson & Säljö, 2013).

Not much educational research has been performed on the motivation to learn Physics of proceeding (e.g. generation Y) and current generation (generation Z) students as well as on the role of virtual and laboratory work to enhance motivation for learning Physics. Current researches are focusing on presenting new technologies and disclosing their advantages rather than analysing the impact of these technologies on learning process and its outcomes (Furberg, 2010).

RESEARCH METHODOLOGY

In order to explore how inquiry-based and e-learning determines the motivation for learning Physics of learners of generation Y, the secondary correlative analysis of the results of national research has been conducted. National research of the achievements of tenth formers was carried out in 2004; 2006 and 2008. The research sample is reliable (Table 1) and representative (probability cluster sample). The research tools are also valid and reliable. The scope of the current article is limited to the data of 2004 and 2008. The

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data of 2004 is covering learners born in 1984-1987 with ones born in 1987 composing the major part (75.0%). According to sociological theory learners born in 1984-1987 belong to generation Y (1977-1994). Learners covered by the data of 2008 were born in 1990-1993 (Table 1). The major part of these respondents is born in 1991 (80.6%). Thus they also represent generation Y.

National research provides data on the learner attitudes towards learning Physics and their motivation to learn this subject. Extrinsic motivation is related to the assessment performed by the teacher (Question B34e) (The national student achievement test, 2008).

Table 1: Number of respondents participating in national research (2004-2008)

Year	Date of birth	Number of tenth-form respondents
2004	1984 -1987	3083
2008	1990-1993	3217

To explore intrinsic motivation the particular research questions has been selected. The main selected question was: *What is your attitude towards Physics – Do you like Physics?* (Question GF1) (The national student achievement test, 2008). Motivation was explored with regard to experiential learning and the questionnaire for learners included a number of questions related to structured-coordinated activities of an inquiry in classes of Natural Sciences: planning of inquiry-based activity, search for information in traditional and non-traditional information sources, explanation of the causes of analysed phenomena, drawing of conclusions, and knowledge application in everyday situations.

The motivation for learning Physics was explored not only under the aspect of inquiry based learning but also by the aspect of e-learning. The survey (2004 and 2008) also comprised questions about the application of information and communication technologies (ICT). The following areas of computer-aided activity were distinguished: playing games (*for playing computer games)*; e-learning (*for learning)*; e-communication (*for communication (e-mails, Skype, chats, etc.), e*-creative leisure (*for personal interests (like drawing, music, etc.)*; retrieval of information important for the teacher (*for the retrieval of personally important information);* and retrieval of information important for the learner (*for the retrieval of personally important information; for the retrieval of information outlined by the teacher).*

All the answers of the respondents regarding the issues analysed in the current article were presented within the ordinal scale. Correlation analysis was applied to identify statistical correlation between the motivation for learning Physics of tenth formers (*I like Physics)* and questions on ICT application and experimental activity in Physics.

A qualitative research was conducted in 2013 (semi-structured interview), which involved 40 tenth formers. The tenth form was selected pursuing to compare the results of qualitative research with the data of previously conducted national research of tenth formers' achievements in Lithuania (in 2004 and 2008). Therefore, learners of the same age group were selected (16-year-olds), who represented a different generation: the learners of 2013 survey belonged to generation Z (born in 1995-2012), whereas the learners of 2004 and 2008 surveys represented generation Y. The aim of the interview was to reveal the interest of generation Z learners in Physics, as well as the effect of virtual and real laboratory experiments on their motivation. The learners were surveyed after the completion of two real laboratory works that complied with the structured inquiry; and

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after completing two virtual laboratory works that also complied with the structured inquiry. The sample of the qualitative research was purposive modal instance sampling (Patton, 2002).

RESULTS OF RESEARCH

Factors determining motivation for learning Physics of generation Y learners

The data of national research (2004) has been analysed in order to disclose factors determining the motivation for learning Physics of generation Y learners. The correlation coefficients between inquiry-based activity (planning and performing labs in Physics using different physical devices); computer related activity (playing computer games, e-communication with friends, and e-learning); motivation for learning Physics *(I like Physics)* and learning outcomes in Physics (semester grade for Physics) have been calculated.

Statistically significant but weak correlations have been identified between the internal learners' motivation for learning Physics (*I like Physics*) and inquiry-based activities of planning and performing physics labs (r = 0,238; p** = 0,01) as well as between motivation and using different physical devices (r = 0,205; p** = 0,01). Also a statistically significant but weak correlation has been estimated between the learners' positive motivation towards the subject of Physics (*I like Physics*) and the semester assessment (mark) for the subject (r = 0,212; p** = 0,01).

Analysis of 2008 data indicated statistically significant correlation between learners' replies about internal motivation (*I like Physics*) and performing physical labs (r = 0,256; p** = 0,01) as well as between motivation and use of different physical devices (r = 0,249; p** = 0,01). However a statistically insignificant correlations was established between the learners' replies regarding the motivation for learning Physics (*I like Physics*) and observation of experiments conducted by the teacher (r = 0,192; p** = 0,01). This implies that experiments performed by the teacher do not carry statistical significance for the motivation for learning physics of generation Y learners. A conclusion could be drawn that learners are mainly motivated by their own experimental activity.

It is noteworthy that using the research data of 2008, statistically insignificant correlations was established between motivation for learning Physics (*I like Physics*) and semester assessment for Physics (Physics mark). This leads to an idea that the motivation for learning Physics of generation Y learners does not statistically significantly correlate with the final learning outcomes in Physics. Therefore, learners with poorer learning outcomes in Physics can demonstrate positive motivation to learn the subject. A weak but statistically significant correlation (r = 0,212; p** = 0,01) was established while analysing the results of 2004 survey. Summarizing the results of both surveys (2004 and 2008), a conclusion could be drawn that the statistical correlation between learning motivation and assessment in Physics was decreasing.

A statistically significant correlation between a learner's motivation for learning Physics *(I like Physics*) and his/her afterschool activity related to the computer was established twice: retrieval of personally important information (r = 0,202; p** = 0,01); and retrieval of information outlined by the teacher (r = 0,224; p** = 0,01) (Table 2).

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The coefficient of the retrieval of information outlined by the teacher and motivation to study Physics (r = 0,224; p** = 0,01) was marginally stronger than the coefficient of retrieval of personally important information and motivation to study Physics (r = 0,202; p** = 0,01). No statistically significant coefficients were established between other computer related activities (playing games, e-learning, e-communication and e-creative leisure) and learning motivation (Table 2). Summing up the obtained data, it could be concluded that information retrieval promoted the motivation for learning Physics of generation Y learners. Learners searched for information in pursuance to answer encountered questions and seeking for new knowledge. This is the very essence of inquiry-based learning. Inquiry implies that the interaction with the environment is guided by a question; it is when we are in an indeterminate situation that we engage in inquiry in order to transform the problem encountered into something that we can grasp and act on (Petersson, Andersson & Säljö, 2013).

Table 2: Spearman's correlation coefficients of the motivation for learning Physics of learners and computer related activities (correlations have been calculated using the data base of the national research of 2008)

	Computer related activities						A motivation and Outcomes	
	1. Games	2. Learning	3. Communication	4. Retrieval of personally important information	5. Retrieval of information outlined by the teacher	6. Creative leisure	7. Physics mark	8. Motivation
1.	1,000	-,142**	-,027	-,097**	-,125**	,105**	-,104**	-,124**
2.		1,000	,126**	,388**	,512**	,161**	,198**	,196**
3.			1,000	,412**	,246**	,272**	,041	,074
4.				1,000	,521**	,297**	,104**	,202**
5.					1,000	,193**	,165**	,224**
6.						1,000	,026	,106
7.							1,000	,182**
8.								1,000

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

No statistically significant correlations have been determined between learners' semester assessment for Physics and different computer related activities (see Table 2). Hence, playing computer games, e-communication and aesthetic-artistic leisure does not statistically significantly correlate with the semester assessment for Physics. There was a case of establishing a higher correlation coefficient between computer-assisted learning and semester assessment for Physics (r = 0,198; p** = 0,01); however, the correlation was not statistically significant.

Statistically significant correlations were determined between different computer related activities of learners (Table 2). Activities related to information retrieval were marked by high correlation coefficients in the group of significant correlations. Retrieval of personally important information significantly correlated with e-learning (r = 0,388; p** =

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0,01), and e-communication (r = 0,412; p** = 0,01). Retrieval of information outlined by the teacher also established statistically significant correlations with e-learning (r = 0,512; p** = 0,01), e-communication (r = 0,246; p** = 0,01) and retrieval of personally important information (r = 0,521; p** = 0,01).

Factors determining motivation for learning Physics of generation Z learners: qualitative research results

The results of the qualitative research demonstrated that more than a half (59%) of the informants of generation Z (2013) liked Physics. Similarly, in the national survey of learner achievements (2004), 52% of the respondents of generation Y maintained liking Physics. Summarizing the obtained results, it is possible to state that about a half of research participants representing different generations (Y and Z) took interest in Physics. There was a nine-year gap between the two surveys. Consequently, the motivation of the target age group to study Physics experienced no considerable changes in a decade.

The attitude of informants towards real (performance of physics labs with real devices) and virtual (computer-aided) labs was explored. It was determined that 42% of informants believed that laboratory work in Physics was better accomplished on a computer. It is noteworthy that this opinion was characteristic of the learners disliking Physics. Summarizing the answers provided by the informants about the advantages of performing physics labs with a computer, the following categories could be distinguished: simple and clear technique of performing (*It is easier to perform physics labs on the computer, you don't have to take care of the devices', 'It is much easier to perform physics labs on the computer, since all the information is provided in detail', 'There is less mess'*), fast accomplishment of the work (*'Performance of physics labs on the computer is easier and less time-consuming, you don't have to take care of the devices', 'It is easier, simpler and faster'*), and individual speed of performance physics labs (*'I prefer to perform physics labs using a computer because there is no need to hurry rather than doing the work with others in the classroom'*).

More than a half of the informants of the qualitative survey (58,0%) stated that they liked Physics. It is noteworthy though that semester assessments for Physics were moderate ones. The same regularity can be observed as when accomplishing the secondary data analysis of the 2008 survey. A statistically insignificant correlation was established between the learners' interest in Physics and their semester assessments (r = 0,182; p** = 0,01).

It was determined that learners who liked Physics preferred performing real labs in Physics. Having analysed the data of interview records the most frequent statements of informants have been selected which are related to performing real physics labs. In this regard, the following categories were distinguished: hands-on dimension (*'It is more interesting for me to touch, calculate and measure everything myself', 'Real laboratory work is much better. While accomplishing it, you can touch, fiddle and try yourself. It is much more interesting')*, sense of reality (*Doing something yourself is more interesting, you can examine everything'*), and application of teaching materials in practice (*'working with conventional devices, you can perform laboratory work yourself, learn the new information and apply the knowledge of Physics in an easier way'*).

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The analysis of informants' replies demonstrates that by indicating the advantages of real laboratory work, the learners most often signify the hands-on dimension: *I prefer doing it with my own hands, measure, fiddle* and *touch*. It seems that the informants of generation Z are bored with the traditional hand motoric employed in managing the mouse or managing a programme by touching. The informants of generation Z preferred the activity, which would ensure more diverse hand motoric: touching, fiddling and doing with hands. *Importance of 'hands-on' dimension* lies in the fact that 'hands-on' activities are central in an inquiry process and can be proposed virtually (Klahr, Triona & Williams, 2007; Zacharia, Olympiou & Papaevripidou, 2008). The informants' ideas showed that the accomplishment of laboratory work using real devices created the sense of reality (*When you conduct the laboratory work yourself, you can get involved into the process of its accomplishment and materials, 'because I prefer seeing what happens and how it happens myself)*, and ensured the joy of discovery *(performing physics labs using conventional devices is much more interesting: you can feel like a professor).* According to the informants, laboratory work conducted in the real settings developed an ability to apply theoretical knowledge in practice.

DISCUSSION

The conducted comparative analysis of the motivation for learning physics of generations Y and Z to in terms of the performance of physics labs in the real and virtual environment has confirmed the assumption of Z. Nedic, J. Machotka & A. Nafalski, 2003 that there is no simple answer to the dilemma which laboratory is the best for students.

The correlation analysis of the national research data on learning achievement of generation Y learners did not reveal a significant effect of using computers on the assessment of the subject of Physics or learning motivation. Surveys accomplished by other researchers (Zacharia & Olympiou, 2010; Changeiywo, Wambugu & Wachanga, 2011) demonstrated that the application of modern virtual environments enhanced motivation for learning Physics and raised interest in the subject. Thus, it is assumed that two approaches could be distinguished while analysing the role of ICT to study Physics: generalized statistical approach (in our case) and a specific approach (specific experiments of using technologies in a specified place and time). However, the analysis of the employment of virtual learning platforms in specific conditions (Ince, Kirbaslar, and Yolcu at all., 2014) merely reveals the effect of specific technologies on the learning process and motivation to study Physics.

Our qualitative research disclosed that the interest of generation Z learners in Physics was promoted by the laboratory work conducted in the real environment. The learners expressed their interest in the 'hands-on' activity, where they could fiddle and touch the devices and materials. This conclusion approves of the conclusions of other researchers (Swarat, Ortony & Revelle, 2012) that activity that were 'hands-on' in nature and allowed for engagement with technology elicited higher interest. We need to place more emphasis on the role of activity in constructing interesting learning environments. While conducting virtual laboratory experiments, learners are obliged to accomplish only the pre-programmed assignments. The learner does play according to someone else's rules and design. This is profoundly different from a learner having an original idea to make or do something.

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Both the quantitative and qualitative research confirmed that there was no correlation between motivation for learning Physics and learning outcomes in Physics. Not only had the learners that achieved good results in learning Physics liked the subject of Physics. The gap between learning motivation and learning outcomes was also noticed by other researchers, who analysed the use of interactive boards in the process of learning (Higgins, Wall & Smith, 2005; Higgins, 2010). The aforesaid means encouraged learners' interest; however, no positive changes in learners' progress were observed.

CONCLUSIONS

Motivation for learning Physics, expressed by comprehensive school learners representing generation Y, is conditioned by inquiry-based learning and experimental activity. Experiments conducted by the teacher have no statistically significant effect on the motivation for learning Physics. Learners are motivated mainly by their own performing experimental activity.

Motivation for learning Physics of generation Y learners bears no statistically significant correlation with the use of the computer in afterschool activities: e-communication, computer games, e-learning and e-creative leisure. However, the motivation for learning Physics of generation Y learner is promoted by information retrieval from the virtual platform. Information retrieval aims at answering the encountered questions and solves subject-specific problems. This is an important stage of inquiry-based learning, which enhances learners' motivation to study Physics.

The learners of generation Z, who like Physics, prefer conducting real rather than virtual laboratory work in Physics. They state that performing laboratory work in reality creates conditions for 'lifelike' exploration by touching and fiddling the devices and materials (hands-on dimension), as well as permits experiencing the sense of reality and applying theory in practice.

The learners of generation Z, who do not like Physics, prefer performing virtual laboratory work. They highlight the uncomplicated and clear technique, fast accomplishment as well as individual speed of conducting virtual laboratory work.

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Innovative Pedagogy: Developing of Pupils' Competencies Through the Use of Modern Technologies in the Classroom

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Abstract

The fast development of modern technologies has strongly affected all areas of people's lives. The educational process is no exception. Technological advances mean that the role of the teacher in the classroom is dramatically changing. The amount of information is uncontrollably increasing and the knowledge, which teachers used to impart to pupils and students, has become available every step of the way. These can now search for information and knowledge online and with the help of different applications anytime, anywhere. They need to be prepared to be able to critically assess information, to use it creatively, to be able to solve problems, while at the same time successfully communicate and use modern technologies. The Innovative Pedagogy in Light of 21st Century Competencies project develops modern approaches in education, which will prepare students for life.

This article presents a qualitative study, which tried to assess the applicability of information and communication technologies (ICT) for the development of pupils' 21st century competencies (OECD, 2013) with regard to individual subject areas. The study has shown that the development of 21st century competencies by using ICT activities is more efficient in social sciences and the humanities, such as Social Sciences and Slovenian language. According to the collected statements, natural sciences enable more experimental work, while in Mathematics, the prevailing 21st century competency was the development of a subject-specific competency.

In light of such diversity of proposals, we are aware that this is specific to individual fields, which would be sensible to confirm with a more extensive study.

Keywords

Innovative pedagogy. Competencies of the 21st century. Pre-service teachers. Information and communication technologies.

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INTRODUCTION

After completely taking over our way of life in the last twenty years, information and communication technologies (ICT) have divided the public as regards their use in education:

- the expert public (educators and teachers), who regard ICT in education from the viewpoint of quality and sustainable knowledge of students,
- the publishing lobby, which sees e-materials as a competitive threat,
- the lobby of software and hardware manufacturers, which sees profit in the introduction of tablets in schools, etc.

The Slovenian educational arena has been facing a silent but radical revolution in the last ten years. The strong lobby of software and hardware manufacturers has been subtly exerting pressure on corresponding stakeholders, who decide on changes in schools.

An independent observer gets the feeling that the strongest will win! The consequences for the final decision will however be borne by generations of our descendants. The below text is thus a presentation of introducing ICT through the eyes of the educator, who does not feel the direct financial consequences but instead tries to find and propose the best possible solutions through research and development.

Including modern technologies in the teaching process

Teachers have "outgrown" the initial enthusiasm over using computers in teaching, which often neglected the educational aspect of the comprehensive educational system. They began exploring possibilities of how to include technologies in their classroom while simultaneously maintain the comprehensive educational concept. Buabeng-Andoh (2012) reviewed personal, institutional and technological factors that encourage teachers' use of computer technology in teaching and learning processes.

Earle (2002) linked ICT integration with the concept of wholeness, when all elements of the system are connected together to become a whole. For instance, the two important elements of teaching and learning which are content and pedagogy must be joined when technology is used in lesson.

Eventually, they found that the successful inclusion of technology in lessons depends on how an individual teacher overcomes the thus related barriers. Walker and Shepard (2011) conducted an analysis of why some teachers were able to successfully integrate technology in their classrooms by exploring the barriers they overcome. These barriers were found in teacher attitudes and beliefs about technology in an era of high-stakes testing, the availability of technology support, strategies for gaining technological skills and know-how, teacher self-efficacy in using technology, and established pedagogy and classroom practices. Successful initiation and implementation of educational technology in school's program depends strongly on the teachers' support and attitudes (Hew and Brush, 2007; Keengwe and Onchwari, 2008). This allows us to conclude that a decline in the teacher's motivation to use ICT also means a decline in the pupils.

A significant change in the thought concept and perception of ICT in the education is being observed; as opposed to the initial frequent use of ICT at any cost, this phenomenon has now settled down. Educators have started including ICT in teaching in a more planned

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manner and on the basis of scientific research and findings. Šverc et al. (2013) point out that efficient use of modern technologies in teaching the net generation requires particular emphasis on changing the teachers' work and their role.

Innovative Pedagogy 1:1 in Light of 21st Century Competencies

Technological advances mean that the role of the teacher in the classroom is dramatically changing. The amount of information is uncontrollably increasing and the knowledge, which teachers used to impart to pupils and students, has become available every step of the way. These can now search for information and knowledge online and with the help of different applications anytime, anywhere. So, what is expected from a 21st century teacher?

The message for teachers in the last OECD publication (OECD, 2013) refers particularly to the preparation of suitable learning environments which enable efficient learning. An efficient learning environment is defined as one:

- that places learning at its heart, encourages commitment to learning and enables students to see themselves as students;
- where learning is social and often collaborative;
- that is as harmonised as possible with student motivation and the importance of emotions;
- that is highly sensitive to individual differences, including prior knowledge;
- that is demanding for every student, but does not overburden them;
- that uses evaluation, coordinated with objectives, with a strong emphasis on formative feedback;
- that promotes horizontal interaction between curricular and extra-curricular activities and subjects. (OECD, 2013)

The characteristics of an efficient learning environment mentioned above are pursued as the main objective in projects that have consecutively appeared recently, and which uniformly use the term *"pedagogy 1-to-1"* or *"1:1 environments"*. Beside the learning environment, the emphasis is placed on establishing the right balance between the teaching strategies used, and special attention is given to the development of 21st century competencies. 21st century competencies, as determined by OECD, are presented in Table 1:

Table 1: 21st century competencies (OECD, 2013).

Analytic skills	**Interpersonal skills**	**Ability to execute**	**Information processing**	**Capacity for change**
Critical thinking	Communication	Initiative and self-direction	Information literacy	Creativity/innovation
Problem solving	Collaboration	Productivity	Media literacy	Adaptive learning/learning to learn

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Decision making	Leadership and responsibilities		Digital citizenship	Flexibility
Research and inquiry			ICT operations and concepts	

"Innovative Pedagogy 1:1 in Light of 21st Century Competencies" is a project, which is currently taking place in Slovenia, and is financially supported by the Ministry of Education, Science and Sport of the RS and the European Social Fund. The project (Flogie et al., 2013) follows the goal of OECD's message to the teachers and is based on increasing the individualisation of teaching and the personalisation of learning.

The goal of the "Innovative Pedagogy 1:1 in Light of 21st Century Competencies" project is therefore to set the foundation for the introduction of innovative pedagogy in the Slovenian educational arena. In order to achieve this objective, the following phases are planned: development, implementation (testing in pilot classes) and evaluation. Due to their extensiveness, these phases will take place within all expert groups along the entire educational vertical, and will include 13 consortium partners.

Those of us, who are part of the project in the development phase, have already partially included the concept of innovative pedagogy in the process of teacher education. It is important for pre-service teachers to gain a thorough insight into the competencies that OECD defines as 21st century competencies and to learn how to facilitate their development in pupils.

The below text presents a qualitative study into how pre-service teachers of elementary education see the applicability of ICT for the development of 21st century competencies with regard to individual subject areas.

METHODS

The study included 70 fifth-year students of the Elementary Education study programme at the Faculty of Education of the University of Maribor. These are students of the last year, who will complete their studies in six months. Their prior knowledge and experiences were essential for the implementation of the study:

- during their studies, students have gained a thorough insights into course syllabi and acquired quite a lot of practical experiences with pupils;
- they learned about different types of modern media, which can be used in education, in the Interactive Media and Electronic Technologies in Education course;
- they learned about OECD's recommendations for teachers.

The students were divided into groups of 4 to 5 and given the task to choose a study activity with the use of ICT for a subject matter of their choice from the predetermined course syllabus. They had to choose the study activity so that it systematically facilitates the development of the chosen competency from the list of 21st century competencies. The study activity could determine the development of no more than two competencies.

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The groups prepared their proposals and presented them to other students before a semi-structured interview was conducted with them.

Data processing

Qualitative data processing according to Roblek (2009) was used as shown by Figure 1.

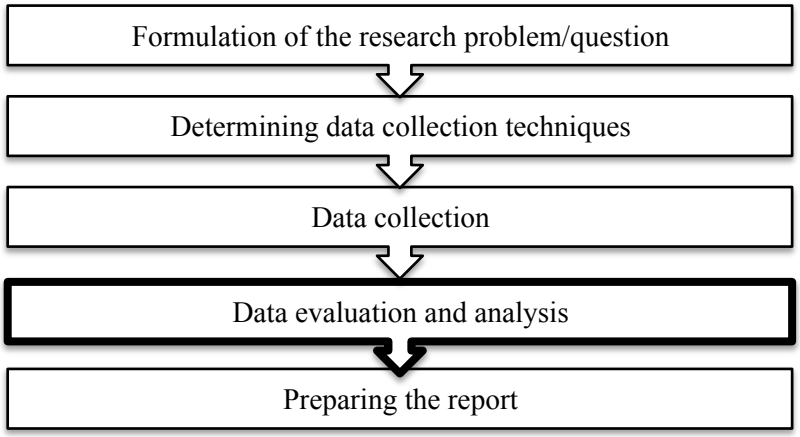


Figure 1: The course of the qualitative study

The study looked into the research problem of how pre-service teachers (who will be teaching 6- to 10-year-old pupils) see the applicability of ICT for the development of pupils' 21st century competencies with regard to individual subject areas.

Data were collected in the form of presentations of proposals and a semi-structured interview. A systematic review was made on a sample of 16 proposals of using ICT activities in the classroom in order to develop pupils' competencies. This was followed by an evaluation and analysis of the chosen activities for the development of competencies with regard to individual subject areas.

RESULTS

Analysing proposed ICT activities, it was established that students planned the development of the following competencies: digital literacy prevails (10 proposals), followed by problem solving (2 proposals) and communication (2 proposals). The groups also provided one proposal for the development of critical thinking, creativity and collaboration respectively. Table 2 shows summarised proposals of the groups.

Table 2: Overview of proposed study activities

Group	Syllabus for the subject area – grade	Subject matter	Pupils' activity	Competency
1	Mathematics 1st grade	Arithmetic operations	Doing interactive exercises	Digital literacy
2	Mathematics 2nd grade	Getting to know addition	Doing interactive exercises	Digital literacy

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3	Mathematics 3rd grade	Addition, subtraction	Interactive game	Digital literacy
4	Mathematics 4th grade	Forms and shapes	Solving a quiz	Communication
5	Mathematics 5th grade	Parts of a unit	Solving a quiz	Digital literacy
6	Environmental Sciences 1st grade	What do plants need to grow	Project work	Digital literacy
7	Environmental Sciences 2nd grade	Meaning of traffic signs	Problem solving of a rebus	Problem solving
8	Environmental Sciences 2nd grade	Environmental pollution, waste management	Solving a quiz	Communication
9	Environmental Sciences 3rd grade	The human life cycle	Making a video	Digital literacy
10	Natural Sciences and Technology 4th grade	Moving and transporting	Interactive didactic game in PPP	Problem solving
11	Natural Sciences and Technology 5th grade	Environmental pollution	Solving a quiz	Digital literacy
12	Social Science 4th grade	Children's rights	Doing an exercise/Hot Potatoes -JMatch	Digital literacy
13	Social Science 5th grade	The Romans in Slovenia	Searching for resources online	Critical thinking
14	Slovenian language 3rd grade	Understanding literary genres	Making a picture book using the computer	Creativity Digital literacy
15	Slovenian language 4th grade	Jobs	Interactive game	Collaboration
16	Slovenian language 5th grade	Non-literary text - invitation	Making an invitation using the computer	Digital literacy

The elementary level subjects were combined into the following three subject areas:

- Mathematics,
- Natural Sciences (Environmental Sciences, Natural Sciences and Technology) and
- Social Sciences and the Humanities (Social Sciences, Slovenian language).

The conducted analysis monitored the types of competencies that the groups of students developed in the pupils with regard to the subject areas. Table 3 shows the development of competencies according to subject areas.

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Table 3: Overview of competencies according to subject areas

Subject area	Type of competency	Number of proposals
Mathematics	Digital literacy	4
	Communication	1
Natural Sciences	Digital literacy	3
	Problem solving	2
	Communication	1
Social Sciences and the Humanities	Digital literacy	3
	Critical thinking	1
	Creativity	1
	Collaboration	1

DISCUSSION

In mathematics, the groups of students' proposed ICT activities that predominantly (4 out of 5 proposals) facilitate the development of digital competencies and one proposed activity that facilitates the development of the competency of communication. Based on the submitted proposals and conducted interviews, a detailed analysis was carried out with regard to the individual subject area. One of the groups, who dealt with the field of mathematics, said:

> *"Our activity foresees the learning of addition by playing an interactive computer game. Through the activity, the pupils practise the digital competency, however the emphasis lies on the development of the mathematical competency. We established that it is really difficult to find an activity in mathematics, which would develop any other 21st century competency, e.g. critical thinking."*

Similar statements were provided also by other groups, who dealt with the subject area of mathematics.

If pupils are offered series of websites or ICT tools (e.g. CD ROMs, multimedia, etc) then the teacher is not integrating ICT into teaching since he/she is not tackling the pedagogical issues (Earle, 2002). The use of ICT aids for implementing different study activities has to be distinguished from the scheduled development of the digital competency, for which pupils have to be actively engaged in the ICT activity. A detailed analysis of the proposed activities for the subject area of mathematics has shown that the proposals, which were supposed to develop the digital competency, actually only used ICT as an aid. They did however facilitate the development of the subject-specific competency.

Interesting findings were provided through interviews with those groups of students, who dealt with the subject area of natural sciences. One of these groups said:

> *"We had to try really hard to find an ICT activity, which enables the development of pupils' problem solving competency. The activity, which we proposed and where pupils have to solve a rebus, does facilitate the development of the problem solving competency, however searching for proposals, we established that employing the 'learning-by-doing' method through an experiment would allow pupils to achieve much higher objectives. Subjects from natural sciences*

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> *namely allow a broad range of experiments, which we believe to be the best possible way of teaching children."*

The students' finding that subjects from natural sciences allow a broad range of experiments, which are the best possible way of teaching children, can be corroborated by the findings of Šorgo et al.. (2008), whose study confirmed that pupils found the hand-on experiments interesting and helpful for understanding the biological processes. Furthermore, the results from testing indicated that the pupils had a deeper understanding of the processes.

The groups of students, who dealt with the subject area of social sciences and the humanities, said in the interviews that they see digital pedagogies to be a great opportunity for the development of 21st century competencies, such as critical thinking or creativity but also the digital competency. One of the groups said in the interview:

> *"In light of the specifics of social sciences, which do not enable interesting experiments in the way that natural sciences do, we saw the use of ICT activities in lessons to be a great advantage. The activity, which we proposed, requires the students to go online and search for different sources of information on the Romans in Slovenia and try to critically assess them. In addition to the pupils achieving the content-based study objectives through the proposed activity, they also develop a critical attitude towards online sources and thus the competency of critical thinking. Really an excellent opportunity!"*

Similar enthusiasm was also expressed by all other groups that dealt with the subject area of social sciences and the humanities.

Even though the students were instructed to try and facilitate different competencies in pupils, it has been established that the planning of competencies differs according to individual subject areas. It has especially been established in the subject area of mathematics and environmental sciences that pre-service teachers plan the development of "basic subject-specific competencies" and in the field of social sciences and the humanities also of more complex competencies.

In light of such diversity of proposals, we are aware that this is specific to individual fields, which would be sensible to confirm with a more extensive study.

CONCLUSION

Digital literacy is a competency that is unavoidable in the 21st century, however due to our way of life and technological embeddedness in everyday activities it is the least "problematic" one for pupils. Lin (2007) even uses the term "digital native" for the young generations. Teachers often complain that pupils are more digitally literate than themselves. The European Commission's "Use of ICT in Education: a survey of schools in Europe" corroborates such dilemmas, as it has shown that almost one half of students assess teachers' digital confidence as low (Wastiau et al., 2013).

A digital pedagogy, if properly realised, promotes higher order thinking skills and students move from remembering content to gaining a deep understanding of concepts

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(Kent and Holdway, 2009). It develops critical analysis, metacognition and reflection, often through creation, editing and publishing online (Luckin et al, 2009). Further, digital pedagogies can include Web 2.0 technology for social networking, with the use of blogs, wikis, i-phones and i-pads for learning. In this way, digital pedagogies help develop communication competencies. (Kent and Holdway, 2009; Milton, 2013). We have not found a study that would compare the efficiency of digital pedagogy in different subject areas.

The present qualitative study has provided an insight into how pre-service teachers see the possibility of developing pupils' competencies. The study has shown the main differences between different subject areas and the opportunities that these offer in the field of digital pedagogy. In order to be able to generalise the results to the entire population, a more extensive study should be conducted.

To ensure the proper application of digital pedagogy, pre-service teachers need to have, or develop a high level of digital literacy themselves whilst simultaneously learning how to use a range of technologies within digital pedagogies and for which subjects and content digital pedagogy works best.

The key findings were that pre-service teachers need more practical workshops with hands on experience with new technologies. Even so, pre-service teachers can develop digital pedagogies to teach by combining theory and practice of using new technologies in their practicum teaching. However, strong relationships need to be fostered between universities and schools so that both work together so that learning about digital pedagogies can be developed in a practical application.

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REPUBLIKA SLOVENIJA
MINISTRSTVO ZA IZOBRAŽEVANJE, ZNANOST IN ŠPORT



Naložba v vašo prihodnost
OPERACIJO DELNO FINANCIRA EVROPSKA UNIJA
Evropski socialni sklad

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Twenty Years of Applied Informatics Study Programme: Graduates´ Evaluation

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Abstract

The paper provides analysis of research survey dealing with graduates´position on the labour market. The analysis focuses on Applied Informatics graduates studying at the Faculty of Informatics and Management, University of Hradec Králové, Czech Republic since it was established 20 years ago. Data were collected by the questionnaire method from graduates who registered on the faculty web site; thus they provided interest in their "Alma Mater" current activities and willingness to contribute to its today´s activities. The survey monitors situation on the labour market from the graduates´point of view discussing relating topics: unemployment rate of university graduates, their career history, work experience, economic matters (salary, type and length of work contract) and relating fields. All collected data relate to the event called HIT Career which is annually held at FIM UHK and provides university students and graduates with the opportunity to monitor the current situation on the labour market, learn what positions are required, offered and vacant on the labour market and relating information.

Keywords

University graduates. Unemployment. Job opportunities. Survey.

INTRODUCTION

University–industry collaboration and innovation are crucial topics for university students and graduates. To succeed on the labour market is an objective each student is targeting to. The co-operation between companies and higher education institutions is highly required, supportive and helpful for both parties. (Cavanagh, 2013)

University of Hradec Králové and particularly FIM within this university ranks among members of an association of companies working in the field of information technology called Hradec IT Cluster (HIT Cluster). The HIT cluster comprises legal entities engaged in the field of information technology and other related services, universities and high schools and non-governmental organizations that deal with information technologies. The aim of the association is especially research, development, innovation, collaboration with universities, colleges and research institutions, industry promotion and IT consultancy, training and employment development. There are nearly twenty companies involved into HIT Cluster that do the business in the field of information technologies, for instance the

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Technological Centre of Hradec Kralove, GIST, FG Forrest, GMC Software Technology, or ALTEC, etc..

The FIM regularly invites company's experts to read professional lectures. Within study programs innovations, the companies participate in such activities as defining the graduate´s profile, content of study programs, they comment the learning content of single subjects etc. In addition, companies offer FIM students topics for their final bachelor and diploma theses, dissertations and projects; and last but not least exchange study programmes in those and other companies are provided to students.

Nevertheless, for middle-sized companies and universities the partnership is a relatively new phenomenon, not frequently researched yet. Numerous authors mention that innovation of industry-university co-operation has played an extremely important role in the process of economic development. (Feng, Ding, & Sun, 2010), (Hui Xu, 2010), (Lundberg & Andresen, 2012), (Serdal, Scholten, Cengiz Akdeniz, Fortuin & Omta, 2013), (Temel & Glassman, 2013) Currently in time of economic globalization, informization and networking, traditional modes of cooperation among industries, universities and research institutes no longer adapt to requirements of development under the new situation.

Regional university-industry cooperation has been focused on innovations in the enterprise and region. The social network analysis method was applied to depict how universities, scientific research institutes and enterprises co-work to innovate.

However, co-operation between the companies, public sector and universities could be obstructed by different approaches and action purposes. (Kozlinska, 2012) Coupled with a now widely accepted educational view of entrepreneurship as a practical domain, the task becomes even more relevant and challenging to accomplish. (Tartari & Breschi, 2012), (Novak, Krupka & Petr, 2012) Despite the recognized importance of co-operation between universities and businesses in our society, the present university-industry environment in Europe is underdeveloped and highly fragmented, 40 % of academics still are not engaged in this co-operation at all.

UNIVERSITY GRADUATES´ UNEMPLOYMENT RATE

Within the last 20 years the amount of university graduates was steadily increasing in the Czech Republic, mainly those without any work experience.

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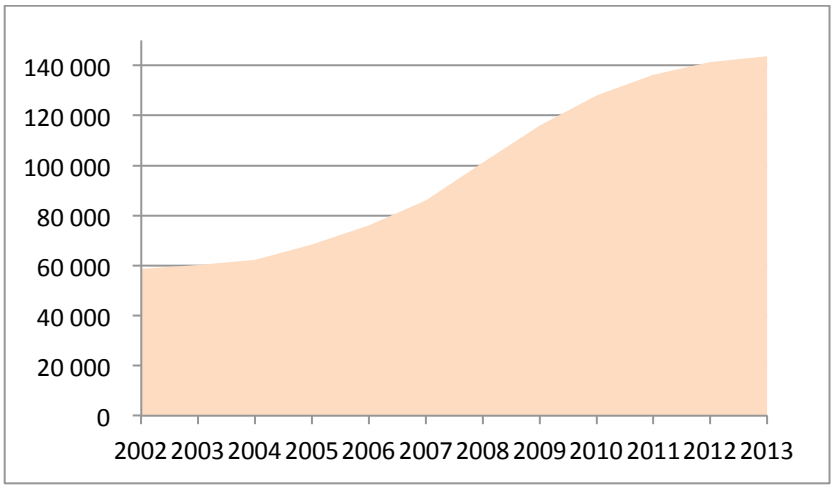


Figure. 1. Amount of university graduates in the Czech Republic

In the stated period of 2002-2013 totally 1.177,796 students graduated from public universities. (See Figure 1) Despite the unemployment rate of university graduates is lower than in other social groups, currently a relatively large amount of young university graduates cannot find a job after leaving school. Compared to the world situation (Sinha, 2013), in the past 12 years about 2,600 latest university graduates have been annually unemployed. (The term of university graduate unemployed refers to a job applicant registered at the Labour Office, who successfully completed his/her studies at a university no later than two years ago. The unemployment rate of university graduates is calculated as a proportion between the number of the unemployed university graduates and the total number of university graduates.). Specifically, from 2002 to 2013 total amount of the unemployed university graduates reached 31,255. (See Figure 2) According to different types of universities, the unemployment rate of university graduates fluctuated between 1.0 % - 17.6 %; 4.5 % on average. (Anon, 2014)

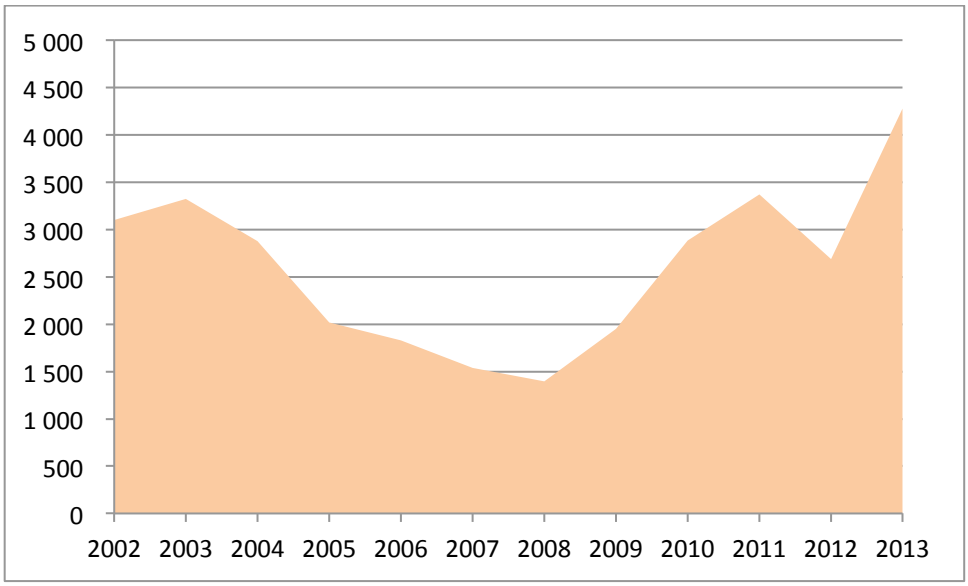


Figure. 2. Amount of unemployed university graduates in the Czech Republic

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Eight faculties within the Czech public universities are Informatics-oriented providing IT study programmes. Two study programmes can be studied at the Faculty of Informatics and Management, University of Hradec Králové (FIM UHK): Applied Informatics, System Engineering and Informatics, in the bachelor, master and doctoral study programmes.

Totally, 64.893 students graduated from all IT faculties in the Czech Republic in last twelve years and 1,604 of the graduates were unemployed for some period. (See Figure 3) An average rate of unemployment of the IT faculties' graduates fluctuates between 2.1 % - 13.1 %. (Anon, 2014)

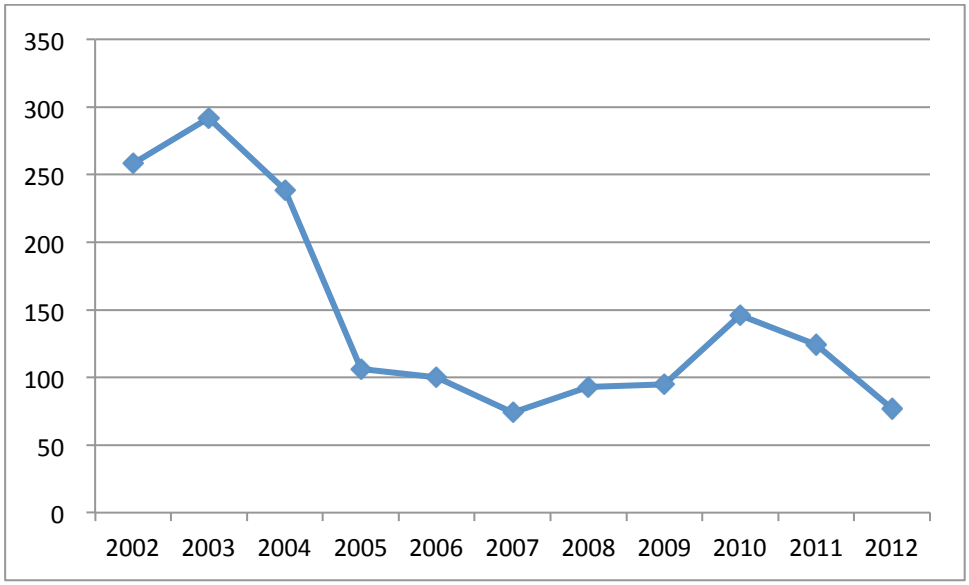


Figure 3. Amount of unemployed graduates of IT faculties

Totally, 203 of students graduated from FIM UHK in last twelve years were unemployed for some period. The unemployment rate of FIM graduates fluctuated between 2.1 % - 8.4 %., i.e. 4.8 % on average. (See Figure 4) Despite these values are lower than national average, the graduates´ unemployment is considered a serious problem by the FIM UHK.

From this reason, faculty attempts to innovate study programmes and also co-work with graduates and the companies located in region since these companies are potential employers for their graduates.

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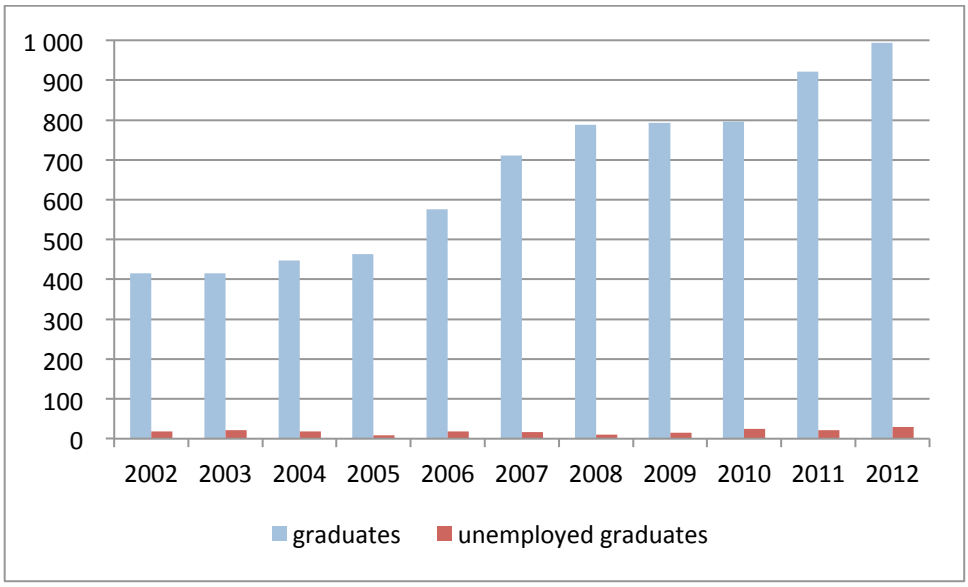


Figure 4. Graduates and unemployed graduates of FIM UHK

APPLIED INFORMATICS GRADUATES

At the beginning of 2013 a questionnaire survey was applied to monitor the professional fulfilment of FIM graduates. The questionnaires were distributes in February 2013 by e-mail to 800 graduates who had registered on the Graduates´ Club on the FIM UHK web page, i.e. they provided the contact address and agreed the e-journal The Graduate to be sent them twice a year.

The data were collected by the questionnaire in GoogleDoc by the end of April 2013. Totally, 282 questionnaires were processed. The FIM was established in 1993, so more than 5,000 students have graduated. The return rate of the questionnaire was 35 %, so it can be stated 6 % of the total amount of graduates participated in the survey (56 % male and 43 % female respondents, 3 of them did not answer this item). Nearly half of respondents (43 %) graduated from the Economics and Management bachelor study programme, two fifths of them (38 %) graduated from the System Engineering and Informatics bachelor and follow-up master study and about one fifth of respondents (18 %) graduated from the Applied Informatics bachelor and follow-up master study programmes.

Below, partial results provided by Applied Informatics graduates are presented.

Totally 52 respondents graduated from the Applied Informatics study programme (male 92 %, female 8 %, 50 % of respondents studied in the present form of study, 50 % in the combined form, 60 % of respondents graduated from bachelor degree, 38 % from master degree and one respondent from doctoral degree).

Respondents studied at FIM UHK since 1994 to 2012, more frequently in 2004 – 2008 period. (See Figure 5)

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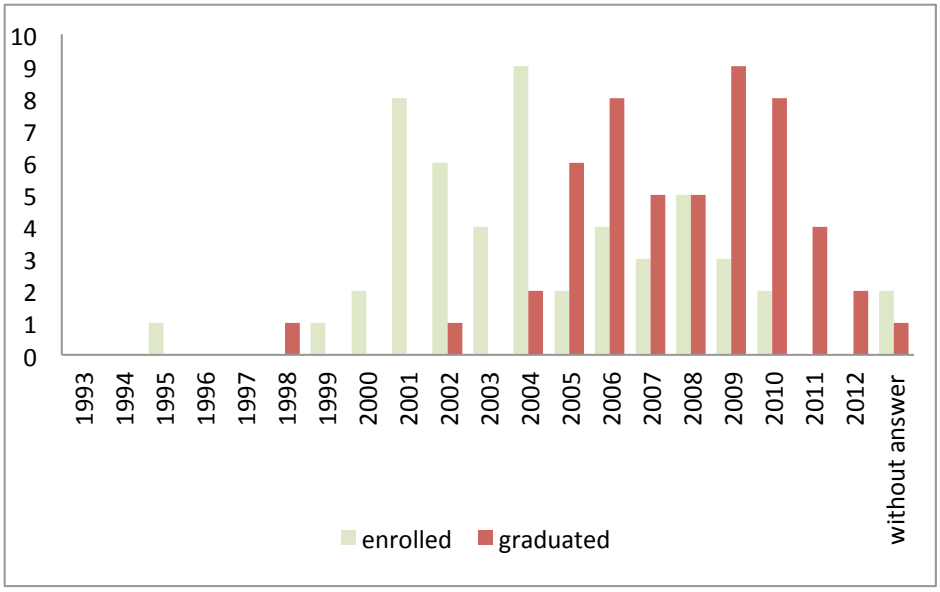


Figure 5. Graduates´period of study

Besides others, graduates provided information about their situation in last final two years before graduation. It was detected 40 % of them were full-time students (i.e. university study was their main activity) and 60 % of these respondents had full-time jobs and studied. This result exceeded the amount of part-time students in the combined form of study (50 %).

Work experience relating to the studied programme before enrolment was detected with 52 % of respondents, during the study the amount increased up to 73 %.

Totally 98 % of Applied Informatics graduates got jobs after graduation (the others did not provide answers), 69 % of respondents continued with the same job they had been doing during their studies. Half of the Applied Informatics graduates started search for job before graduation (48 %), 21 % of them very close to the graduation and only 10 % after graduation; 19 % of graduates got their first job without any search – they were offered the job by another person. (See Figure 6)

The job-search period after graduation was 1 – 3 months (0.54 month on average). Before graduation the period was substantially longer – average period was 2.12 months (median 1), the period was from 0 (no search) up to 24 months. The most frequently detected way of getting job was via the Internet (27 %); graduates themselves contacted the employer in 23 %; 15 % of respondents were addressed by the employer and contacts of family members or friends help them (12 %).

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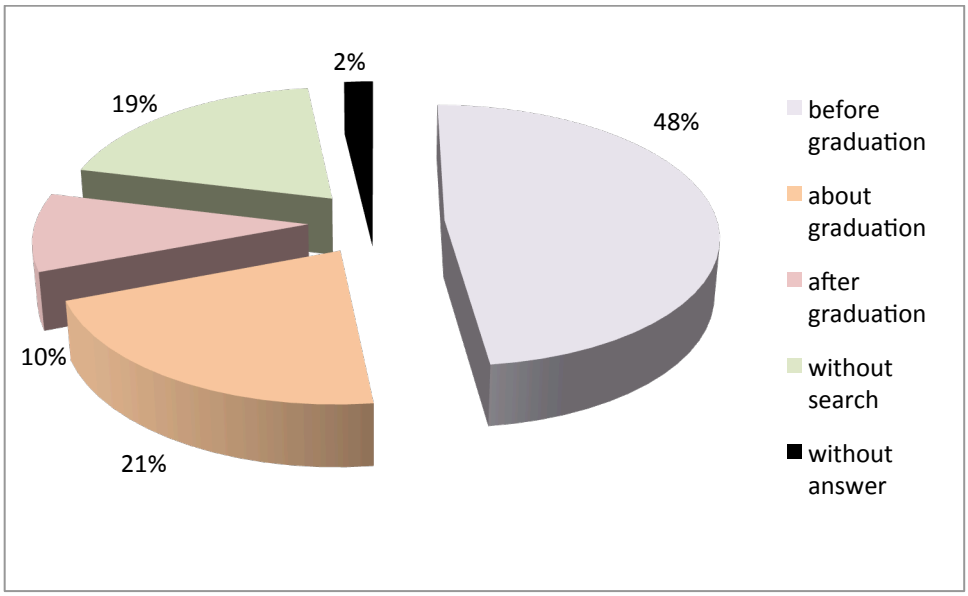


Figure 6. When did you start searching for job?

After graduation most respondents (88 %) worked in the private sector, 12 % in the public sector (public service, public and state education system), 31 % started their own entrepreneurial activities. After graduation only 5 % of respondents had an employment contract for limited period of work, 75 % for unlimited period. The length of limited period varied from 12 to 36 months.

The average starting salary of Applied Informatics graduates was 30,811 CZK (approx. 1,200 EUR); respondents provided amounts from 5,500 to 90,000 CZK. (See Figure 7)

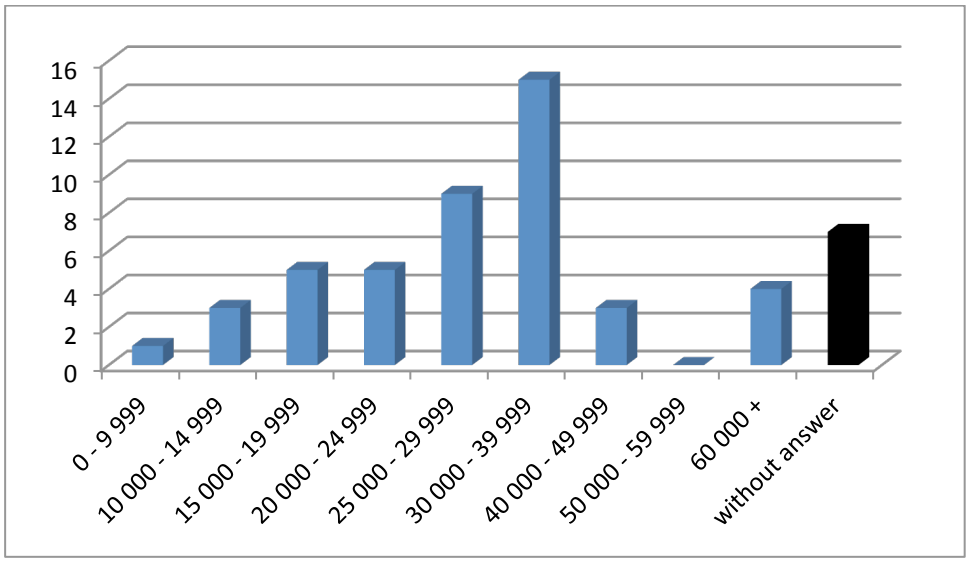


Figure 7 Monthly salary

Almost ¾ of respondents worked for one or two companies since graduation and 10 % respondents stated they had more than one job. Only 17 % of respondents were unemployed, usually up to three months (one respondent lost his job four times, totally he was unemployed for 12 months).

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Respondents also answered questions focusing on their current jobs. Amount of private entrepreneurs decreased from 31 % to 21%. Average work time was 40.1 hours per week, while the length varies from 8 to 50 hours. Average monthly salary was higher than after graduation, it reached 44,625 CZK (approx. 1,750 EUR). Graduates´ current salary varied from 10,000 to 100,000 CZK.

Totally 90 % of respondents worked in the Czech Republic, almost half of them in Prague (capital) and 30 % in Hradec Králové region. Nearly one third of respondents were on managerial positions (31%) leading other employees (2 -100, more often 10).

The question "Which study programme do you consider most suitable for your current job?" was answered as follows: 11 % of graduates completely confirmed good choice of the programme they studied, 73% would add another one of relating content, only 8 % would prefer another programme and 4 % currently work on positions where no specialization is required. (See Figure 8)

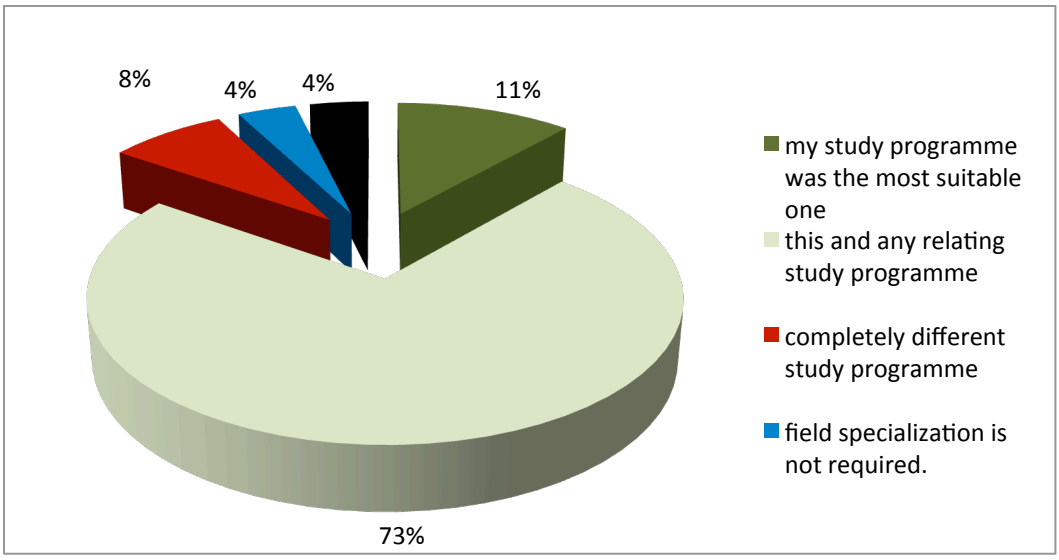


Figure 8. Reflection of study programme in practice

The final question "If looking back, would you have studied the same study programme at the same institution?" was answered as follows: Yes - 88 % of respondents, another programme at the same institution - 10 %, another programme at another institution - 2 %.

CONCLUSION

The above mentioned results show that current students appreciate chances to get information about job opportunities and companies in the region, about new developments in business, and especially about the job opportunities which they will search for after graduation. From the graduates´ point of view to make contact and get in touch with prospective employers during the university study is crucial for succeeding on the labour market after graduation. Furthermore, it seems that more and more the first-year students consider their future career and employment just at the time of submitting

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the application form to a university. Therefore, the FIM makes efforts to react to these needs and establishes and promotes co-operation in the field of research and business with the companies in Hradec Kralove region which in return offer job opportunities and expertise for the FIM graduates.

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Business Process Model of Key Performance Indicators Harvesting and Measuring

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Abstract

Key Performance Indicators are quantifiable measurements, agreed to beforehand, that reflect the critical success factors of an organization. They will differ depending on the organization and on the area of industry. They have to be minded from head of managers, from information systems, from business rules and business inputs and outputs. There are many common and many specific indicators but always they have to be control and systematically measured and kept in special tool and database. The topic of this article is design of the main conception of method of searching, selecting, harvesting and especially systematically maintenance of key indicators performance in SME. The basic inventions are presented by the business process model in notation UML. This model can serve as a baseline of methodological approach to systematical management of business performance. The emphasis is on activities in discussion with processes owners and process modelling. The important part of article is list of possible attributes of performance indicators. The emphasis on SME is important because there is no methodical and systematical approach for management of KPI in this part of companies. I Suppose the most of universities in Czech republic can be involved in SME group of businesses.

Keywords

Activity diagram. Business process modelling. Business performance. CPM. KPI. KPI's attribute. UML.

INTRODUCTION

Business and business management are influenced with a range of changes – technical, economic, social and political. The changes are in all business areas, in competitiveness, in technical development, in environmental principles. The changes in business conditions change the requirements on systems management, on information assuring and especially on qualification and knowledge of managers and business employee. The common point of actual changeable conditions of business processes are the customer, dynamics of process innovations and products but also the measure of uncertainty in success achievement in future. That is why the performance of business is so important. There is no the systematical approach to performance measurement in SME (Small and Medium Enterprises). Also there is no the method in this area. Improvement the performance in organization in our method is supported by better understanding of main business processes and by discovering opportunities for activities improvement.

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The progress in SME from traditional approach is founded only on financial indicators measurement profit, profitability, cash flow to up-to-date approaches as is VBM (Value Base Method), BCS (Balanced Scorecared), ABC (Activity Based Costing). There are not supporting or technical tools for measure and management of other type of nonfinancial performance markers. They are specifics and they have to be gain from company. Many of indicators we gain from ERP (Enterprise resource Planning) systems, but not all of them. Some ERP have not their controlling or analysis modules for required results. (Businessinfo, 2013)

The ability to understand business processes and to recognize their characteristics is the way to know how to use them effectively. This is the main question and reason of this article and the aim of methods of measurement of key performance indicators. It contributes to knowledge of managers and helps them in decisions.

METHODS

The common element of up to day changeable conditions of business is the necessity to measure and to manage the process performance.

In CSN EN ISO 9004:2002 states that organization has to use properly methods of monitoring and measurement of process performance. These methods have to prove ability of process to achieve the planned results. When the results are not achieved the business has to make correction or to make preventive measures (ISO-norms, 2014).

The system of performance measurement has to measure the right things, have comprehensive system of measurement and use the results right. For example a business may have as one of its key performance indicators (KPI) the percentage of its income that comes from return customers, a school may focus its KPI on graduation rates of its students or a KPI for a social service organization might be number of clients assisted during the year. Whatever KPI, they must reflect the organization's goals, they must be key to its success, and they must be quantifiable (measurable).

There are a number of definitions in multiple resources. We searched approach of Pollock (Pollock, 2007). He said, that there are numerous definitions of KPIs available in business textbooks, through services trade associations, or on the Web, each comprised of their own keywords, buzzwords and, oftentimes, competitive branding. However, regardless of which definition you ultimately embrace, there are still some conventions that you will need to accept as well. Basically, KPIs are tools that may be used by an organization to define, measure, monitor, and track its performance over time toward the attainment of its stated organizational goals. TheFreeDictionary.com defines KPI as "a set of quantifiable measures that a company or industry uses to gauge or compare performance in terms of meeting their strategic and operational goals". It goes on to say that "KPIs vary between companies and industries, depending on their priorities or performance criteria".

Metrics are a set of measurements that quantify results. Performance metrics quantify the company’s performance. Project metrics tell us whether the project is meeting its goals. Business metrics define the business' progress in measurable terms.

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KPI is a quantifiable measure a company uses to determine how well it meets the set operational and strategic goals. This means different businesses have different KPIs depending on their respective performance criteria or priorities. At the same time, the indicators are usually followed industry-wide standards.

We note that every key performance indicator is also a metric, but not vice versa because there is a subtle difference between key performance indicators and business metrics. Indicators do not necessarily have to be financial but are important in activities of management, improvement business operations, obtaining the competitiveness and supporting the decision.

In (Marketingabout, 2013) there are some characteristics of KPIs. Quantitative (they can be presented in form of numbers, practical (they integrate well with present company processes), directional (they help to determine if a company is getting better) and actionable (they can be put into practice to effect desired change). All KPIs must be based on legitimate data and provide context that echoes business objectives. They must be defined in a way that factors beyond the control of a company cannot interfere with their fulfillment. Another key factor is that they have specific time-frame divided into key checkpoints.

In other resource (BusinessInfo, 2013) there are three main categories of performance metrics; time, cost and quality.

- Time - metrics that relate to time, as they are easily calculated, easily understood, and clearly show operational effectiveness (level of on-time deliveries, on-time receipts, time to process purchase orders, and time to fulfill an order).
- Cost – metrics that show how efficient parts of the company is (inventory carrying costs, cash flow).
- Quality – metrics about customer satisfaction.

In (Tdwi, 2013) there are 12 characteristics of effective metrics, we agree and these characteristics we have in mind in our approach (strategic, simple, actionable, owned, timely, accurate, correlated, game-proof, aligned, standardized, relevant).

In addition we can classify the performance indicators from other views. From organization view we can classify the indicators according the department in company and subject of indicators or according processes to be concerned. Interesting approach to classification is also according complexity and level of severity to measuring and monitoring or according the level of changes of processes to be measured. The views of classification play important role in project of business excellence gaining and they play important role in our proposed methodic. They are attributes of indicators that we can sorted, filtered, locate. In practice, when we assign the attribute to indicators, we can more effective administrate the indicators not only in SME but also in large enterprise.

Corporate performance management (CPM) is the area of business intelligence (BI) involved with monitoring and managing an organization's performance, according to key performance indicators (revenue, return on investment, overhead, and operational costs). CPM is also known as business performance management (BPM) or enterprise performance management (EPM). The issue of our proposal is the contribution in these management areas.

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Historically used within finance departments, CPM software is now designed to be used enterprise-wide, often as a complement to business intelligence systems. CPM software includes forecasting, budgeting and planning functions, as well as graphical scorecards and dashboards to display and deliver corporate information. A CPM interface usually displays figures for KPIs so that employees can track individual and project performance relative to corporate goals and strategies.

In the approach in this article, we make a metrics-based analysis of a company's operations and performance and we focus on the financial and nonfinancial aspects and metrics of business. We don't do the difference between metric and indicators. We use UML (Unified Modelling language) notation for business process modelling of our methods and we explain important activities in our proceedings. Also in (Rábová, 2012) we used the same approach. Some activities are supplemented with annotations and notes. These notes are our knowledge from business cases that the diploma students made and validated in praxis (Lucký, 2013, Rešlová, 2013). The other option of process modelling (Petri nets) is used for example in (Balogh, 2012, Klimeš, 2010).

RESULTS AND DISCUSSION

The disadvantage of up to date approaches to performance management in SME but not only in SME is that they are aimed most mainly on financial indicators and that there is the absence of quality and validated tools for performance measurement and monitoring. The high costs of implementation, operation and service is also the big problem. The main disadvantage that I see in this area is the unavailability of methods and many of nonfinancial indicators that are not watched and measured. Hence I began the work at the methodical approach. The main sketch of methodic is designed for SME.

The principal idea of designed method is to create the model of business activities and to discuss it (its characteristics, features and constraints) with process owners and business managers in order to gain its indicators.

In this article the method is presented by process model in UML. This process model and its activities sequence and main assumptions and ideas are result of a number of business cases and studies in automotive industry and agriculture.

There are three main issues published in this paper, the business model as a sequence of activities, the list of questions for activity Controlled discussion and communication with process owners and the template of KPI attributes. All three issues are depicted in more detail in the next part of paper.

- The business process model

The business process model on the Figure 1 presents the first version of planned methodical approach in introduced research. Every activity in Figure can be improved and specified in more detail. Process model is means of visualizing the main concept of methodic for gathering, harvesting, storing and measuring, thus management, of performance indicators in SME business but not only SME, but also in a lot of schools and at universities.

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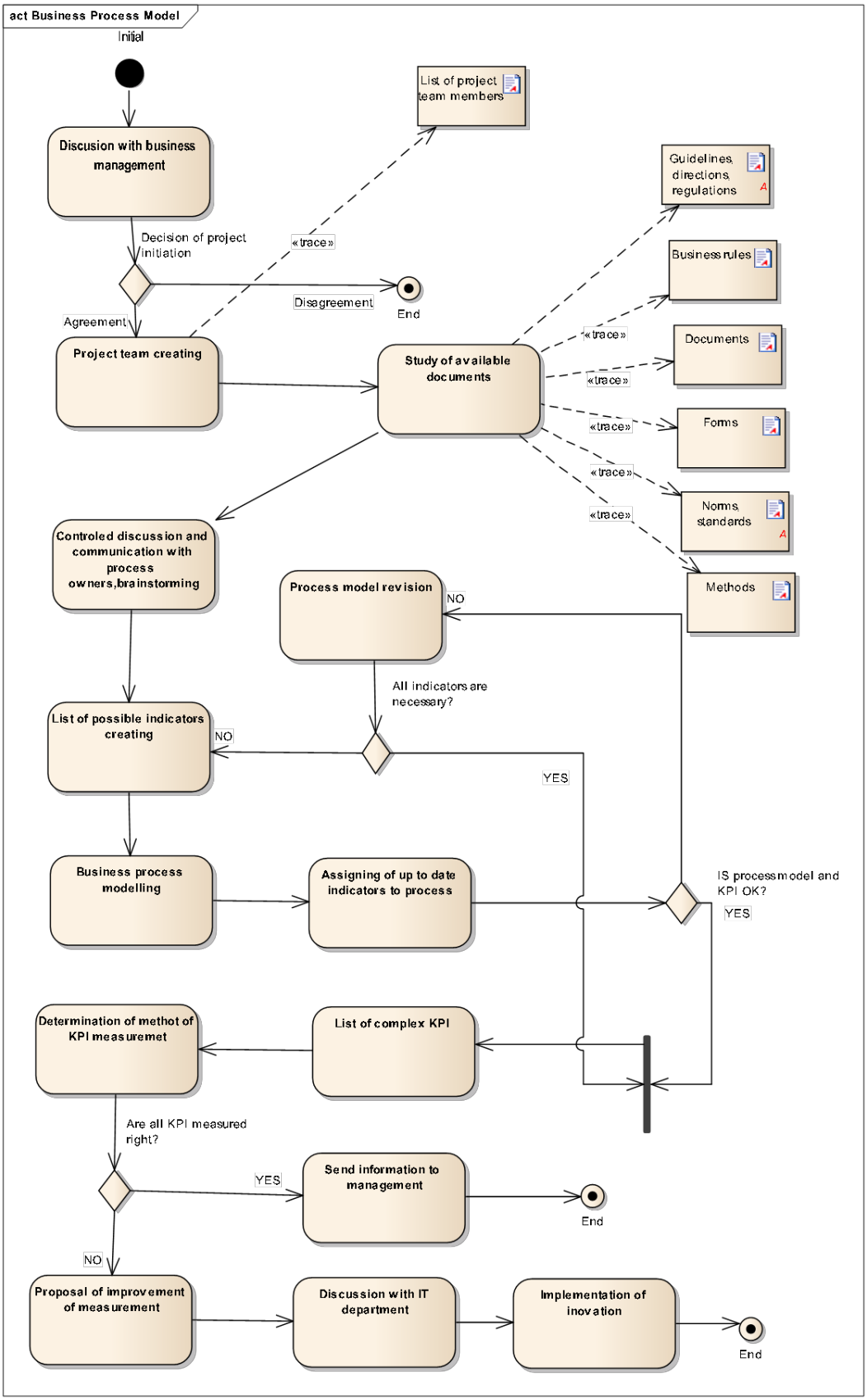


Figure 1: The business process model

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In the first activity "Discussion with business management" the necessity of measuring performance is discussed, vision and goals are formulated and the project is approved. The project is approved in time, cost and requirements.

The result of the second activity "Project team creating" is List of team members (strategic manager, process owner, process worker, quality manager IT worker). The activity "Study of materials" is very important. Chosen team members study the guidelines, legislative, business rules business limitations and constraints in business documents and directions.

- Questions for PKI's gaining in discussion with process owners

In activity "Controlled discussion and communication with process owners" is possible to take brainstorming with these following questions to the process participants or business process owners:

- Which event initiates the process?
- What is the first activity started up by this input event?
- Are there any more possibilities that can start this process?
- What output is created as a result of performing this activity?
- Who performs this step, are there any IT applications used in performing this activity?
- How often is this step performed during one day/week/month and how much time does it take?
- What can be done to resolve potential challenges in performing activity?
- Are there any measurements taken in these steps (Performance Indicators)?
- What happens in this step?
- Do you know where the outcome of this activity is used further in the process?
- KPI's attributes

The resulting process description is a powerful tool to analyze and improve the process. The iterative procedure of working with business process model consists of couple of activities in which the list of possible indicators including method of measurement is created. After these activities we have the list of main indicators a can allocated other attribute to them. The resulting chart can be elaborated as a database in computers. This idea is presented in following chart.

Table 1: KPI's attributes

KPI definition	KPI identification		
	KPI name		
	KPI description		
KPI location	Company		
	Department	Responsible person	
	Process	Process goal	
		Process owner	

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		Process workers	
		Process model	Process activities
			Input event
			Output event
			Decision's activities
KPI scope	Internal part of business	Money, productivity, …	
	External part of business	Customer, partner, competition, …	
KPI type	Financial, nonfinancial		
KPI feature	Qualitative		
	Quantitative		
	Trend measuring		
KPI measurement	Measure unity		
	Measure frequency		
	Way of measurement	Level of IT support	KPI Enumeration
			Data resource for measurement
			Archiving of measured KPI
	KPI value	Up to date value	
		Demanded value for excellence	
		Minimal acceptable value	
		Maximal acceptable value	
Level of innovation of process optimization			
Relationship with other KPI's			
KPI priority			

This sheet shows possible attributes of KPI. It can serve as a template for comprehensive KPI. Views of KPIs (main attributes) are subdivided into five sections, everyone section is divided into subsections etc. Managers can use this sheet in the second part of method in activities that results from business process modelling in company (Assigning of up to date indicators to process).

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CONCLUSION

When a company wants to look at the performance of its processes, there are a great many metrics that can be used. Each supply process performance metric gives a slightly different view of a piece of the company. The important decision for any company is to prioritize which process metrics are important and how they will be used. Many companies use performance metrics that are easy to calculate but may not necessarily give a true indication of how the process is performing. If manager measures the wrong things, he is going to get the wrong answers and subsequently takes the wrong actions.

The presented methodical concept (business process model) on Figure 1 is only the first version of proposal method but it can improve the organization's performance by better understanding and governing key business processes and indicators. The important and innovational part is the template of indicators structure presented in TABLE 1. This approach is created neither in SME nor in other companies, but our emphasis is on SME. The method is open and it can be customized for different areas of SME. The interesting extension of method is list of potential questions for actions in activity "Controlled discussion and communication with process owners". This extension can be created also for other activities, but I think here is the most useful. The issue of paper is assigned to business process analysts, business owners and to strategic management at all.

Using this methodical approach business manager can discover opportunities for business improvement and make business decisions with the right information and at the right time.

The issues are applicable in SME as well as at academic environment. In future the Key Performance Indicators will be measured for every department or educational process at the universities to obtaining certificates of quality.

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Reliability/Item Analysis of Statistical Literacy Tests

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Abstract

The paper provides case study of reliability/item analysis of test utilization. The aim of the test was to determine the level of statistical literacy of students of Computer Science at the University of Constantine the Philosopher in Nitra. Also, the aim was to determine whether and how teaching the Computer data analysis using e-learning course and working in statistical software affects the level of statistical literacy students. We have created tests and aim of this paper was to evaluate the reliability of pre-test and post-test, to identify suspicious items and propose modifications or removal of suspicious items from the test. This will make it possible to improve these tests to actually test the ability, for which testing was the establishment, i.e. statistical literacy.

Keywords

Statistical literacy. E-testing. Reliability/item analysis. Reliability.

INTRODUCTION

It often happens that while the statistical information is transferred from producers to the recipients, for example media, stakeholders or other people involved in the process of transferring statistical information. For example, the media can interpret this data so that recipients are juggled and media change the true meaning of statistical information. Recipients can also interpret these interpretations in a wrong way. This gave rise to interpretations of interpretations, which can be very far from the truth.

If we want to know how to work with statistical data, graphs and tables, we must have ability called “statistical literacy”. Statistical literacy helps us to properly understand what information is provided.

The purpose of the pre-test and post-test, which we developed, was to verify whether the teaching of subject Computer data analysis (CDA) in e-course impact on statistical literacy of students. The most effective way to test is to use an existing tool – Learning Management System (LMS) (Capay, Magdin and Mesarosova, 2011). The purpose of this paper is to clarify the concept of statistical literacy and investigate reliability of the tests from an experiment that we realized on the students of Informatics at the University of

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Constantine the Philosopher in Nitra. There is briefly described the course CDA and testing conditions.

WHAT IS STATISTICAL LITERACY?

Take the information, whose focus is ”word”, respectively verbal information. If we examine the information purely deductive, talking about logic or logical reasoning. Concept of critical thinking would be identified as inductive reasoning and partly deductive. Similarly, if we look at the information based on “number”, we could think deductively about numerical information using mathematics, areas of mathematics deal with probability or a large part of statistics. Primarily inductive and partly deductive is an area dedicated to statistical literacy.

Table 1: Focus and methods of reasoning (Schield, 2004).

	Methods of reasoning	
Focus	*Exclusively deductive*	*Primarily inductive* *Some deductive*
Words	Logic	Critical Thinking
Numbers	Math, Probability, most Statistics	Statistical Literacy

Simply put statistical literacy is the ability to work with statistical information in the form of graph, table etc. and further interpret this information. But the statistic education literature speaks about several definitions of statistical literacy. Some of these definitions (Rumsey, 2002):

- „People’s ability to interpret and critically evaluate statistical information and data-based arguments appearing an diverse media channels, and their ability to discuss their opinions regarding such statistical information“ (Gal, 2000);
- „The understanding of statistical language: words, symbols, and terms. Being able to interpret graphs and tables. Being able to read and make sense of statistics in the news, media, poll, etc.“ (Garfield, 1999);
- „…the ability to understand statistical concepts and reason at the most basic level“ (Snell, 1999);
- „…comprehend text and the meaning and applications of the statistical information in it, in the context of the topic to which (it) pertains“ (Watson, 1997).
- “…ability to read and interpret statistical data, use basic statistical concepts and understand their meaning, but also to think critically when dealing with different views of statistical information located in different contexts. It is the individual’s ability to recognize and understand the role of statistics in the world, to use statistics and to deal with it like need of life of a reflective and constructive citizen in the information society (Vrabelova, 2013).

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USED METHODS FOR ANALYSIS OF TESTS

Reliability testing was realized using Computer analysis of the data subject. Students of this course were tested using created tests that were oriented to test the statistical literacy. Test tasks are from various sources and contain various interesting statistical tasks, several paradoxes or even basic statistical tasks.

Validation of students statistical literacy ability was carried out on the basis of pre-test of statistical literacy at the beginning of the semester and post-test of statistical literacy at the end of the semester. We have created two groups for an experiment: experimental and control group.

The experimental group was composed of students of the Department of Computer Science, who study full-time in Applied Informatics or Informatics teacher training. The dominant group consisted of students of Applied Informatics. All students in the experimental group attended regular courses of subject CDA and worked with various statistical data sets and real case studies using analytical tools. Students worked in electronic course CDA and with modules and activities that included e-course CDA. For these students, we expect average or low degree of statistical literacy.

The control group was composed of part-time students of the Department of Computer Science. They were students who are also employed and they work with statistical information in their jobs. We did not expect it at full-time students. Therefore, we supposed a higher level of statistical literacy among part-time students. Students of the control group did not work in electronic course CDA and they worked in the statistical software from the professional supervision of the teacher only twice.

The objective of the testing was to verify whether and how much the subject CDA, e-course CDA and practical work with the statistical software affected the statistical literacy of students. In order to have reliable test results, we had to first verify the reliability of these tests by analyzing what is the point of this paper.

E-course called Computer data analysis was created for the purpose of teaching the subject CDA. Teaching the CDA was realized with students of the University of Constantine the Philosopher in Nitra. The aim of this course is to teach students of Informatics teacher training and Applied Informatics basics of areas data mining, inference and exploratory analyze (Reichel, 2013). The course is mainly focused on practice, i.e. to solving tasks with the help of statistical software, where students work with a variety of fundamental, but also advanced, statistical methods and draw conclusions from information.

The method we used to analyze the test item is called Reliability/item analysis.

CREATION OF TEST TASKS

When we create test tasks, it is necessary to consider four aspects (Vrabelova, 2013):

- Context – tasks should be based on real situations in which the test persons may find themselves,
- Content – tasks should include different areas of mathematics as a percentage, combinatorics, probability, statistics, etc.,

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- Competence – basic statistical competence involves the following components (Rumsey, 2002):
  - data awareness,
  - an understanding of basic statistical concepts and terminology,
  - knowledge of the basics of collecting data and generating descriptive statistics,
  - basic interpretation skills,
  - basic communication skills.

    - tasks should be taken into account competence of test groups,
- Views – different forms, in which statistical information may be contained in the task (text, table, chart).

The test was mainly oriented for reading charts, reading from the tables and mathematical thinking. Good statistical citizen should have these abilities at a certain level. Therefore, we complied tests from various sources and we made an effort to create pre-test and post-test statistic literacy test that will be similar difficult.

Pre-test

Task 1.

Which of the following sketches best describes the graph of function $y=1^x$?

Answers 1.

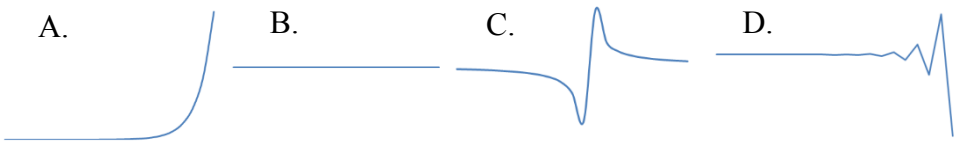
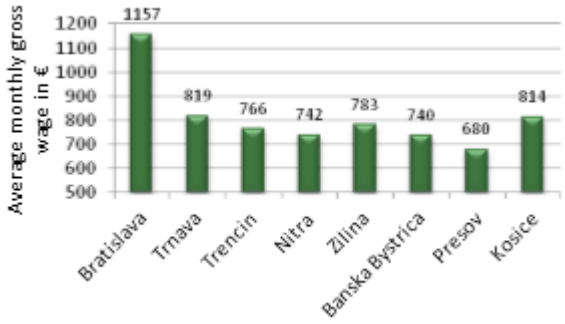


Figure 1: Answers to task 1 (sketches of graphs).

Task 3.

The picture shows a graph of the average monthly gross wage in 2011 divided by region.



Source: Hermanovska, I. 2013

Figure 2: Graph of the average monthly gross salary in 2011 divided by region.

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Students' task was to verify the veracity of these assertions:

1. From this graph it is possible to determine the average monthly gross salary in 2011 in Slovakia.
2. In Zilina, every employed person has a higher salary than in Presov.

Post-test

Task 1.

Based on information obtained from the chart of the amount of turnover ecommerce sort ascending following 4 items: personal computers, tablets, cell phones and components.

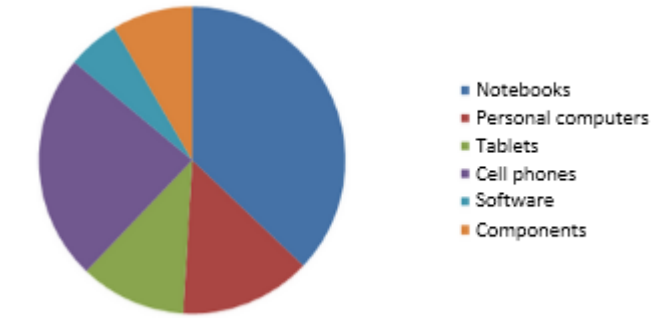
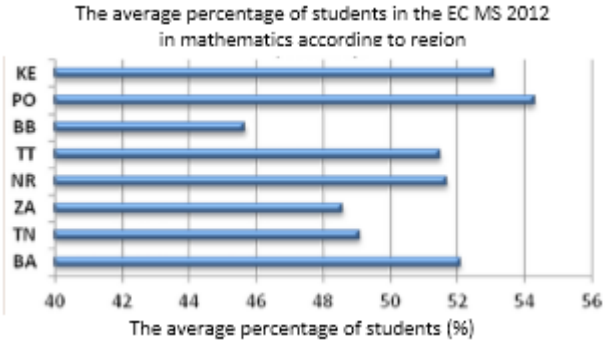


Figure 3: Pie chart of sales.

Task 2.

Graph in the figure indicates the average percentage of students in the EC MS 2012 in mathematics according to region.



Source: Hermanovska, I. 2013

Figure 4: The average percentage of students in the EC MS 2012 in mathematics according to region.

8,753 students from 413 schools dealt test. Of these, 5,619 students of grammar schools and 3,134 secondary vocational school students. The average percentage of students in the math test was 50.8%.

Students' task was to verify the veracity of some assertions which could be read from the data presented and graph.

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Task 6.

Tell based on the chart, whether the measured temperature equal to 12 o'clock and 18 o'clock.

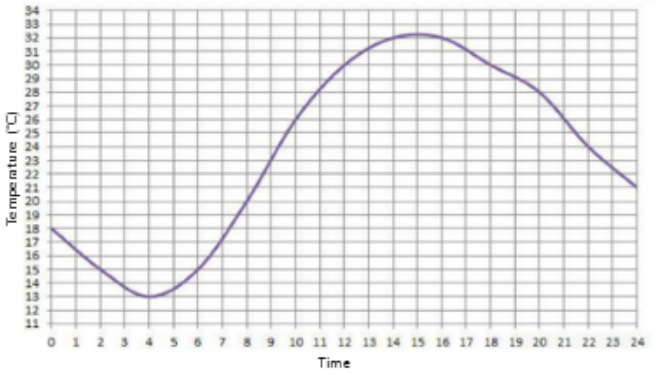


Figure 5: 24 hour temperature graph.

RELIABILITY/ ITEMS ANALYSIS

Reliability/item analysis belongs to multidimensional techniques of research and helps to judge quality – reliability of measuring procedure such as a scale of a questionnaire as well as to identify its suspicious items (Zahorec, Munk and Haskova, 2008). Reliability analysis is used to verify the quality of the questionnaire or test. To estimate reliability in a direct way Cronbach's Alfa coefficient is used

$$\hat{\alpha} = \frac{m}{m-1}.\left(1 - \frac{\sum s_j^2}{s^2}\right), \quad (1)$$

where m is number of items of the questionnaire, s^2 is variance of the scale of the questionnaire, s_j^2 is variance of the scale of j item of the questionnaire (Zahorec, Munk and Haskova, 2009).

Estimation of reliability can be calculated from average correlation coefficient $\bar{r}$ of the particular items. It is called standardized Cronbach's Alfa coefficient

$$\bar{a} = \frac{m\bar{r}}{1+(m-1)\bar{r}}, \quad (2)$$

where m is number of the items.

If assessments are only incidental and do not reflect the real knowledge, then these are just random errors and these are uncorrelated. In this case, Cronbach's alpha coefficient equal to zero. In the event that all tasks are reliable and reflect the actual level of knowledge, coefficient alpha is equal to one. The larger Cronbach's alpha is, the more reliable test is (Munk, 2011).

ANALYSIS OF TEST RELIABILITY

To analyze test reliability and suspicious items appropriate techniques and methods for this purpose have been used. From the correlation matrix in Table 2 we can identify

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suspicious items of the test. From the correlation matrix on figure 1 we can see that most results are statistically important for most items. This means that there is a certain dependency between these items. The closer the correlation coefficient is to value 1, the stronger the proportional dependency is (Zahorec, Munk and Haskova, 2008).

Table 2: Correlation matrix of pre-test.

	I1	I2	I3	I4	I5	I6
I1	1	,2418	-,1265	,0912	,1219	-,0939
I2	,2418	1	,0103	,2638	,1093	,1013
I3	-,1265	,0103	1	,0268	-,0329	,0942
I4	,0912	,2638	,0268	1	,0312	,1216
I5	,1219	,1093	-,0329	,0312	1	,2674
I6	-,0939	,1013	,0942	,1216	,2674	1

In Table 2, we see that all correlations are rather low. The correlation between item number 3 and other items is not statistically significant. Relatively high correlation values are between items 1-2, 2-4 and 5-6.

Table 3: Statistics of pre-test.

Number of items in scale:		6	
Number of valid cases:		78	
Mean:	2,422616306	**Sum:**	188,964072
Standard Deviation:	1,102630611	**Variance:**	1,21579426
Minimum:	0	**Maximum:**	5
Cronbach's alpha:	0,349402068	**Standardized alpha:**	0,3484581
Average Inter-Item Correlation:		0,082951929	

Reliability coefficient value 0.35 (35 %) expresses extent of variability total sum of item scale to total pre-test variability. Results of both estimations (Cronbach's Alfa and standardized Alfa) are similar, i.e. particular items have identical variability (Table 3). This means that the reliability is not high and that the tasks are not testing the same ability.

Table 4: Test statistics (pre-test) after elimination of a certain item.

	Mean if deleted	Var. If deleted	StDv. If deleted	Itm.-Totl. Correl.	Alpha if deleted
I1	1,871334	0,845675	0,919606	0,117149	0,358146
I2	2,268770	0,862386	0,928647	0,309864	0,205561
I3	2,345693	1,148299	1,071587	-0,033441	0,401202
I4	1,953094	0,972886	0,986350	0,202837	0,286035
I5	1,704668	0,830820	0,911493	0,203439	0,274689
I6	1,969522	0,991508	0,995745	0,174547	0,302536

Table 4 confirms the low reliability of task number 3. After elimination of the item number 2 the reliability coefficient dropped. The first and third item activates an opposite phenomenon - in its case, the value of the reliability coefficient increased. This shows that the 3rd item decreases the total questionnaire reliability.

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For the post-test, we generated tables 5, 6 and 7. The highest correlation coefficient is between items 3-4, 4-5, or 2-3 and lowest in items 1 and 6. Therefore, it is necessary to change tasks 1 and 6.

Table 5: Correlation matrix of post-test.

	I1	I2	I3	I4	I5	I6
I1	1	,0708	,1487	-,0017	,0097	,1831
I2	,0708	1,0	,2064	-,0017	,0903	,0826
I3	,1487	,2064	1,00	,2276	,1547	,1266
I4	-,0017	-,0017	,2276	1,00	,2309	,0511
I5	,0097	,0903	,1547	,2309	1,00	,0791
I6	,1831	,0826	,1266	,0511	,0791	1,00

Table 6: Statistics of post-test.

Number of items in scale:		6	
Number of valid cases:		81	
Mean:	3,344496193	**Sum:**	270,90419162
Standard Deviation:	1,092090683	**Variance:**	1,192662059
Minimum:	,502994012	**Maximum:**	6
Cronbach's alpha:	,384446795	**Standardized alpha:**	,427159038
Average Inter-Item Correlation:		,111227262	

Table 7: Test statistics (post-test) after elimination of a certain item.

	Mean if deleted	Var. If deleted	StDv. If deleted	Itm.-Totl. Correl.	Alpha if deleted
I1	2,628595	0,901385	0,949413	0,103033	0,404748
I2	2,747838	0,947081	0,973181	0,153648	0,358483
I3	2,806387	0,867423	0,931355	0,333855	0,250616
I4	3,171657	0,893083	0,945031	0,198544	0,329602
I5	3,011163	0,783369	0,885081	0,206536	0,327164
I6	2,356842	1,119971	1,058287	0,195851	0,370104

CONCLUSION

The analysis results show that the pre-test and post-test have relatively low reliability. Particular task number 3 in the pre-test and tasks 1, 2, 6 in the post-test are problematic. The likely reason for the large number of issues with low reliability is an effort to use several paradoxes or teasers that could reduce the overall reliability of the tests.

The pre-test was especially problematic task number 3, which focused mainly on reading from the graph and understanding what level of salaries in the regions represent. Only 7 of the 81 responses to this task were correct. This may mean a high difficulty task or that we should rephrase the task. However, we think that the task number 3 belongs to test statistical literacy and, therefore, we need to rephrase the task. Removal item number 1 increases reliability, therefore this item will be replaced by another in the future.

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Post-test contains up to three troublesome tasks. Task no. 1 was focused mainly on the concept of „ascending“, to which several students had problems (results can be biased because students discussed the concept with each other during the test). Tasks number 1 and 6 were relatively easy, which may have influenced the results of the analysis. Task number 2 is oriented to reading from the graph, but this task requires adjustment. Analysis is recommended to replace task number 1. However, we modify the task number 6.

By increasing the number of items (tasks) we can also increase the reliability of the tests. In this case, it would be necessary to add about 11 tasks. But it would extend the time for each test from the original 15 minutes to more than an hour. And this is not appropriate in our test conditions.

Results of the analysis tests are finding that the reliability of all tasks reached a maximum mean level of reliability and the test must be adjusted. It will be necessary to replace a number of no reliable tasks and then add the reliable tasks. It should be avoided paradox and teasers.

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Social Communication in Online Courses under the Virtual Observation

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Abstract

The paper presents results of the virtual observation which was held at the Faculty of Informatics, University of Hradec Kralove in 2007/8 – 2012/13 academic years. Data were collected in distance online courses of English for specific purposes in LMS Blackboard within the learner-tutor communication. Unlike in other analyses, not the pedagogical but social communication was monitored, just at the time when students submitted assignments to be assessed by the tutor. The submission tool provides students with opportunity to send a message to the tutor if they wish; although this activity is appreciated, it is not obligatory – it is considered a cetratin way of ´social communication´, i.e. a feature of positive climate in the class. Thus the main research objective was to monitor and analyze the social communication so that to reflect the social climate in the course – the more frequent the communication is, the warmer social climate can be felt in the online course, which may make the teaching/learning process more pleasant and thus easier. More than 2,000 students participated in the given period and more than 2,400 assignments were monitored and analyzed according to 14 criteria by the methods of frequency and content analyses. The results show slight increase in the frequency of communication where rather short messages are used to socialize and middle – length sentences to explain reasons of late submissions and/or discuss other problems.

Keywords

Communication. Social communication. Virtual observation. Online course. ICT. English for specific purposes. Research.

INTRODUCTION

The information and communication technologies (ICT) have penetrated all spheres of human being, including education. The ICT-supported process of instruction is based on the same didactic principles as the traditional approach to teaching/learning, i.e. the Comenius theory and practice (Comenius, 1907); under the conditions of e-society the role of ICT has to be taken into consideration.

Communication (from Latin *commūnicāre*, meaning "to share") (Harper, 2005) is the activity of conveying information through the exchange of thoughts, messages, by speech, visual, signal, writing or behaviour modes; it is the meaningful exchange of information between two or more living creatures. The communication may be held in the intentional or unintentional way, it may involve a sender transmitting an idea, information, or feeling

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to a receiver using conventional or unconventional signals, taking verbal or non/verbal means (Prizant, 2014). It requires a sender, a message and a recipient, although the receiver may not be present or aware of the sender's intent to communicate at the time of communication. Thus communication can be held across vast distances in time and space. Effective communication occurs only if the receiver understands the exact information or idea that the sender intended to transmit (Harper, 2005). Social reciprocity is a type of social interaction which is displayed through the use of joint attention to share experience and emotions with another person for a variety of events and in a variety of contexts. Joint attention is the ability to coordinate one's visual attention through eye contact, eye gaze and/or gestures with a social partner. The person is expected to respond to, as well as independently initiate behaviour of joint attention to reflect the ability to act in a socially reciprocal manner. The social partner expects the person to be responsive to social partners interests and needs, not just to their own interests or personal needs (Cook, 2014). Either there is no standardized definition of the term currently recognized and, at the same time, numerous definitions are provided considering communication from different points of views, generally, the communication can be defined as e.g. the synergistic emergence of social interaction, social cognition, pragmatic, receptive and expressive language processing, requiring at least two entities for a social interaction. (Adams, 2005). Thus the social communication is specified as a field that primarily explores the ways information can be perceived, transmitted and understood, and the impact those ways will have on a society, regardless whether in a real or virtual environment (Adams, 2005). In practice the best way to communicate in a social conversation is to contribute one's opinions and experience/s while simultaneously listening to the other's viewpoints. Nonverbal communication means such as gestures, facial expressions, eye contact, voice tone etc. are also important when speaking but these are not visible in the virtual communication.

A special form of communication is detected within the process of instruction – the pedagogical communication. It works as a means of education and its course closely relates to reaching the learning objectives. Under the conditions of ICT-supported process of instruction, the pedagogical communication is an obligatory part of online courses and a frequent subject of research activities, when its processual, affective and regulative elements are monitored (Nesbit, Martin, 2014). Engaging students in learning and keeping them engaged has often proved to be a problem. The concept of engagement in learning has been the subject of much research in an attempt to address student´s motivation in learning situations. Three types of engagement have been identified as having behavioral, emotional and/or cognitive engagement. The behavioral engagement relates to running the positive conduct and following rules and norms; emotional engagement refers to students´ affective reactions in the (virtual) classroom, including interest, boredom, happiness, sadness, and anxiety; the cognitive engagement refers to psychological investment in learning, learner´s desire to go beyond the requirements and a preference for challenge (Fredricks et al., 2004).

Observation belongs to traditional, natural and widely spread research methods of collecting data within the educational environment. Generally, it is understood as the process of monitoring sensitively perceived phenomena, mainly human behaviour, course of activities etc. (Mareš et al., 1995). Some authors emphasize it to be objective, intentional, purposive, systematic, planned and directed but on the other hand having some limits. Relating to the wide variability there exist various typologies covering e.g.

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long/short-term, intro/extrospective, non-/structured, non-/mediated, in/formal observation (Travers, 1969).

The information and communication technologies have introduced a new approach to observation (Šimonová et al., 2010). Some authors call it the virtual observation, i.e. the observation in the virtual environment, others use the term of tracking. It is defined as a record of exact facts which can be monitored either by single electronic tools (e.g. e-mail, discussions), or by the whole virtual learning management system (LMS). The records monitor all learner´s activities while being logged in the LMS, i.e. the frequency and length of time spent, the tools used, evaluation of work and outcomes, participation in discussions, team work, submission and evaluation of assignments etc. If the observer is expected not to disturb the process of instruction during the real observation, i.e. to be hidden from learners, this requirement is met to maximum extent with the virtual observation, as it is the LMS which plays the observer´s role and stores the collected data. From this point of view the virtual observation applies the ex-post-facto approach, as the data describe past activities which cannot be changed and serve for deducting conclusions. The quality of data is both supported and limited by technologies, i.e. particularly by the range of tools in LMS. It records the pre-defined phenomena and no other (additional, unintentional) data can be received. Modern technologies, e.g. ICQ, Skype e-mail, short message service etc. running on the Internet are understood as a special way of (electronic) communication. Despite the limits, the observation supported by ICT/LMS provides valuable data which enable to tailor the course of instruction to learner´s needs and thus make teaching/learning more efficient (Nelešovská, 2006). Nelešovská deals with educational communication just because of its importance in the process of instruction; she considers sducational communication the elementary professional skill of each teacher. That is why communication skills should be /and often are) a research subject of the teacher skill model. Nelešovská defines educational communication from the point of its functions, participants, rules, forms, school climate and atmosphere and emphasizes different students´ approaches to the communication, also reflecting various disorders, e.g. jitters, speech impediments etc. (Nelešovská, 2006).

This research did not focus on discussions dealing with professional topics (Thomas, 2002). We monitored communication which ran at the moment of submitting assignments in the online course. On the starting tutorial students receive information there exists a tool within the LMS which offers possibility to send a message and/or comments at the moment of submitting an assignment but they are not intentionally invited to do this. We call this activity a non-invitational, non-obligatory, optional communication. Despite it is desirable, invited and appreciated by teachers, we think it also proves there is something more than an obligation, ´a must´ on student´s side, we hope a positive relation towards the teacher, tutor, learning has been developed or has been under development if the students adds ´something more´ when submitting the assignment. Generally, it is widely accepted people vary in the view upon the same situation, they do not do things and see the world in the same way as the others do. That is a cause there exist numerous psychological, pedagogical and other reasons why a student decides to communicate in the situation like this. The individual approach based on student´s learning style is one of them (Smith et al., 2002).

Relating to the above mentioned, the main objective of this paper is to present results of a study monitoring and analyzing the tutor-learner social communication in online

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courses. We do not deal with the above defined pedagogical communication – our virtual observation focuses on the non-obligatory learner-tutor social communication.

RESEARCH DESIGN

Research objective

This research focuses on the student-tutor communication in the situation when the student is submitting assignment to the tutor´s evaluation within the LMS. The main objective is to monitor the situation and consequently recommend and take such measures which will support the frequency and quality of communication in the future. Such non-obligatory communication is expected to improve the student-tutor relations and consequently contribute to the learning "climate" in the virtual class.

Research sample

The research has been held at the Faculty of Informatics and Management (FIM), University of Hradec Kralove (UHK), Czech Republic since the 2007/8 academic year and currently it has been going on. The sample group included students of the bachelor study programmes of Applied Informatics (AI) and Information Management (IM) in the 1st – 3rd year in six subjects of English for specific purposes (ESP, E1 – E6). All subjects were taught by the same tutor, fully qualified and experienced academic staff. Totally 36 online courses were included in the research where 45 assignments were submitted, i.e. 2,403 assignments were analyzed and 2,067 students participated in the research.

Research description

The process of instruction was organized in online courses running in the LMS WebCT (Blackboard since 2011). The frequency and type (content) of communication were monitored and analyzed. Hypotheses intentionally were not defined, but researcher´s expectations were stated only. The reason, relating to the research objective, was that the process of verifying hypotheses was not required for the above defined research objective. We expected the frequency and extent of learner-tutor communication will be increasing during the three-year course of ESP study, which will be an indicator of a positive climate in the virtual class contributing to learners´ success in learning.

The methods of frequency and content analyses were applied, so the communication, i.e. single messages, were structured according to 14 criteria as follows:

1 Assignment sent without comments.

2 I am sending my assignment.

3 I am sending my assignment and greetings.

4 I am sending my assignment and greetings and some comments.

5 I apologize for ... (not for late submission).

6 I apologize for late submission.

7 I apologize for late submission and provide a brief explanation (1 line).

8 I apologize for late submission and provide a medium-long explanation (2-3 lines).

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9 I apologize for late submission and provide a long explanation (4-more lines).

10 I apology for late submission and provide a brief explanation (1 line) and propose some extra work for being late.

11 I apologize for late submission and provide a medium-sized explanation (2-3 lines) and propose some extra work for being late.

12 I apology for late submission and provide a long explanation (4-more lines) and propose some extra work for being late.

13 Assignment sent without apology for being late.

14 Other comments.

Because of low data occurrence under criteria 7-13, the data were re-structured into 6 groups according to the criteria 1-6 while all items relating to criteria 7-13 were included under the criterion 6. The criterion 14 was stated as it had been defined.

RESEARCH RESULTS AND DISCUSSIONS

The collected data were processed by the NCSS 2007 statistic software, analyses are displayed in tables and figures below. The data are of the nominal type; we consider this way of presentation the most suitable and adequate to the objectives we focused on.

First, the frequency analysis was applied, i.e. the occurrence of communication was monitored. Second, the content analysis was run structuring students´ messages under 14 criteria.

Frequency of the learner-tutor communication

First, the frequency of communication was monitored, i.e. we focused on the question whether there ever exists any communication between the learner and tutor when the assignments are being submitted. Under the criterion 1 (Assignment sent without comments) non-communicating students were included who did not provide any message to the tutor when submitting their assignments. The data were considered from the point of academic year – 2007-12 (table 1, figure 1) and the subject learned – E1-E6 (table 2, figure 2). The tables and figures display the amount of communicating students, i.e. those who added any message (under criteria 2-6) when submitting their assignments.

Table 1: Communicating students in 2007/8 – 2012/13 period.

	2007	2008	2009	2010	2011	2012	Total
Assignments (n)	362	442	541	270	348	440	2,403
Criteria 2-6 (n)	97	162	107	87	108	164	725
Criteria 2-6 (%)	27	37	20	32	31	37	Mean 32 %

Table 2: Communicating students in six subjects of English for Specific Purposes (E1 – E6).

	E1	E2	E3	E4	E5	E6	Total
Assignments (n)	470	506	393	356	366	312	2,403
Criteria 2-6 (n)	79	118	112	123	163	130	725
Criteria 2-6 (%)	17	23	28	35	45	42	Mean 32 %

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Table 1 displays the occurrence of communication. Total amount of messages sent from students to the tutor was 725 within the period of 2007/8 – 2012/13 academic years (32 %, single values vary from 20 % in 2009/10 to 37 % in 2008/9 and 2012/13), while 1,678 learners did not provided any type of learner-tutor communication in this period. Figure 1 shows there was no regular increase in frequency detected within the given period. On the other hand, from the point of single subjects E1 – E6 the progressive increase was monitored (see figure 2), starting from 17 % in E1 to 45 % in E5, but except the final E6 subject. The decrease in E6 was not sharp; the frequency of communication declined from 45 to 42 %, i.e. 3 % only, and at the same time it still kept rather high. This result proves our expectations on step-by-step (semester-by-semester) development of closer learner-tutor relation expressed in the increase in communication in successive subjects.

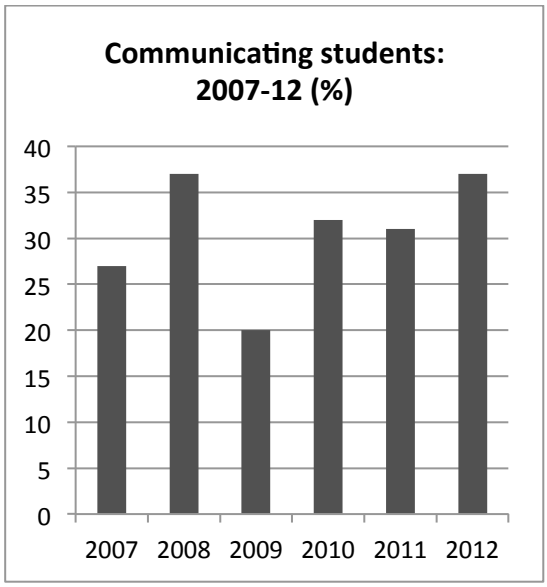


Figure 1: Communicating students in 2007-12 period (left).

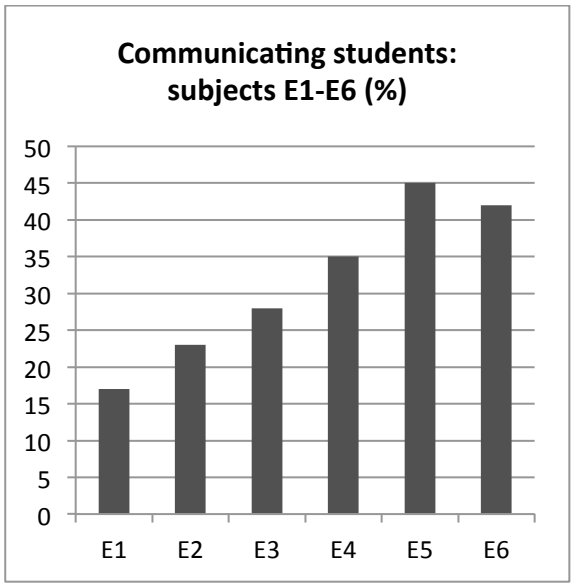


Figure 2: Communicating students in six subjects of English for Specific Purposes (E1-E6, right).

Content of the learner-tutor communication

The content of the learner-tutor communication was analyzed according to

criterion 2 (I am sending my assignment);

criterion 3 (I am sending my assignment + greetings);

criterion 4 (I am sending my assignment + greetings + some comments);

criterion 5 (Apology (not for late submission);

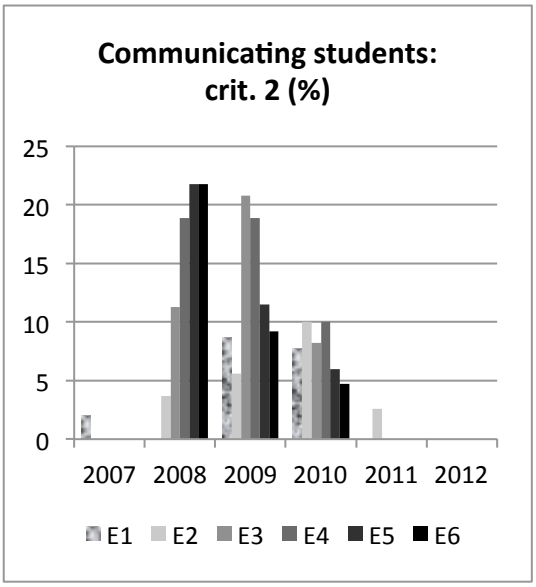
criteria 6-12 (Apology for late submission; Apology for late submission + brief explanation, 1 line; Apology for late submission + medium-long explanation, 2-3 lines; Apology for late submission + long explanation, 4-more lines; followed by the same scale including some extra work for being late);

criterion 13 (Submission without apology for being late)

and criterion 14 (Other comments).

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Received results are displayed in figures 3-6. As clearly seen, the figures do not display all values. It does not mean the data are missing but zero values were detected in some academic years and in some subjects.



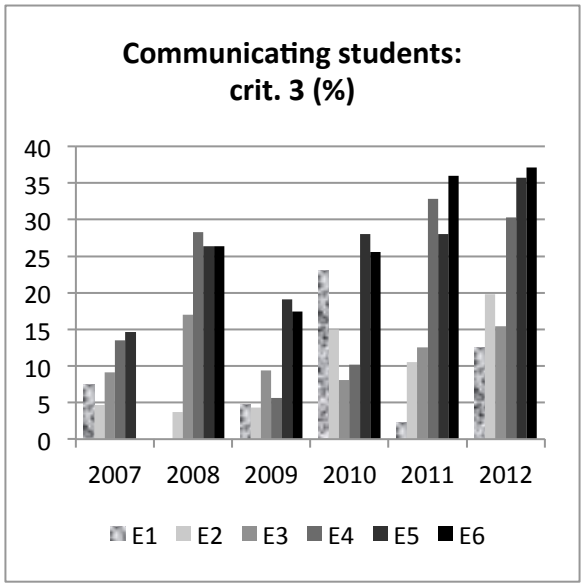


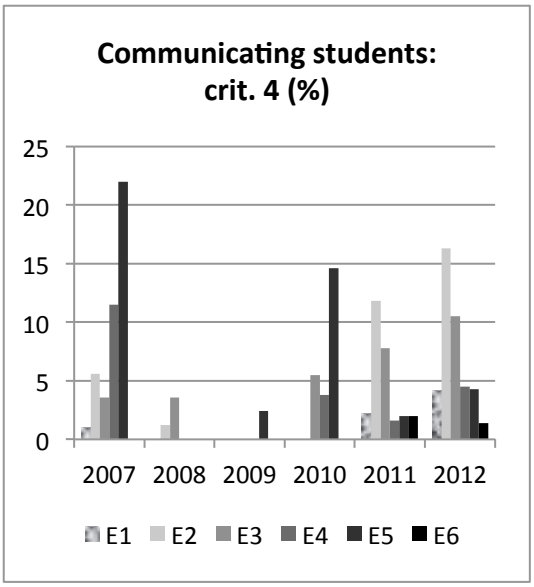
Figure 3: Communicating students – I am sending my assignment (left).
Figure 4: Communicating students – I am sending my assignment + greetings (right).

Comparing figures 3 and 4 the increase in frequency of communication is confirmed, when the type of shortest message notifying about submitting the assignment was more frequently sent in 2008/9 – 2010/11 academic years; in other years zero values were detected, i.e. this type of message was not used by the students (criterion 2, see figure 3). The longer message informing about the submission and adding short greetings (criterion 3, see figure 4) appeared more frequently; the values were increasing semester-by-semester including the final one, which comprises difference to figure 2. The gradual increase was observed in single years (except 2009/10) and in single subjects.

Figures 5 displays an exemplary increase in communication from the point of frequency and content in 2007/8 academic year, when a type of rather long message containing notification about submission, greetings and some comments was most frequently detected. Unfortunately, in following two years hardly any communication of this type appeared. On the other hand, the 2012/13 academic year serves an opposite example – messages of this type most frequently appeared in E2 subject, i.e. in the first year of study, but the frequency sharply declined in following semesters.

In figure 6 all types of apologies listed above are summarized. The results show students do not apologize for late submissions very often (if they do, rather frequent are healthy reasons and workload).

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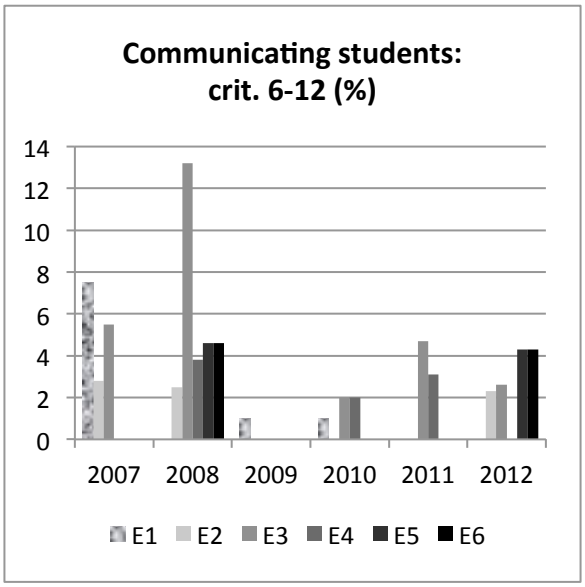


Figure 5: Communicating students – I am sending my assignment + greetings + some comments (left).

Figure 6: Communicating students – Apology for late submission (of different extent + explanation the reasons; right).

Apologies from other than late reasons are included under criterion 5 but mostly zero values were detected, except the 2008/9 academic year where 1.9 – 4.9 % of messages were sent. Criterion 13 displays the occurrence of submissions without apology for being late which should correspond to reverse values in figure 6 and the frequency of late submissions.

Finally, other comments were included under criterion 14; this type of message was used by two types of active learners – they either proposed e.g. additional sources for assignments solving, asked additional questions etc., or they were ´active´ and invented and introduced their own redundant ´original´ solutions of problems which unfortunately had been solved by other scientists long before.

CONCLUSIONS

As it results from the above presented data, the ICT development influenced great deal of population and currently it is understood to be standard. Thus the rate of computer literacy increases as one of the necessary preconditions of the ICT-implementation into the process of education at all types and school levels. Having solved the problems with hardware and software equipment, it is time we started to pay attention to didactic aspects. What are the results? Are teachers able to apply suitable methods and forms of instruction, create and use appropriate didactic means which are offered by new technologies? Do students know more after the process of instruction which is supported by ICT than having been taught in the traditional way? The most important question dealing with the research topic is as follows: Are the new didactic means, i.e. methods and forms supported by modern technologies, able to optimize the

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cognitive process of creating knowledge? Is the communication able to contribute to this process, and if yes, what way and to what extent?

We hope the presented results will support the ICT-supported process of instruction. Current approaches to tertiary education mean to tailor the teaching/learning process to both latest requirements of the society, technical development, and individual student´s preferences. The ICT-supported process of instruction provides tools for tutors how to optimize the process, apply individual learning styles, not only in teaching but mainly in learner-tutor communication. Despite the demandingness it is teacher´s/tutor´s task to accommodate the required style/s and offer such teaching methods which will satisfy students´ preferences to a large extent.

Communication is an essential part of the process of socialization and the core of upbringing and education. This research aimed at a small part of educational communication only which appeared in the ICT-supported distance form of instruction in online courses in the virtual learning environment WebCT/Blackboard. Despite this some recommendations can be deduced. Positive relations and trust between teachers and students are reflected in the way of mutual communication, and it contributes to higher quality of the educational process and warmer climate within the learning environment, i.e. it supports positively the course of instruction. The ´non-invitational communication´, i.e. such a type of learner-tutor communication which is not obligatory but desirable, is highly appreciated. Current fast development of information and communication technologies makes the distance communication easier. It still holds man is the sociable creature longing for communication in any form. Following long-time observations would be highly desirable as they could provide other data and result in conclusions applicable to teaching other subjects and to the field of the ICT-supported instruction in general.

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Creation of Interactive Teaching Materials Using Adaptive Support Web 2.0

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Abstract

Interactivity in the learning process has a unique place. Many experts from the field of pedagogy and psychology agree that the term of interactivity cannot be understood only as a bipolar interaction between pupils (students) and teachers. Currently with the massive arrival and implementation of ICT in the educational process the concept of interactivity have much broader meaning as in past. Importance of interactivity has increased particularly after the introduction of e-learning as an effective learning support and as a standard supplement of learning process, designed not only for the development of knowledge but also skills of the students. With questions, that relating to the use of interactive media elements in the educational process for the development of cognitive and intellectual abilities of students, experts in the field of pedagogy and psychology deal with for quite a long time. Skills and possibilities of created study materials are currently at position to be closer to the abilities and skills of students through the technology, which include not only elements of adaptation, but also the personalization of learning in an e-environment. This creates a strong real interactivity of students and learning environment. The integration of adaptive educational systems is relatively recent trend in technology learning with the support of web applications. One reason is that the adaptation of e-learning courses for to support of learning have a positive impact on the learning process, which leads to increased didactic efficiency, effectiveness and satisfaction of students.

Keywords

E-learning. ICT. Adaptive systems. Personalization of learning. Web Based Learning. Interactive Systems.

INTRODUCTION

The ICT with its basic character enables us to increase the quality of educational processes (Kostolanyová, Takács, Šarmanová, 2012). Nowadays, we can't even imagine education in our information society without its electronic form (Kostolanyová, 2012). Since that e-learning has become a phenomenon currently, it is also necessary knowledge and skills to accept faster than hitherto used methods of teaching. How is it possible it that young, but also older people accept the information immediately with the use of new information technologies? Easier we accept information in a pleasant environment and form and which is very important at a time of your choosing (Turčáni, 2008). E-learning is

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multimedia support of a learning process, combined with modern information and communication technologies (Koprda, Polák, Klocoková and Záhorec, 2006). The explosive growth of the Internet has been accompanied by rapid growth in e-services. E-learning, that is, a type of e-services, has been one of the most significant recent developments in both schools and corporations. It provides convenience and flexibility with anytime and anywhere accessibility, enables users to access up-to-date knowledge, find solutions for their studies/work-related problems, contribute to their experience and knowledge (Violante and Vezzetti, 2013).

Although e-learning has changed higher education significantly in the recent years, little attention is paid to individual differences (Horký, 2013). Modern technologies provide a great potential for individual differences application in pedagogy. This approach respects and values learning styles and strategies, motivation, autonomy, creativity, or multiple intelligences (Dörnyei, 2005; Gardner, 2006). The issues of education individualization are solvable in several ways - from the technical point of view, it is possible to apply the principles of neural networks or expert systems. From the perspective of view categorization of individualization type, it is possible to adapt the education process according to various criteria, e.g. according to learning styles, multiple intelligences, special education needs, talent, etc... (Allen, 2003; Bain, 2010). And this is the area for Adaptive e-learning systems.

In paper, we focus on the precondition that the interactive animations that have been implemented in e-course Computer Architecture, are not effective to the extent to which they may be. Thus, we are trying to figure out which parts of animations are not essential or necessary for students. For their adjustment were used features of adaptive systems with already known technique of teaching - support materials in e-learning. Most experts of Pedagogy agrees that interactive teaching, which allows crossfading of "teachings with practice" raises interest and motivation for another study of certain issues.

ADAPTIVE E-LEARNING SYSTEMS AND THE NOTION OF ADAPTIVITY IN LEARNING PROCESS

In adaptive e-learning we try to make learning more efficient by adapting the process of learning to students' individual needs. To make this adaptation possible, we need to know key students characteristics - his motivation, group learning preferences. sensual type and various learning styles (Takács, Šarmanová, Kostolányová, 2011).

Adaptive system of education is the process in which the learning of individual is adapted for its skills and acquired knowledge are evaluated through feedback from the ground monitoring the effectiveness of teaching and routing to the maximum performance within the individualization of learning itself. To meet the above conditions include adaptive e-learning systems the following elements:

- Defined Learning Strategies;
- Continuous monitoring;
- Feedback on student performance.

Nowadays achievements of adaptive e-learning systems we can see in the area of provision of education through modern of techniques personalization of teaching.

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Accoring to Czeczotková, Kostolányová and Šarmanová (2011) personalized e-learning is understood as not only an instruction tailored to each student according to his characteristics, but it is also adaptable according to the actual conditions under which the learning takes place.

Experts from various research disciplines are of the same opinion to the personalized e-learning environments: the principle of modern teaching based on known paradigms is that different learning objectives require different didactic approaches.

Known learning paradigms provide different approaches to teaching for different students as reflected primarily in the need for different teaching materials. Evaluation results show that individual learning styles are identifiable and that adaptation to the specificities of students improves the performance of learning in preparation of students (Rasmussen and Davidson, 1998).

Learning styles have been a subject of extensive research (Coffield et al., 2004; Cohen and Weaver, 2004; Robinson, 2002), however the research focuses predominantly on their identification and classification. According to Horký (2013) generally learners employ their dominant style and consequently use subordinate ones to some extent. The dominant style can be replaced with the subordinate one as a result of age, environment, maturity, learning content, or targeted instruction.

Of the community which working in the field of e-learning with those elements of adaptive techniques are shown under the term Adaptive e-Learning (AEL). One of the main advantages of use AEL is efficient use of supporting teaching materials that are developed by the particular on the basis of characteristics of students. This task is not trivial and, moreover, is not the only challenge for the fulfilment of the objectives. In order to allow realize the optimization of the personalization of education, we must be aware of the acceptance of certain rules, this means that we should not forget the principles of didactics and with use these make crucial decisions. For process personalization of education in adaptive e-learning is a very important area of analysis of the learning environment, through which undergoing student and on the basis it is necessary not only to evaluate information from procedure in system but also adapt the environment in order to achieve the learning goal. The proposed AEL needs properly represent every interaction with user. Information about individual users can be obtained directly from users or on the basis of evaluating of their approach during the learning process.

The design and development of components for modelling of users adaptive systems is not a trivial matter and assumes solve some problems relating thereto e.g. how to identify the individual characteristics of user, as to distinguish between facts and assumptions about the user, or how protect private user data, how to properly analyze the properties of user and these provide in the system.

As regards the applicability of e-learning is very important to realize that computers cannot handle the learning process themselves. Learning is a cognitive process that has to be realized with using selves' students. This means that in terms of the student, learning is an active process (Ebner et al., 2006). So not only provision of knowledge, but also the solution of practical tasks students (e.g. learning by doing) is essential for successful e-learning. One possibility to achieve this is to use a method exploratory learning (diSessa et al. 1995).

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MODELLING OF INTERACTIVE ANIMATIONS IN LMS

Currently is the market quantity of LMS (Learning Management Systems) and LCMS (Learning Content Management Systems), which has been successfully used in the educational process. Moodle is not fully adaptive system. Its advantage over most other systems is the openness of its code for a wide range of professionals (programmers, experts of Pedagogy and psychologists) where its development may for be involved. Moodle is based on the so-called modularity. The modules are the parts that form the core of the system. Anyone who wants to contribute to the development of the system may programmed module and embeds him between the communities, where then verifies its functionality and is approved for further use. In this way it is possible to create your own modules, or use already existing modules designed to personalize learning.

According to Kostolányová, Takács and Šarmanová (2012) LMS Moodle apart from delivering curriculum, boosting illustration and providing communication tools, it provides tools for the evaluation and assessment of students.

Interaction between student and LMS in the process of teaching and learning is a composite process (Balogh and Koprda, 2012).

In order to design a model of transition student in interactive animations, it is necessary to provide a method by using which is possible to record how students use animation. For this reason, it is also necessary to recognize which user is logged in the system Moodle, i.e. whether it's a student or teacher. It should also be recorded which interactive animation is displayed and that they parts in the animation are used.

The distinguish between the student from the teacher is necessary to ensure that only the teacher had access to statistical data (we mean descriptive statistics) obtained from handling a given interactive animation. Whereas the precondition for the this realization was to retain the original structure of the module contained in Moodle for statistical evaluation approaches and creating records on participants in the course, we designed and created their own way of obtaining results from the interaction of action within the animation. System Moodle is supplemented by tables and linking them into a single functional unit we called module "BeSt" (BeSt - designed Magdin, programming by Benjik, Struhar and Magdin).

Using this module we can get for each interactive animation descriptive statistics separately. Likewise is with the removal of the results - either for each separately, but absolutely for all. Since Adobe Flash does not communicate directly with the database Moodle, but can easily communicate with PHP files at runtime interactive animation, we created necessary to PHP files for to communicate between animation and the database Moodle. Description how working module "BeSt" has been described in this paper Interactivity elements implementation analysis in e-courses of professional informatics subjects (Balogh, et al., the paper was presented in Efficiency and Responsibility in Education 2011: 8th International Conference).

In to the animations we added two functions, with using which is possible:

- Send data via POST method (this method allows us to communicate with PHP files);
- Identify the type of user who is currently logged on.

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As a modelling tool for creating a model of transition of student in animation we use Petri Nets. Petri Nets were introduced in 1962 as a mathematical tool for modelling distributed systems, and in particular concepts such as concurrency, nondeterminism, communication and synchronization. To their further development helped the fact that they we are able by using them to simply model the synchronization process, co-operation and conflict whether resource sharing.

From the pedagogical point of Petri Nets can be a very effective tool for modelling certain processes. In this way, it is possible to create a directed graph, through which we can very easily understand certain issues. Petri Net is a modelling tool with which we can create a directed graph that will show the sequence of events in a particular system and can thus serve as a model or algorithm, which simply and effectively displays the progress of the action. This modelling tool is useful, when system in the real world is not understandable by visual observation.

Thus, the Petri Net we can be used for to show systems in different areas. With simulating, we can achieve a higher quality of teaching as well as generate greater interest among students. From a pedagogical point of view, modelling of the system using Petri Nets can also be used to optimize or improve the teaching materials. That is why we have chosen Petri Nets as a modelling tool using which we can detect parts of animations which are unnecessary for a student and then delete unnecessary parts and thus simplify usability of our animations.

Model which arises represents formalized knowledge's of the modelling system and covers only the part that we want to examine, and which is important for us. Because the model is always based on some subset of knowledge that is incomplete, we can model only what we are able to understand and describe (Peringer, 2006). Thus we can say that modelling is the process of creating a model system based on certain knowledge's.

CASE STUDY

Data on how students use interactive animations in e-learning course with a name Computer Architecture were recorded during one semester, particularly during the summer semester of the academic year 2011/2012. With using the module BeSt we created a simple statistics of access of student - easy way for to record in the database Moodle how many times was used certain part of the animation.

During the summer semester we had sample of students (52), who had used animation and during this time we recorded 14059 interactions with animations (total count of animations in the e-course was 9), where the average per student was 270,37 interactions.

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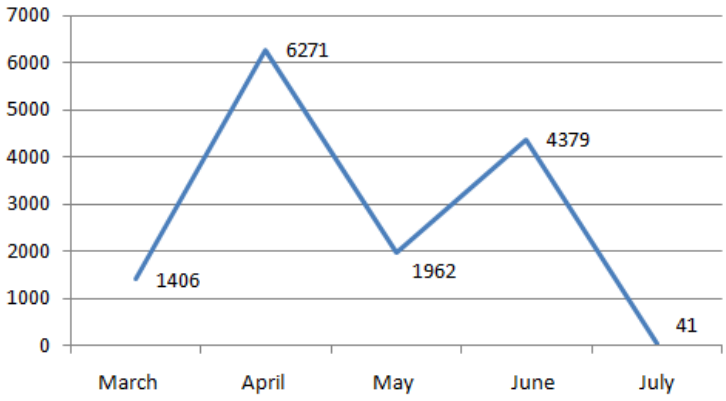


Figure 1: Overview of activities of students for individual months.

Interactivity is one of the fundamental characteristics of interactive animations, and is the last step towards their perfection, because the affects the behaviour of animation and her total output. It is needs to has been conditional on the existence of a feedback with the possibility of sending of certain requirements. This will pose a direct and active entry to animation, resulting in the user's creativity. It is important to not lie only in the choice of response options, whether the ability to start or stop the animation. Number of interactions in different parts of animations for each month is shown in the Figure 1.

THE PROCEDURE OF CREATING MODEL OF INTERACTIVE ANIMATION USING PETRI NETS

Data on how students use interactive animations in e-learning course with a name Computer Architecture were recorded during one semester, particularly during the summer semester of the academic year 2011/2012. With using the module BeSt we created a simple statistics.

By way of example within the case study we present an interactive animation - motherboard of PC.

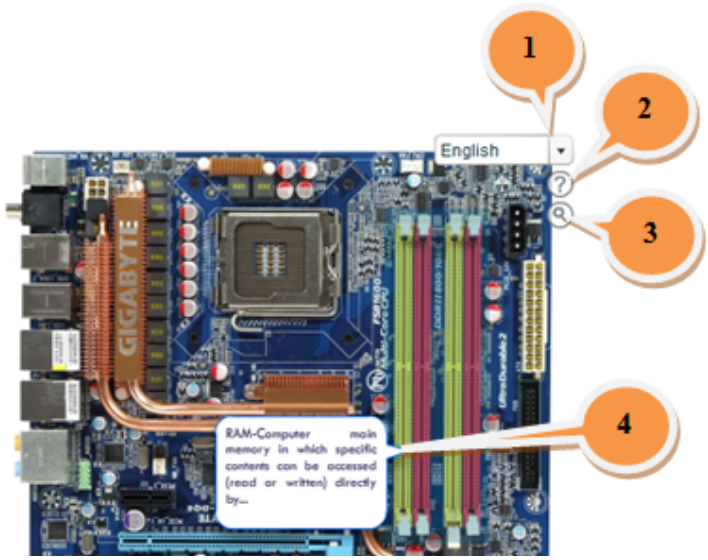


Figure 2: Interactive parts of animation (motherboard PC).

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Explanation:

1. Change language
2. Help
3. Zoom
4. MouseClick or Mouseover to selection

Interactive animation of PC motherboard is created for the students so to have an overview of all parts of motherboard PC and also to enable a simple way to access the necessary information. Precisely for this reason, when a student moves the mouse pointer over a component, then the text appears, which describes the problematic part and click to display the rest of the text, which provides a more detailed description. Essential parts of animations are shown below.

Original interactive animation (not yet unadjusted) contains the following sections:

- The ability to change the language to English;
- Help button, which when clicked will highlight any interactive parts;
- Button to zoom, which can be used to observe the motherboard detail;
- Other buttons are designed so that was displayed the description of a certain part (only short description) and when you press was displayed the entire text.

Table 1: Overview use of certain parts of the animation of motherboard for individual months.

	March	April	May	June	July	Average
Mouseover to selection	2035	4853	1582	5053	203	2745,2
Help	2	29	19	12	0	12,4
Zoom In	4	6	7	9	0	5,2
Zoom Out	4	5	5	7	0	4,2
MouseClick to section	89	141	93	170	5	99,6
Change language	89	141	93	169	5	99,4

For to the analysis of the possible transition, we have created a Petri Net from all animations by using which we are visualized interactions of the student with animation. By the term possible transition we understand visualization to which place is the student may get to while using animation. Use of Petri Nets as a modelling tool is particularly useful for data analysis, we have obtained from the database. It us also allows to analyze the obtained data, which parts of the animation students use, and which are not. On the basis of analysis of creation of these models with data, we can more accurately determine the importance of each part of the animation for the student. After analyzing models of Petri Nets, we have removed unnecessary place in animation and thus we to created new models, which remained only those place that are important for students. Removal of conditions is possible only in the case that is not endangered the very meaning of interactive animation.

To the following figure is created a model of Petri Net, where we displayed all the possible places in to which a student can get.

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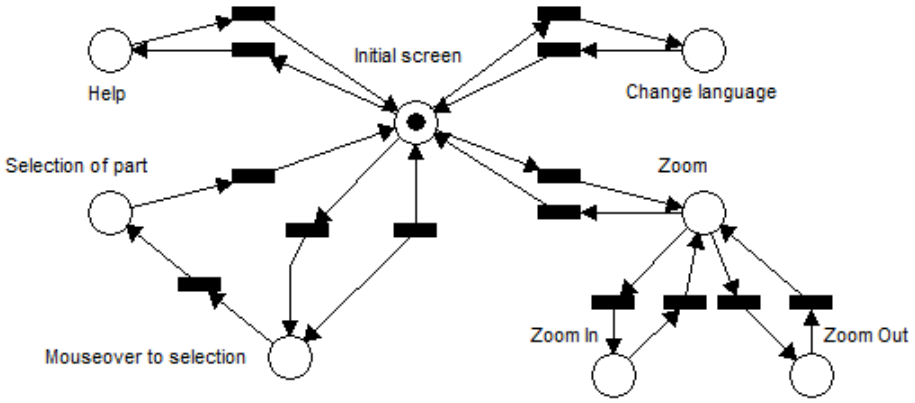


Figure 3: Petri Net for animation of motherboard.

On the basis of Table 1 we can see that very little of students uses the option zoom to the motherboard, from the results we can also see that after is activating button Zoom some students were not able to get back to the start screen. This fact tells us that the Back button is not the right place or not sufficiently highlighted. Help button during the entire semester was used 62 times, while the number of students was 52. From this fact, we can estimate that every student at least once a semester activated button Help.

Other buttons students often use what it tells us about how students worked with the animation. From the statistics, we can see that most of the students undergone with the mouse pointer to a specific part, without that clicked and find out more about that part. Unfortunately, on the basis of these data, we cannot determine exactly how many times students did not clicked on a part (fully displayed description). But we can say that in most cases they are only interested about a shortened version of the motherboard.

We can say that from 28 different places students had possibilities to click on 26, in animation were only two places to who students could not click away. From the data obtained, we can see the difference that on average the students have undergone the mouse on a certain part of 2745,2 times and clicked only 99,6 times. Also, we can notice that the button Help was ignored. We need to realize fact that button Help brings a new information for student where indicated to the which parts students can click away. Button Zoom in essence only swells what the student has already seen. After the analysis we applied acquired knowledge's so, that we have removed zoom for motherboard. In the following figure we displayed the new modified Petri Net model.

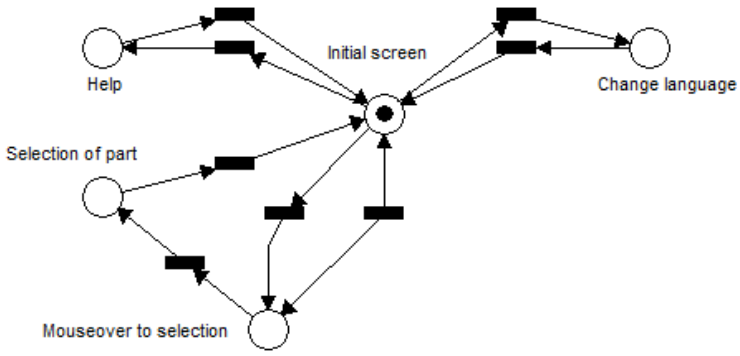


Figure 4: Petri Net of motherboard after removing unneeded places.

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When we created a new model for interactive animation of the motherboard, we had to apply these changes to animation in Adobe Flash. When applying these changes, we adjusted animation for students on the basis of transition of the interactive animation. With using obtained data analysis, we discovered how students use animation in e-course Computer Architecture. Most of the animations are edited so that we removed those parts of the animation that proved to as unnecessary for students. When removing unimportant parts, we placed emphasis on the fact that we did not remove any part. Thus we can say that we not delete those parts which would have led to new information or new teaching materials.

EVALUATION OF RESULTS

With this case study, we found that students do not need a control bar, using which is possible get to navigate through the fully animation. In all interactive animations, in where was implemented this control bar, from the statistics we can see that the buttons on the bar were used minimal. In this case, it is interesting that most of the students at the end of the animation rather uses a button, by means of which is possible re-start the animation how control bar, through which they could be immediately relocate to the desired part of the animation. We also found that students do not need the extra features in animation, if this function does not provide new information. This fact it was found in the animation of the motherboard, where existed a possibility zoom to specific part the board. From the statistics, it is clear to us that the students were not interested of this option.

CONCLUSION

Interactivity as the tool of developing abilities and skills of the student is certainly a suitable complement within an e-learning support of education (Turčáni and Magdin, 2012).

According Pinter (2012) various researches focusing on the effectiveness of learning with the help of visualization point out that in order for the animation to be well accepted, by the (Moreno, 2007), (Weiss, Knowlton and Morrison, 2002), (Um, Song and Plass, 2007) the following have to be kept in mind :

- Positive effects in learning can only be achieved in topics that are dynamic in character;
- An exaggerated multitude of colours in the animation will have the exact opposite effect;
- It is important for the application to contain an optimal amount of information.

Programmer when creating animation often encounters the problem that his interactive animations they are very simple to use and as a result thinks that no Help button is needed. This is because that the alone programmer creates such an interface, which is according to him very easily to understand and use. It is therefore important to realize that this is just a personal or individual proposal to address the problem. Thus, what appears to be for a programmer easy for uses, it certainly does not mean that it will be for all easily understandable. This rule also confirmed by the fact that the programmer

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spends several hours to create the design and programming, only he knows all parts of the animation to the smallest detail and also he know of how it all works in the background. Therefore, programmers are often unable to properly test their interactive animations. On the basis of these problems mentioned above, it is necessary to test interactive animations by using test group, which consisting of experts from different fields (we mentioned at the beginning of this paper). Thereafter it is then possible by observing and analyzing to determine what are the weaknesses in the new animations and to modify their so, in order to achieve a higher degree of interactivity and intuitiveness.

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The Information Literacy and Creative Originality of Trainee Teachers of Technologies

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Abstract

The paper explores the information literacy of female trainee teachers of Technologies in Lithuania. It was determined applying Mažeikienė et al.'s (2008) test, and their creative originality was analyzed by means of Torrance's technique of personal creativity diagnostics (a verbal expression questionnaire). The paper analyzes the relation between the informants' information literacy and creative originality. These investigations and discussions justify the significance of Technology teachers' information literacy management and creativity expression as well as enable to conduct a qualitative research on the trainee Technology teachers' information literacy, creativity and the interrelation of these two components. The trainee Technology teachers' acquired knowledge and experience facilitate the expression of creative originality, yet, they are not a decisive factor of originality expression – high average grades do not determine high points for the expression of creative originality. The tasks which require description of objects / phenomena are most favourable for the expression of originality of students of Technology Education. Even though the task which required logical, analytical thinking and imagination did not reveal a high expression of the informants' creative originality, the statistic creative originality in this task was higher than the total statistic verbal creative originality of the informants. Technology education students were able to answer a half of the questions in the information literacy test. Only the informants with the highest average grade (10) got the highest scores of information literacy in the group. Constructive information search requires creative originality which facilitates the creation of different strategies of information acquisition. Information selection and integration into the possessed experience is a complex holistic process which requires logical thinking, creative thinking and knowledge. On the basis of the research results, there was a "threshold" theory formulated: the informants whose verbal creative originality is lower than 145 points have lower skills of information assessment and integration.

Keywords

Information literacy. Creative originality. Trainee teachers of Technologies.

INTRODUCTION AND THEORY BACKGROUND

For the last three decades UNESCO has been trying to promote the development of media and information literacy (http://unesco.lt/komunikacija-ir-informacija/mediju-ir-informacinis-rastingumas). Information literacy is the result of media education (the process of teaching and learning) and they key to life-long learning. The open-minded,

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educated and constantly learning information society which manages information is inevitably using information and communication technologies not only in their working environment, but also in different spheres of social, cultural, economic and political life. It is conditioned by the continuous reception, acquisition and transfer of knowledge with a special emphasis on the novelty and otherness of the present situation, the influence on human consciousness which is reflected in educational issues (Daujotytė-Pakerienė, 2001; Raeis, et al., 2013; http://unesco.lt/komunikacija-ir-informacija/mediju-ir-informacinis-rastingumas).

Modern students are a generation which is being brought up by different technologies, including the information technologies, and any activity of theirs is related to technologies (Engestrom, 2001; Fischer, 2005; Jenkins, 2006; Cross-Bystrom, 2010; Rosen et al., 2013). Educators aim not only to manage information efficiently themselves, to innovatively improve the programmes of education and implement them, but also to encourage the growing generation to use information constructively, assess it critically, integrate into their possessed knowledge, ethically use it and create it by themselves (Daujotytė-Pakerienė, 2001; LaPorte, 2008).

The goal of any country is to train the future specialists so that they are able to answer the needs of the EU and global market in order to improve the economic competitiveness of the country. A necessary precondition for the implementation of this goal is perfect information literacy (Poler Kovacic, et al., 2012), hence, researchers all over the world conduct studies aiming to reveal the students' (Ladbrook, Prober, 2011; Maitaouthong, et al., 2011; Poler Kovacic, et al., 2012; Raeis, et. al., 2013) and teachers' (Korobili, et al., 2011) skills of information literacy.

The international research and theoretical analysis determined that the use of digital technologies directly affects students' lives and attitudes. The students who use information technologies have a wider approach to the analyzed issues, they have better skills of information literacy, and they are able to think critically (Ladbrook, Prober, 2011). However, the results of some other studies show that teachers are not inclined to apply information skills in their professional activity and thus restrict their trainees' attitude to information (Korobili, et al., 2011).

Researchers conceive the certain influence of information literacy on the quality of activity and thus try to create effective techniques for integrating information literacy into bachelor degree studies (Maitaouthong, et al., 2011). The 21st century society faces the space and time of other possibilities, thus, the goal is to make the consumer become the creator of information. Every creator is expected to produce unique works, or, in other words, they have to be original (Daujotytė-Pakerienė, 2001; LaPorte, 2008).

Originality is frequently directly related to creativity Becker-Textor, 2001; Rowlands, 2011; Bhasin, 2011). Creativity expands the limits of cognition as well as production of scientific information and its development. In the era of information products, information literacy enables every individual not only to be inquisitive and look for information, but also to search for the target truth which helps to make individual decisions. The aforementioned processes are connected not only with personal or professional development and self-realization, but also with survival, adaptation, and competitiveness in the market. When solving the issue of survival in the era of information products, of key importance is creativity not only at universities, but in all institutions of education.

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Moreover, the ability to manage information is the reason to be proud of oneself and be confident of one's powers. Information management and confidence also affect creativity and its expression (Hensley, Arp, Woodard, Beth, 2004; Raeis, et al., 2013). Hence, constructive and productive activity requires two interrelated components – creativity and information literacy.

The General Programmes of Technologies for Basic Education in Lithuania (2008) state that Technological Education consists of learners' creative and productive activity, for the implementation of which information literacy and creativity are especially important. Good skills of information literacy help to distinguish between learning about the influence of the media, education technologies and educational media, and at the same time they can help to assimilate these spheres and become a creator of information. According to Pearson and Young (2002), modern society is directly dependent on technologies, which it at the same time creates; therefore, every person has to be familiar with technologies. The fast development of technologies and information alongside with the scientific progress require new patterns of thinking, knowledge and skills (Birmontienė, Tamutienė, 2001) which all rely on creativity. Creativity enables a person to interpret, assimilate new information with the old one, flexibly use the possessed knowledge, accurately apply the abilities in order to cognize, employ and create technologies Meyer, 2012).

The curricula of the 21st century include various abilities; nevertheless, creativity is incorporated into all education documents as one of the most important skills of survival (Jaquith, 2011). Creativity and creation have always raised a lot of questions and discussions (Guilford, 1950; Belcher, Davis, 1971; Torrance, 1971; 1974; 1977; 1987; Barron, 1988; 2004; Gardner, 1993; Gage, Berliner, 1994; Burleson, 2005; Olatoye, Oyundoyin, 2007), but the present-day attention to creativity is raising even more topical questions (Jaquith, 2011; Kozik, Handlovska, 2011; Díaz, 2011; Rowlands, 2011), especially in teacher training which is directly related to the world of tomorrow. Promotion of creativity expression is one of the major objectives of today's education (Meyer, 2012). These investigations and discussions justify the significance of Technology teachers' information literacy management and creativity expression as well as enable to conduct a qualitative research on the trainee Technology teachers' information literacy, creativity and the interrelation of these two components.

The research problem is the information literacy and creative originality of female trainee teachers of Technologies as well as their interrelation.

The object of the research is trainee Technology teachers' information literacy and creative originality.

The goal of the research is to investigate the information literacy and creative originality of trainee teachers of Technologies and to reveal their interrelation.

The methods used: scientific literature and documents review and a qualitative analysis, based on Mažeikienė et al.'s (2008) test and Torrance's methodology.

Research questions:

- What is the creative originality of the students of Technology Education?
- What is the information literacy of the students of Technology Education?
- Is the information literacy of trainee Technology teachers related to their creative originality?

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RESEARCH METHODOLOGY

Research instruments

The Methodology for a Diagnostic Analysis of Creative Originality

The assessment of creativity involves a number of criteria such as novelty, relevance, effectiveness, usefulness, and surprise (Boden, 2004; Cropley, 1999; Plucker, Beghetto, & Dow, 2004; Sternberg, Lubart, 1996,). Research on the assessment of creativity has been criticized for not having adequate criterion measures as well as for relying on subjective judgments and for using creativity tests that have theoretically too general or unimportant items to measure such a complex construct (Sak, Ayas, 2013).

The instrument for the analysis of trainee Technology teachers' creative originality (in verbal expression) was composed on the basis of Torrance's test technique (TTCT). The study also used Torrance's (1995) and Kim's (2006) works.

One of the features of creativity, i.e. originality, is determined according to the number of unexpected, non-standard, unusual answers. An answer is considered to be original when it is unique, exclusive in the group of the informants. Every original answer is assessed with 5 points. Different groups provide different original variants of the answer.

The questionnaire for the analysis of creativity features consists of two parts: verbal (*TTCT – Verbal*) and nonverbal (*TTCT – Figural*). This paper presents the investigation of creative originality on the basis of only one – verbal – part of the questionnaire (Fig. 1). When the informants were completing the tasks in the verbal part, they had to give answers in textual form. The verbal part of the questionnaire consists of four different tasks in which the research participants have to reveal the variety of objects / phenomena; describe objects / phenomena; foresee the possibilities of using the objects; foresee the possible consequences of using the objects. Every task has to be completed in 3 minutes. The tasks of the verbal part are composed on the basis of the curriculum of Technological Education which consists of four spheres: nutrition, textile, constructive materials, and electronics (General Programmes, 2008).

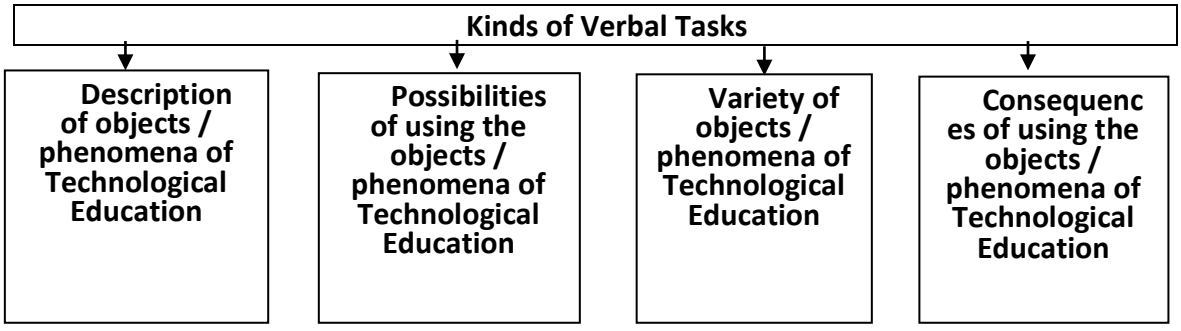


Figure 1: Kinds of Verbal Tasks in the Study on the Expression of Creativity Factors.

The Methodology for a Diagnostic Analysis of Information Literacy

The diagnostic analysis of information literacy was based on Mažeikienė et al.'s (2008) information literacy questionnaire which was adapted for Lithuania. The information literacy questionnaire consists of five groups of questions which correspond to the

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UNESCO conception of information literacy http://unesco.lt/komunikacija-ir-informacija/mediju-ir-informacinis-rastingumas): 1) perception of the goal and need for information; 2) determination of information search strategy and information acquisition; 3) information assessment, selection and management, integration of the selected information into the possessed system of knowledge and values; 4) information use and creation in order to achieve the target goal; 5) ethical and legal use of information (Fig 2)[10]. The complexity index (CI) of every group of questions was counted using the following formula:

$$CI = \frac{\sum N_1}{\sum N_2}$$

The higher the complexity index, the easier the questions in the analyzed group are.

The third and fourth year students of Technology Education, who took part in the study, answered 42 questions. Every question had four possible answers given and the students had to choose one correct option. The students' correct answers were analyzed according to the determined complexity index (CI).

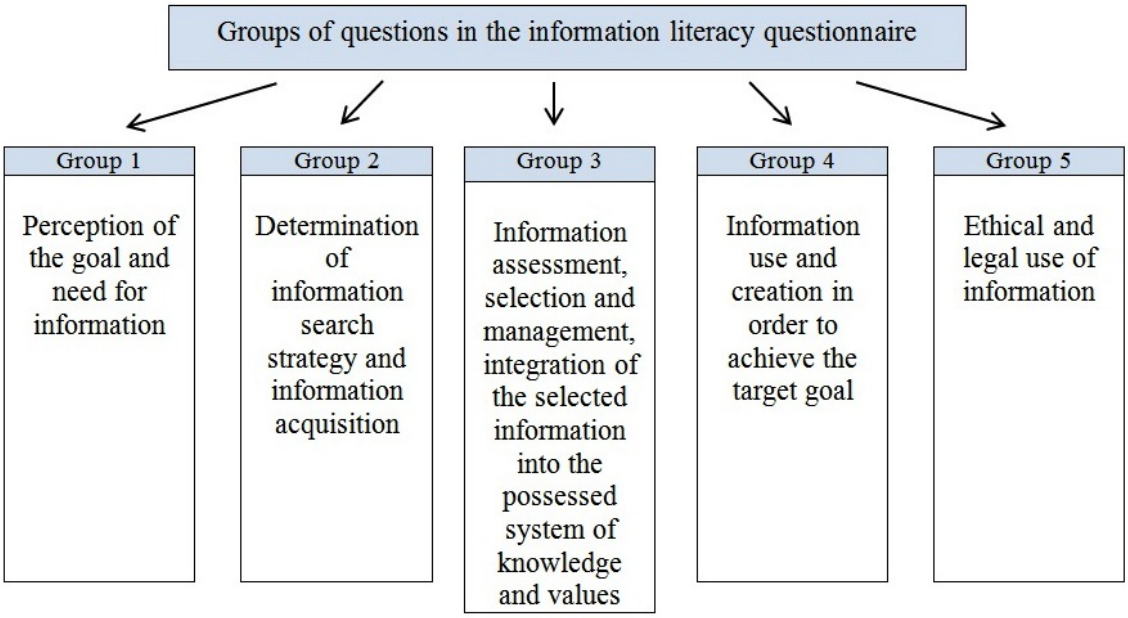


Figure 2: Groups of Questions in the Information Literacy Questionnaire.

[10] N_1 – the sum of the informants' points, N_2 – theoretically possible sum of points

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Characteristics of the Informants

Table1. Educational and Demographic Characteristics of the Qualitative Research Participants

No	Nationality	Average grade of the last (4th) term	Age	No	Nationality	Average grade of the last (6th) term	Age
Third year students				Fourth year students			
1	Lithuanian	9.5	21	1	Russian	9.07	22
2	Lithuanian	10.0	21	2	Polish	8	21
3	Lithuanian	9.03	21	3	Lithuanian	7	22
4	Lithuanian	10.0	21	4	Lithuanian	8	22
5	Lithuanian	9.4	20	5	Polish	9.2	22
6	Lithuanian	9.0	21				
7	Lithuanian	9.7	22				

The sample of a qualitative research is purposive and typically convenient (Patton, 2002). The informants of the research were female trainee teachers of Technology Education at Lithuanian University of Educational Sciences who were studying in the third and fourth years. The informants' educational and demographic characteristics were different (Table 1).

The research participants were all the students in the programme of Technology Education. It has to be noted that in the third and fourth years this programme is studied only by female students. The curriculum of the study programme covers all the spheres of technologies: nutrition, textile, electronics and constructive materials. The average age of the informants is 20-22, and the average grades of the third and fourth year students vary (Table 1).

RESULTS OF RESEARCH

The Creative Originality of the 3rd and 4th Year Students of Technology Education

The highest scores for the expression of creative originality were determined in the respondents' answers to the first task of the research – description of Technological Education objects / phenomena (3rd year students got 75 points; 4th year students – 70 points) (Table 2). The lowest total score (280) for verbal creative originality was determined in the answers to the task about the possible consequences. The completion of this task requires analytical thinking, imagination and logical insight. Despite the complexity of the task, every informant's answers included some unique consequences of the given situation. The results of the second – the possibilities of using the objects – and the third – the creative expression of the variety of objects / phenomena – tasks of the statement analysis showed that the answers of the 4th year students' No. 9 and 11 included no expression of originality. The average grades of these informants were among the lowest in the group (8.0). Moreover, the analysis of the research data demonstrated

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that the informants with high grades for their achievements also had high scores for the expression of creative originality.

Table 2. Evaluation of Trainee Technology Teachers' Expression of Creative Originality

Year	Informa nt	Description of objects/ phenomena	Possibilities of using the objects	Variety of objects/ phenomen a	Possible consequen ces	Total verbal creative originality	Average achieveme nt
III	1	60	5	40	30	135	9.5
	2	**75**	15	**60**	25	**175**	**10**
	3	55	40	15	**35**	145	9.0
	4	45	45	40	30	**160**	**10**
	5	55	45	20	15	135	9.4
	6	35	55	25	20	135	9.0
	7	**85**	**65**	50	30	**230**	9.7
IV	8	45	20	20	5	90	9.0
	9	45	0	20	15	80	8.0
	10	**70**	25	15	5	115	7.0
	11	45	20	0	20	85	8.0
	12	60	**30**	**40**	**50**	**180**	**9.2**
Total score		**675**	365	345	280	139	9.0

Information Literacy of the 3rd and 4th Year Students of Technology Education

The research did not reveal any significant differences between the information literacy of the third and fourth year students, hence, the paper presents the results of the statement analysis of computer literacy of students of both years together. The trainee Technology teachers were able to answer a half of the test questions on information literacy (3rd year – 51 %; 4th year – 48 %) and that shows fairly limited skills of information literacy. It was noted that the third year students who had the highest average grades (10) also got the highest CI points for information literacy (0.58 and 0.61) (Table 3). The research results demonstrated that only the achievements assessed by the highest grades have influence on information literacy.

The informants' CI scores were determined in the ethical and legal use of information (CI – 0.67). The trainee Technology teachers are best at the complex ethics of applying information, and worst at the acquisition of information (CI – 0.38).

The analysis of the trainee Technology teachers' information literacy revealed a relation between the total CI score of information literacy and information acquisition (the 2nd group of questions in the information literacy questionnaire) and assessment skills (the 3rd group of questions in the information literacy questionnaire): the informants of an average total information literacy CI (CI – 0.5) found it difficult to determine the strategies of information search and availability (CI = 0.1 – 0.3) (Table 3); the informants whose total information literacy is higher than the average CI are more able to determine the

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strategies of information search (CI = 0.4 – 0.7), to assess and select the target information and integrate it into the possessed experience of information (CI = 0.67 – 0.83) (Table 3).

Table 3. The Information Literacy CI, Creative Originality and Achievement Scores of the 3rd and 4th Year Students of Technology Education

Informant	Year	1 Perception of the goal and need for information	2 Determination of information search strategy and information acquisition	3 Information assessment, selection and management, integration of the selected information into the possessed system of knowledge and values	4 Information use and creation in order to achieve the target goal	5 Ethical and legal use of information	Total CI average of correct answers	Grades average	Verbal creative originality
1	III	0.6	0.3	0.3	0.57	**0.75**	0.5	9.5	135
2	III	**0.7**	0.4	**0.8**	**0.4**	**0.75**	**0.61**	**10**	**175**
3	III	0.5	0.4	0.7	0.57	0.5	0.53	9.0	145
4	III	0.6	0.4	0.7	**0.7**	0.5	**0.58**	**10**	**160**
5	III	0.4	**0.1**	0.5	**0.4**	**0.75**	0.43	9.4	135
6	III	0.3	0.1	0.2	0.57	**0.75**	0.38	9.0	135
7	III	0.4	**0.7**	0.7	0.57	**0.75**	**0.62**	9.7	**230**
8	IV	**0.47**	0.3	0.5	0.43	0.5	0.44	9.0	90
9	IV	0.13	0.3	0.3	**0.57**	0.5	0.36	8.0	80
10	IV	**0.53**	0.4	0.3	**0.57**	**0.75**	0.51	7.0	115
11	IV	**0.53**	**0.5**	0.67	**0.57**	**0.75**	**0.6**	8.0	85
12	IV	**0.47**	0.4	**0.83**	0.4	**0.75**	**0.57**	**9.2**	**180**
Total		0.47	0.38	0.54	0.53	0.67	0.51	9.0	139

The Relation between the Creative Originality and Information Literacy of the 3rd and 4th Year Students of Technology Education

The trainee Technology teachers, whose points for the expression of creative originality are the lowest (3rd year – 135; 4th year - 80), also got the lowest CI scores which do not exceed the average (0.5) information level (3rd year – 0.38 – 0.5; 4th year – 0.36) (Table 2, 3).

One 3rd year student of Technology Education, whose expression of creative originality scored highest in the group (230), got a significantly higher CI score (CI – 0.7) in the group of determination of the strategy of information search and information acquisition. A constructive search for information requires creative originality which helps to create different strategies related to information acquisition.

The skills of information assessment, selection, management and integration (the 3rd group of questions in the information literacy questionnaire) as viewed by the researchers as the most complicated ones (CI – 0.14). The research results show that the highest CI in the group of information assimilation skills was attained only by the informants whose total information literacy CI (0.57 – 0.61), creative originality score (160 - 230) and the average grade (4th year – 9.2; 3rd year – 9.7 - 10) were the highest in the group (Table 3).

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Information selection and integration into the possessed experience is a complicated holistic process which requires logical thinking, creative thinking and knowledge. The analysis of the research results conditions a "threshold" theory: the informants whose verbal creative originality is lower than 145 points have lower skills of information assessment and integration.

CONCLUSIONS

The trainee Technology teachers' acquired knowledge and experience facilitate the expression of creative originality, yet, they are not a decisive factor of originality expression – high average grades do not determine high points for the expression of creative originality. The tasks which require description of objects / phenomena are most favourable for the expression of originality of students of Technology Education. Even though the task which required logical, analytical thinking and imagination did not reveal a high expression of the informants' creative originality, the statistic creative originality in this task was higher than the total statistic verbal creative originality of the informants.

Technology education students were able to answer a half of the questions in the information literacy test. Only the informants with the highest average grade (10) got the highest scores of information literacy in the group. The informants are best at the complex ethics of using information, and worst at information acquisition (CI – 0.38). The informants who did not exceed the average (CI – 0.5) total information literacy CI had difficulty determining the strategies of information search (CI = 0.4 – 0.7), assessing and selecting the necessary information and integrating it into the possessed information experience (CI = 0.67 – 0.83).

The research participants, whose score for verbal creative originality expression was the lowest, also got the lowest CI scores, which did not exceed the average (0.5) information level, for their information literacy skills. Constructive information search requires creative originality which facilitates the creation of different strategies of information acquisition. Information selection and integration into the possessed experience is a complex holistic process which requires logical thinking, creative thinking and knowledge. On the basis of the research results, there was a "threshold" theory formulated: the informants whose verbal creative originality is lower than 145 points have lower skills of information assessment and integration.

DISCUSSION

Raeis, Bahrami, Yousefi (2013) conducted a study in Isfahan university aiming to determine the relation between medical students' information literacy and creativity. The results indicate that the mean of information literacy was higher than average and the mean of creativity was lower than average. The paper describes a study conducted in Lithuania and the aim of the research was to determine the relation between the Technology Education students' information literacy and creative originality. The research results show that the trainee Technology teachers attain an average level of information literacy. Korobili, Malliari, Daniilidou and Christodoulou (2011) conducted a study whose results demonstrate that educators in Greece do not tend to use their information literacy

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skills. However, the educators who have a Master's or Doctor's degree and less experienced teachers tend to use information technologies more frequently, thus good computer literacy skills are important to experience success. The researchers have no doubt about the necessity of improving the information literacy of teachers (Korobili, Malliari, Daniilidou, Christodoulou, 2011).

We are living in the information age and one of the variables that are associated with creativity is information literacy. The results of Isfahan university research indicated that the students who are more creative are more information literate and can reach higher goals. Therefore we can contemplate that increasing information literacy in the universities and other scientific education centers plays an important role in teaching and training a creative workforce. The results of the research conducted in Lithuanian University of Education Sciences confirm the conclusions of Raeis, Bahrami, and Yousefi's (2013) research. The trainee Technology teachers, whose score for creative originality expression is the lowest in the group, also had the poorest information literacy skills. One 3rd year student of Technology Education, whose expression of creative originality scored highest in the group (230), got a significantly higher CI score (CI – 0.7) in the group of determining the strategy of information search and information acquisition. Information search is a process which clearly reveals creative originality facilitating the creation of different strategies related to information acquisition.

The data of the research with medical students show that there is a significant multiple correlation between 5 dimensions of information literacy (Ability to determine extent and nature of information, effective and efficient access, critical assessment, ability of purposeful application, ability of understanding legal and economic issues) and creativity ($p \leq 0.05$) (Raeis, Bahrami, Yousefi, 2013).

The General Programmes of Technology for Basic Education (5th-10th grade) of Lithuania (2008) state that the changes of the society and individual needs cause changes in technologies – the ways and means of processes of production, the systems of material and human relations and regularities operating in technological processes, people's decisions, knowledge "how to act" in the system *nature-man-material environment.* The further development of technologies depends on personal decisions and the surrounding environment factors: cultural, economic, environmental and social. It has never been so important for learners to understand the influence of the future or already created technologies on nature, people, and material environment, to know how to assess the benefit technologies bring and their possible negative influence on people's and society's health, security and welfare. Technological literacy as the ability to conceive, use, assess and manage technologies, as positive attitudes to the continuous technological development, is significant for the modern society (The General Programmes of Primary (1th-4th grade) and Basic (5th-10th grade) Education / Technologies, 2008). Having in mind the fact that in technological education it is difficult to distinguish between the insights of creative and productive activity, the paper emphasizes originality of creative expression which helps people to orient themselves in the surrounding world, solve problems, make decisions, which would be useful for themselves and the society; promotes a positive attitude to the change of technologies, helps to adapt in the world that is rapidly changed by science and encourages self-expression in activity. James E. LaPorte (2008) states that the ability to manage information improves a person's self-image, continuous improvement in the professional sphere and enables a person to feel proud of himself.

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Teachers, who are able to manage information, can originally operate in their professional sphere and this can nurture unexpected, useful results. Hence, unexpected application of information requires creativity.

In literature and logic of psychology, the issue of "creativity" is considered in discussions of intelligence and thinking and reasoning. Today scientists have recognized the value and importance of creativity for the individual and society and they emphasize it, because they all believe that art and science and technology is the product of human creative process and there is a correlation between creative process and them (Raeis, Bahrami, Yousefi, 2013).

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A Novel Approach for the Increase in Student's Learning Motivation

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Abstract

We did a pilot study of a novel internet-based system and its potential application in education. The target are university students whose study field is largely based on encyclopedical knowledge. We attempted to answer a question, whether the proposed system can be a sustainable educational tool benefiting all involved subjects, i.e. students, senior experts and public. We observed the effect of various extrinsic motivational factors: we focused primarily on how is the students' motivation influenced by minor financial reward. The results after 22 weeks of monitoring suggest the proposed system can be a sustainable tool for students' education and involvement in solving real problems. However, it was difficult to make a conclusion about the influence of motivation factors, a longer monitoring is needed.

Keywords

Learning. Motivation. Multimedia application. Plant identification.

INTRODUCTION

Some professions require a high amount of encyclopaedic knowledge. It is generally more difficult to motivate students of these study fields to memorize such type of knowledge (Carole, 1992). Learning strategies which involve solving real problems has been discussed as more effective (Blumenfeld et al. 1991). Therefore, it is beneficial to try and search for ways where these methods can be applied and encyclopedic knowledge learning can be facilitated.

We launched a project aimed at plant identification recently. A person who wants a plant identified can submit its photo via internet. It is then uploaded to our system where

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a team of botanists can view and try to identify the plant from submitted photos. This task is very simple regarding abilities, but quite difficult regarding the amount of knowledge and experience about plants. Our system enables common discussion and feedback, making this task a team work. The system is intended to be stable, balancing the motivation factors (Fig. 1).

In this study, we analyse the students' performance in time. We particularly focus on motivation in relation to financial rewards, since its positive effect on motivation has been often questioned (e.g. Deci et al., 1999).

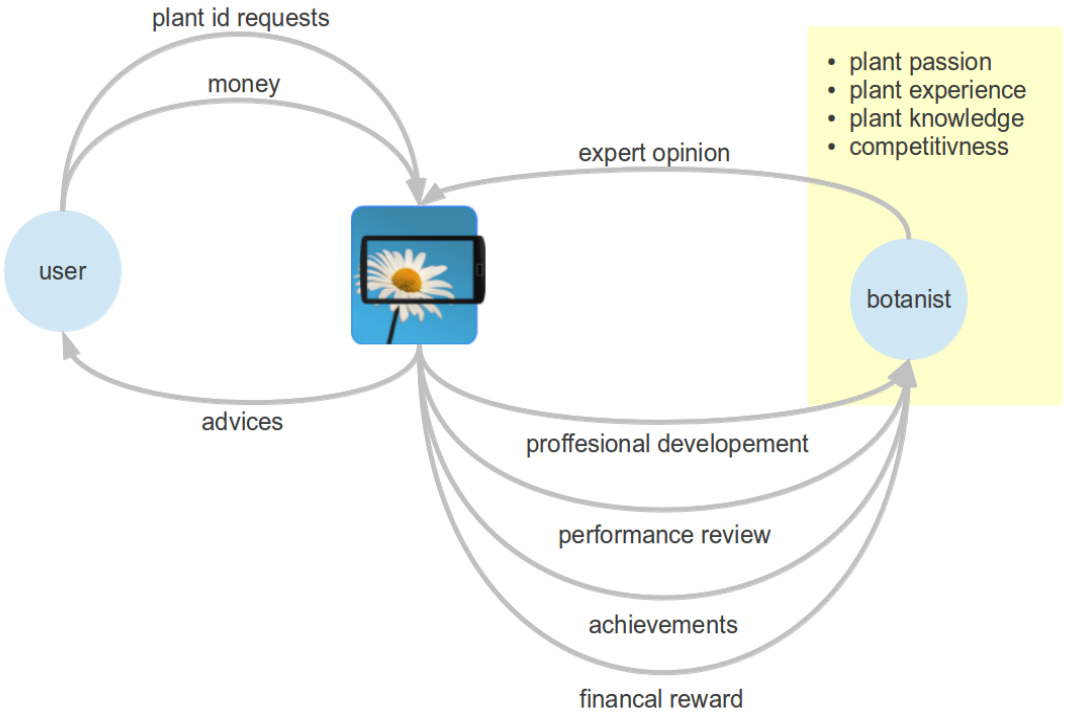


Fig. 1: Visualisation of various factors of motivation in the system. We assume their balance is crucial for its sustainability. The flow is designed to be cyclic to establish win-win relationships. Each arrow represents a particular opportunity to satisfy anticipated need or demand.

DEVELOPMENT METHODOLOGIES

We observed the students' performance in dealing with real issues of plant identification. We used a web browser-based environment (see Fig. 2) where plant identification requests are displayed in the real-time. Joint performance of seven university students of botany and horticulture was observed for 22 weeks.

The whole project adopts lean startup method, proposed in 2011 by Eric Ries. It is based on short development cycles, minimal time and/or financial investments, a tight contact with all participants and immediate adjustments as a result of a frequent feedback.

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The system is realised by two main components: web for botanists and mobile application for general public. Both components are working with the same database.

For the development of both components we used a group of methods called agile software development with a strong focus on extreme programming methodology. During the development, no documentation, specification or schemas were used. To spare resources, we did not use any kind of server development instances or software versioning tools. All changes in the code became immediately part of the operational running service.

Prototype release

In October 2013, we released a functional prototype of a web environment which was designed to receive plant identification requests from two sources:

1. addressed submission of plant pictures using a web form;
2. automatic capture of unaddressed requests from Twitter social network

Fig. 3 shows absolute and relative representation the number of plant identification requests from different sources during time.

The second source of requests was involved because of a low initial demand for this service. We used Twitter Streaming API, which "…. gives developers low latency access to Twitter's global stream of Tweet data." (Twitter, 2014). To filter relevant world-wide tweets, we included only those containing particular words according to following logic expression:

["flower" OR "plant"] AND ["what"OR "name" OR "identify" OR "type"]

Of course, a high number of incoming tweets were still irrelevant. Therefore we asked students to tag these as invalid and executed a simple machine learning algorithm based on bayes filter to establish a second level of tweet filtering. "The advantages of this approach over the knowledge engineering approach (consisting in the manual definition of a classifier by domain experts) are a very good effectiveness, considerable savings in terms of expert labor power, and straightforward portability to different domains." (Fabrizio, 2002) Consequently the number of misqueued requests significantly decreased and became virtually insignificant.

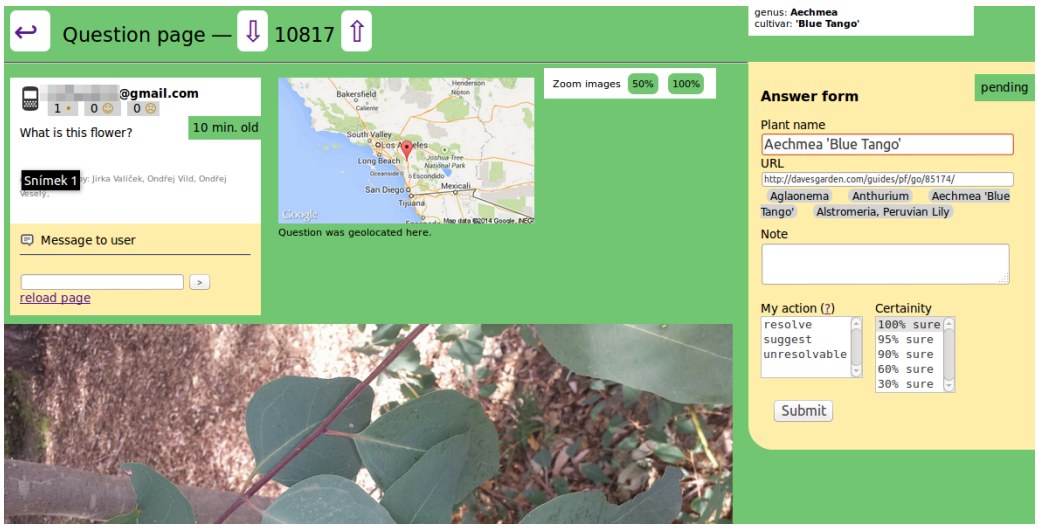


Fig. 2: User interface of web application for botanists

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Mobile app release

We were concerned about sustaining the students' involvement which was reported to drop over time (Xie et al. 2006). Therefore we decided to involve external motivation: a financial reward. To easily create a financial income, a mobile application was created, where users were able to contribute for the plant identifications. The gained money was distributed among the students based on their performance measured as the number of resolved requests. This system has become an easy source of financial rewards for student's work. The possibility of price adjustments gives us useful regulator based on principles of free market.

In the 15th week, we involved a group of senior experts, which excel over the students in the plant knowledge and experience. In the 17th week, the group was informed that from this point onwards, they will be financially rewarded according to their activity. We looked into whether these changes increased or decreased students' motivation.

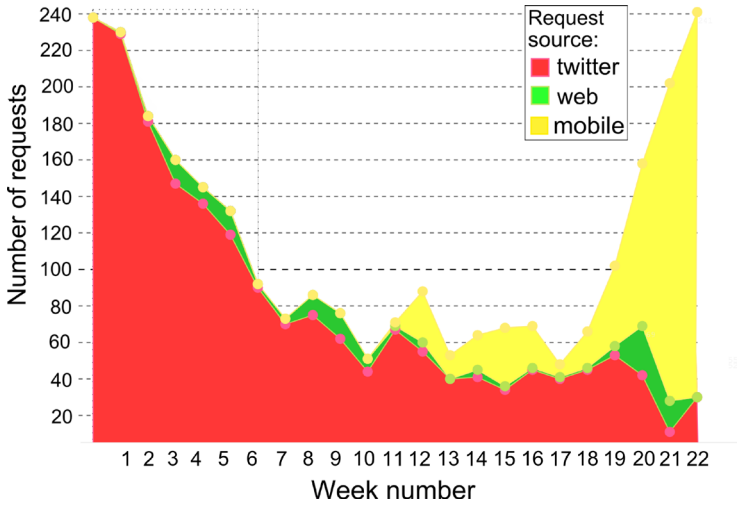


Fig. 3: The weekly number of requests from different sources since September 2013 till February 2014. The initial decrease is caused by winter beginning in the northern hemisphere. The originally prevailing Twitter source was fully substituted by requests from mobile, and recently exceeded the numbers in the late summer.

Data collecting for web usage mining

According to Bayir (2006) we can define web usage mining (WUM) as the application of data mining techniques to web log data in order to discover user's behavioral patterns and website usage analysis for further usage in various website design tasks.

According to Munk & Drlík (2011) it is "very difficult for educators to obtain useful feedback on student's learning" in "traditional e-learning platform which does not directly support any of WUM methods.", that's why we have decided to continuously integrate basic WUM support, for example storing values that express the time which a botanist takes to view a request.

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Technology used

The web app have been developed with Python and Flash framework. The bayes filter mentioned above is implemented via Naive Bayes Filter class from Natural Language Toolkit (Bird, 2011).

The Android mobile app is written in Java, accessible from Play Store (Řihák, 2013).

ANALYSIS OF MOTIVATION AND LEARNING IMPACT

As the main indicator of student's motivation, the difference between time of photo submission and its answering has been chosen. Since the first botanist who knows is able to identify the plant can resolve the request, we assume that motivated students check the queue of pending requests more often than the unmotivated ones.

We also focused on the possible increase in students' range of known plants. We investigated this hypothesis by comparing the number of identified unique plants taxa in each month by each student. Further improvement was expected after knowledgeable and experienced seniors joined the team. We suppose the student's participation is positively correlated with their knowledge of plant species. We evaluated the learning impact using the monthly sum of all particular plant taxa resolved by each student. We accounted for the total number of monthly requests and the measure of "competition" by seniors. Data for February were extrapolated from the available data from the mid of the month.

RESULTS AND DISCUSSION

After 22 weeks of monitoring, our results suggest that the idea of creating a sustainable internet-based system for education of students is feasible. Though a drop in motivation was expected during time (Xie et al. 2006), it remained relatively stable and even increased in the last six weeks (Fig. 4). This was probably achieved partly due to the character of the lean startup method which requires continuous students' attention because of frequent changes in the system environment. Another explanation can be the students perceived increased responsibility when they started to be rewarded.

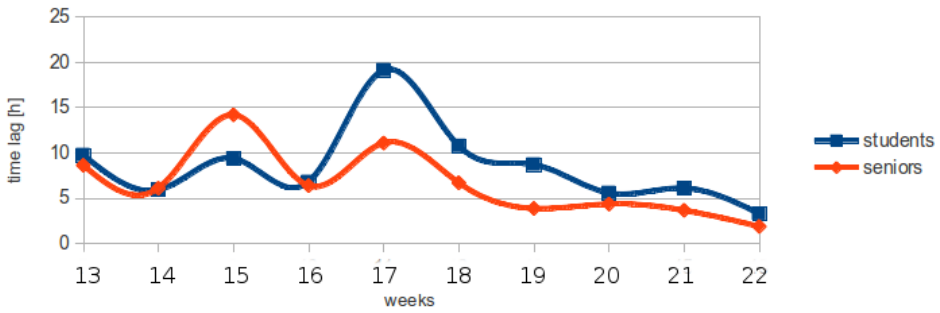


Fig. 4: Time lag values show the time difference between the identification request submission and its display by a botanist. Values are averages for groups of students (blue line) and seniors (orange line).

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The range of used plant taxa by individual students (Fig. 5) was highly variable and reflects mainly their activity, but partly self-confidence (Clément et al. 2006).We observed both a group with decreasing tendency and a group with increasing tendency. However, the range of all plant taxa known by the whole group of students slightly increased in time, therefore we assume they were able to learn from senior botanists and from each other. This effect requires further investigations which would allow an appropriate statistical analysis.

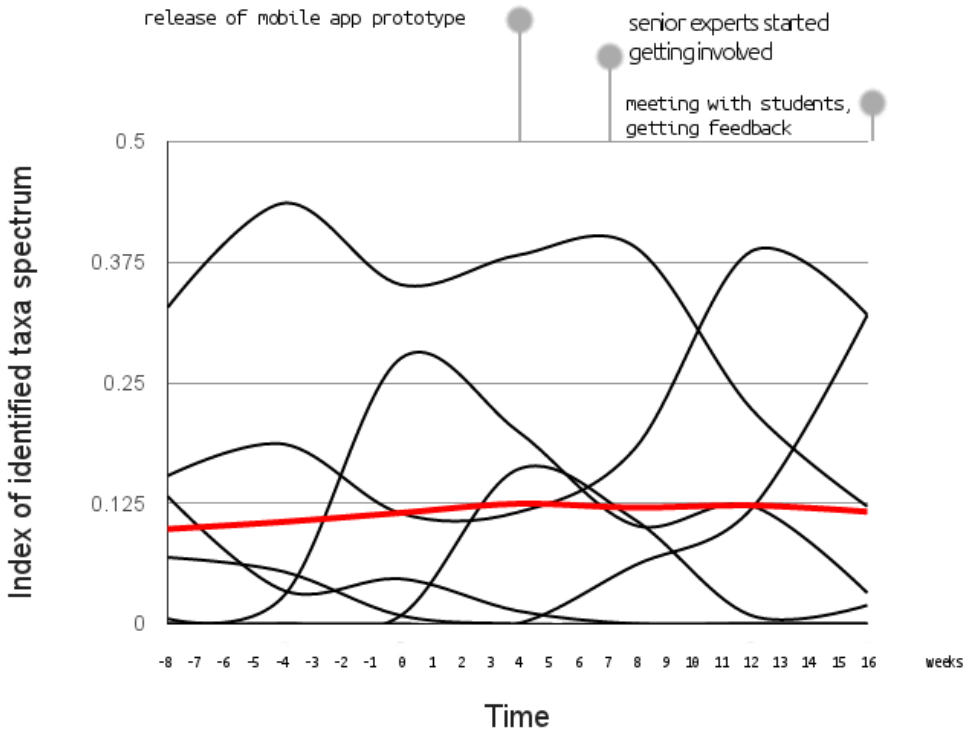


Fig. 5: Monthly changes in spectrum of identified plant taxa by individual students (black smoothed lines). The red line displays average performance of the whole group. The performance is not consistent among students suggesting a different response on the factors of financial reward and involvement of seniors, but the average performance (red strong) shows slightly increasing trend.

The stable performance of the whole team of botanits can be illustrated on the Fig. 6, which shows the proportion between received and resolved identification requests.

After our pilot study we came to a similar conclusion as Balogh & Koprda (2012) that "the teaching interaction between a student and an information system managing the instruction is a complex process" and the usage of additional analytic tools is beneficial for the learning process.

We are planning to improve the environment with additional motivation tools, mainly in the form of achievements reflecting the range of the plant taxa spectrum. We also want to include some tips and individual recommendations for learning new plant taxa.

Fig. 6: Plant identification success rate during time. Green points show the number of received requests, while the red points show the number of resolved requests.

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CONCLUSION

Our results suggest the proposed system can potentially be a suitable tool how to increase students' motivation to learn and involve them in dealing with real problems.

So far, the system performance is stable and indicates we managed to balance the involved motivation factors. Though it has been monitored only for a short time to make predictions for the future development, we think this system type is potentially sustainable. However we admit further monitoring is needed to conclude about the its long term sustainability and performance.

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Development of Informatics Competencies of Non-Informatics Study Programme Students at the ISCED 5 Level

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Abstract

Today's societies place challenging demands on so-called key competencies, a part of which are informatics competencies in meaning of a general computer or digital literacy. The key competencies look different in different contexts, but in of them they should strengthen one's capacity to participate in the world right now as well as in the future. In the paper the authors present a methodological background and results of a pilot research carried out to innovate and optimize informatics discipline teaching within selected non-informatics study programmes at the Faculty of Economics and Management at the Slovak Agricultural University in Nitra. A key part of the research has been a screening of students' requirements and opinions on informatics content which is and should be taught within their study programmes, and their assessment of the quality of the taught informatics disciplines. To collect the required data the authors developed a questionnaire containing 153 items divided into six areas. In the paper there are summarized main results of a pilot research which purpose was mainly to verify the reliability of the created questionnaire. Based on the pilot research data collection this was done by the means of the analysis of reliability/items and the questionnaire reliability value was calculated by using Cronbach's Alpha. The obtained results show high internal consistency of the created measurement instrument and guarantee credible data collection for a broader research which will follow.

Keywords

Informatics. Computer competencies. Digital literacy. Professional profile. Quality of education. Curricula development. Analysis of reliability.

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INTRODUCTION

Today's societies place challenging demands on so-called key competencies. The term *key competency* is not just a new name for the essential skills – key competencies are the capabilities people have, and need to develop, to live, learn and work today and in the future. However in differen contexts the key comptencies can refer to different skills or at least to different level of these skills.

Although the term *competency* refers to a combination of skills, attributes and behaviours that are directly related to successful performance in a job, key competencies are not specific to any profession nor occupation. On the other hand in an information or knowledge society they strengthen one' capacity to employ oneself on the labor market, as they guarantee more flexibility in the labour force, allowing it to adapt more quickly to constant changes in an increasingly interconnecte world. Moreover they are also a major factor in any innovation and competitiveness. Each key competency must contribute to valued outcomes for both society and the individuals, must help individuals to meet important demands in a wide variety of contexts and must be importand not just for specialists but for all individuals. (OECD: Definition and selection of key competencies. Available at: *www.oecd.org/pisa/35070367.pdf*).

Key competencies should be acquired by young people at the end of their education and professional training, equipping them for adult life, particularly for working life, and also forming a basis for their further learning. Without any doubt in an information and knowledge society informatics competencies forms an integral part of the key competenicies. In the strict sense the term *informatics competencies* can be taken in the meaning of general computer literacy competencies and in the broad sense it can be taken in the meaning of digital literacy competencies. Technological awareness joined with these literacies should give young people willingness to learn new technologies, understanding of applicability and limitations of the technology used in common situations, motivation to seek actively how to apply the technology to appropriate tasks.

Currently it is essential to provide youth digital competencies (skills) they will need throughout their education and their practice. Primary goal to include informatics subjects into the economical and managerial study programmes at the ISCED 5 level in the Slovak Republic is to develop those students` informatics competencies which have a broader transfer, mainly from the point of view of the practice and labor market`s requirements, i.e. they can influence also the work performance in particular industry/economy area. That is why it is needed to focus more narrowly not only on the quality aspects of informatics discipline teaching but also on the educational content of these disciplines in the background of the relevant study programmes (Záhorec, 2012). We assume that within the statistical analysis of appropriate research data it could be important to compare students` interest in informatics teaching with their interest in other, non-informatics subject teaching as well as with their professional orientation, i.e. future job preference, could be important. But the question is which informatics matters will actually be necessary to provide relevant key competencies for the non-informatics study programme students. For educators answer on this question is of a great importane as they need, and are asked, to prepare curricula of study programmes for the future technology enriched environment the sudents will live and behave. To identify common key informatics competencies and learning needs of different study branch students required for their

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successful future is not an easy task. But the necessity to solve also these complicated problems led us to start a research which could at least partialy contribute to their appropriate solution finding to assure quality of the offered education what is currently a task of the highest priority in the higher education (ISCED 5) area (Skalka, Drlik and Svec, 2013; Skalka, Svec and Drlik, 2012; Klocokova, 2011).

AIM AND METHODOLOGY OF THE RESEARCH

From a very broad variety of different non-informatics study branches we decided to focus our research only on two of them and these have been economy and management and within them the study programmes which have been taught at the Faculty of Economics and Management, Slovak University of Agriculture in Nitra (hereinafter sometimes referred to as FEM SUA). The main purpose of the research, in a long term point of view, is to support development of informatics competencies of students of economy and management study programmes with regard to their professional profile building. Following the main purpose the research is aimed at comparative assessment of current state of teaching informatics disciplines within the mentioned study programmes in focus on issues of databases.

A very important part of the research is screening of students` opinions on the content of the informatics subject matters they are/should been taught, and also on the quality of the informatics discipline teaching. For screening of the students` opinions we created a questionnaire consisted of 153 items divided into six parts:

- *Introductory part* (collection of data on gender,age and study specialization of the respondent);
- *What I want to learn* (to what extent is interesting the study of some selected topics for the respondent);
- *My future profession* (to what extent are significant for the respondent some selected factors at deciding about his/her future profession or job);
- *What I would like to learn* (to what extent are interesting for the respondent information and knowledge from some selected areas);
- *My education in computer science* (to what extent the respondent agrees or disagrees with givrn statements on education in informatics disciplines s/he passed during his/her university studies);
- *My professional capability in the context of my study profilation* (respondents were asked to choose one of seven alternative answers, they most agree with or which best describes their opinion).

Structure of the created questionnaire was based on an extensive search work of available sources describing relevant research done in Slovakia and aborad, too (Schreiner and Sjøberg, 2004; Ross and Genevois, 2006; Bílek, 2008; Ribeiro and de Gusmão, 2010, Záhorec and Hašková, 2013; Vozar and Kuna, 2012), as well as on consultations with experts dealing with these or similar issues and not least on personal discussions led in community of experts having extensive professional and educational experiences in teaching subjects related to informatics and informatics competencies.

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To verify reliability of the prepared questionnaire, in the academic year 2013/2014 we carried out a pilot research to obtain data necessary for the analysis of its reliability/item questionnaire. As a research sample we used a group of students enroled in the 3rd year of the bachelor study programmes Business Economics, Business Management, Accounting, Business Enterprise.

The main objectige and purpose of the questionnaire verification was to identify problem points of the questionnaire from the view of the respondents and to prevent any possible troubles and difficulties which could occur, whether formal, technical, contentual or methodological. From the statistical point of view the selected group of respondents was sufficient enough so it was possible to use statistical techniques and methods to assess the reliability of the questionnaire and identify its suspicious items. Following the comments of the respondents and the results of the analysis of reliability/items the questionnaire was modified to its final form.

RESULTS OF THE PILOT RESEARCH AND THEIR DISCUSSION

In the questionnaire part entitled *My education in computer science* we asked respondents to what extent they agree or disagree with the given 18 statements (items labeled as E1 to E18, see in Table 1) relating to the education they reached in the area of informatics, to their approaches to this subject and to their opinions on usefulness of the informatics knowledge they were taught. The respondents expressed their opinions and assessments to the particular questionnaire items by the means of the five-point Likert scale (5 – *I agree,* 4 – *I rather agree,* 3 – *I neither agree nor disagree,* 2 – *I rather disagree,* 1 –*I disagree*). Table 1 summarizes descriptive characteristics of the final scores obtained for each item (mean, median, standard deviation, standard error of the estimated average score, lower and upper quartile).

Table 1: Descriptive statistics for the items in the part *My education in computer science*.

Item	Mean	Std. Dev.	Standard Error	Median	Quartile Range	
					Lower Quartile	Upper Quartile
Informatics subjects belong to my favorites. (E1)	3.068	1.127	0.147	3.000	2.000	4.000
Informatics subjects are interesting. (E2)	3.458	1.039	0.135	4.000	3.000	4.000
Informatics subjects have challenging content. (E3)	3.746	1.108	0.144	4.000	3.000	5.000
Informatics subjects are relatively easy to learn for me.(E4)	2.966	1.144	0.149	3.000	2.000	4.000
Informatics subjects opened my eyes to new and exciting activities. (E5)	2.932	0.998	0.130	3.000	2.000	3.000
I like informatics subjects more than the others. (E6)	2.644	1.200	0.156	2.000	2.000	4.000
I think that everybody should learn informatics subjects. (E7)	3.542	1.222	0.159	4.000	3.000	5.000
Knowledge, which I learned in informatics subjects, will help me in my everyday life. (E8)	3.525	1.056	0.138	4.000	3.000	4.000
Knowledge, which I gain in informatics subjects, will help me to increase my chances in future career. (E9)	3.881	1.001	0.130	4.000	4.000	5.000

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Informatics subjects increased my curiosity about phenomena, which we still cannot explain. (E10)	2.966	0.999	0.130	3.000	2.000	4.000
Informatics subjects taught me to understand modern information technologies. (E11)	3.448	0.902	0.118	4.000	3.000	4.000
Informatics subjects showed me the importance of science for our life. (E12)	3.293	1.060	0.139	3.000	3.000	4.000
I would like to work in the area of applied informatics.(E13)	2.483	1.143	0.150	2.000	2.000	3.000
I would like to have at school as many informatics subjects as possible. (E14)	2.379	1.254	0.165	2.000	1.000	3.000
I would like to find a job in the IT field. (E15)	2.475	1.264	0.165	2.000	1.000	4.000
Within the teaching of informatics subjects teacher realizes interesting interpretations of the new subject matter. (E16)	3.254	1.123	0.146	4.000	3.000	4.000
Within the teaching of informatics subjects we solve interesting tasks. (E17)	3.339	1.010	0.132	3.000	3.000	4.000
Within the teaching of informatics subjects we use interesting teaching programmes, interactive simulation models. (E18)	3.103	1.087	0.143	3.000	2.000	4.000

N = 57

From the statistical survey of the assessment of the questionnaire items, which represent selected factors determining and influencing quality of informatics discipline education, we can see that significantly the highest average score our respondents gave to the item E9 (average score 3.88 from 5 point scale). In this item the respondents expressed to the usability of computer knowledge gained during their study, in their future profession. The obtained results is a very positive one, as it allows us to state that students are aware of the fact, that acquisition of informatics knowledge and development of informatics competencies support their employability and general professional adaptability on the labour market, as well as their general adaptability in non-working life. Within the analysis of the obtained descriptive statistics data for the research sample of respondents we can possitively assess also the results for the items E2, E3, E7, E8, E11 and E16 (scale median 4 – *rather agree*s). For the items E3 and E7 and a group of items E2, E8, E11 and E16 it was recorded the same diapason of values of the students responses, whereas the middle 50 % of the assessment values is located in the scale range from 5 to 3 or from 4 to 3, at the maximum value 5.

Final scale median value (3 - *neither agree nor disagree*) at the items E1, E4, E5, E10, E12 and E17 documents that this group of the items was assessed by the respondents in a neutral way.

Students state, that education in the field of informatics school subjects is, as to the contents, interesting enough but rather difficult. Results relating to the item E2 we give into context with the findings at the items B1 to B26, which are in a graphical for presented in Figure 1. As we can see from the graph on this figure, predominant number of the respondents declared their rather positive (scale median 4 in 7 items) or neutral (scale median 2 in 1 item) attitude to teaching the selected topics from informatics disciplines. Approximately on the same positive level the respondents evaluated also the method of presentation of the new subject matter by teachers (in terms of its atractiveness and .interest). The students proclaim also importance of informatics as a part

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of the education of a man and its significance for everybody`s common life. But students diverge in their opinion on inclusion of informatics disciplines to the general part of study programmes (in terms of their popularity).

The research results point out certain limitations and reserves regarding the attractiveness of tasks which teachers use during the informatics lessons. To eliminate this weakness of the education teachers should use more for example learning tasks aimed at creating algorithms, or interpretative tasks solving of which is based on heuristis as a method of creative problem solving. Moreover these tasks have also a motivating character, because they are very interesting, and arouse curiosity and desire to search for a solution.

As follows from the results, students have relatively low interest in topics regarding to still unexplained phenomena as well as in issues of the ICT based society and its functioning.

Table 2: Descriptive statistics for selected items from the part *What I want to learn* and *What I would like to learn*.

$N_B = 53$; $N_C = 58$; $N_D = 44$

Surveyed area/Item	Mean	Std. Dev.	Standard Error	Median	Quartile Range	
					Lower Quartile	Upper Quartile
What I want to learn						
Use of advanced tools and techniques of work with MS PowerPoint to create interactive presentations. (B6)	3.949	0.990	0.129	4.000	4.000	5.000
Creating and formatting of structured documents using MS Word tools. (B7)	3.898	0.941	0.123	4.000	3.000	5.000
Use of standard tools and Windows applications. (B5)	3.610	1.083	0.141	4.000	3.000	4.000
Defining tables in MS Access database application. (B19)	3.397	1.184	0.155	4.000	3.000	4.000
Creating documents for mail merge. (B9)	3.373	1.143	0.149	4.000	3.000	4.000
Creating own expressions by combining different functions. (B14)	2.793	1.196	0.157	3.000	2.000	4.000
Using aggregate functions in queries for statistical, financial and economic data analysis. (B24)	2.759	1.014	0.133	3.000	2.000	4.000
Internal computer architecture. (B2)	2.707	1.214	0.159	3.000	2.000	4.000
Use of tools for analytical outputs. (B16)	2.702	1.052	0.139	3.000	2.000	3.000
Algorithms for solving mathematical problems. (B1)	2.559	1.164	0.152	2.000	2.000	4.000
What I would like to learn						
Web applications programming (chat, discussion forum, e-commerce). (D8)	3.407	1.100	0.143	4.000	3.000	4.000
Malware (viruses, Trojans, spyware, adware, hoaxes). (D14)	3.373	1.312	0.171	4.000	3.000	4.000
Programming and Website development. (D7)	3.362	1.119	0.147	4.000	2.000	4.000
Computer network, sharing of equipment and data information transfer. (D9)	3.237	1.165	0.152	3.000	2.000	4.000

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Cybercrime. (D13)	3.220	1.233	0.160	3.000	2.000	4.000
Use of MS Excel tools for statistical data analysis. (D17)	2.759	1.097	0.144	3.000	2.000	3.000
Work with data in database systems using SQL.(D4)	2.614	1.031	0.137	3.000	2.000	3.000
Creating database applications in database systems Microsoft SQL Server, Oracle or MySQL. (D3)	2.559	1.087	0.142	2.000	2.000	3.000
Advanced work with data through SQL database command. (D19)	2.426	1.092	0.149	2.000	2.000	3.000
Modelling language UML (visualization, design and documentation of software systems). (D6)	2.308	1.147	0.159	2.000	1.000	3.000

Within the results of the statistical processing of the respondents` responses we consider to be alarming data the final achieved assessments at the items E6, E13, E14 and E15 These items have the scale median value equal 2, what means rather negative approach (*I rather disagree*). On the other hand the item E15 (*I would like to find a job in the IT field*) has the largest quartile range and therefore the greatest diversity of student responses, the middle 50 % of the responses is in scale value from 1 up to 4,at the maximum scale value 5.

The lowest value of variability indicator (0.90) was recorded at the item E11 (middle 50% values in scale range between 3 and 4, from the maximum scale value 5), in which respondents expressed to the significance and importance of the knowledge gained in the studied informatics disciplines for the understanding the principles of modern information technologies. The wide diversity of responses in the item E15 is possible to derive from heterogeneity of our research sample.

Table 2 summarizes descriptive statistics of the final scores of the responses achieved for five most positive and most negative assessed items – informatics teaching topics investigated within two areas *What I want to learn* and *What I would like to learn* (5 – *very interesting*, 4 – *rather interesting*, 3 – *neither interesting, nor uninteresting*, 2 – *rather uninteresting*, 1 – *very uninteresting*).

Final assessments of the selected topics level of attractiveness and importance for students related to the area *What I want to learn* are summarized in Box plot 1, (B1 – B26 topics related to informatics; B27 – B37 topics related to accounting; B38 – B46: topics from management; B47 – B56 topics related to the area of finance and currency) and regarding the area *What I would like to learn* are summarized in Box plot 2 (D1 – D22 topics related to informatics; D23 – D32 topics related to accounting; D33 – D41 topics from management; D42 – D48 topics related to the field of finance and currency). Box plots 1 and 2 show the average, standard estimation mean error and standard deviation of the ratings of individual items in the assessed areas.

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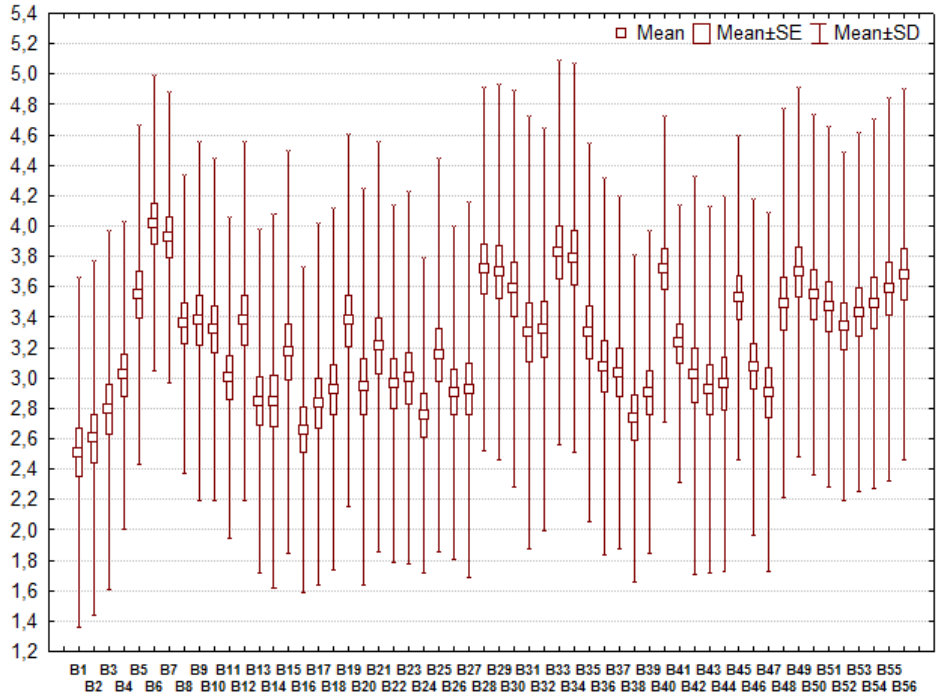


Figure 1: Box plot – differences in ratings of the items from the area *What I want to learn*.

Explanatory notes: B3 – *Number systems, transfer algorithms of numbers between systems;* B4 – *Administration and orientation in structure of objects and data stored in Windows;* B8 –*Input of data using forms, formatting, editing, and data security;* B10 – *Possibilities of (conditional) cells formatting in MS Excel;* B11 – *Filtering large tables, defining filter criteria for the values of different formats;* B12 –*Use of functions;* B13 – *Work with large tables using data tools;* B15 – *Graphical interpretation of data (creation and changing chart attributes);* B17 – *Numerical and graphical analysis of data through the pivot table and pivot chart;* B18 – *Utilization of macros to automate repetitive operations in MS Excel;* B20 – *Defining relationship between database tables;* B21 – *Work with forms in MS Access database application;* B22 – *Selection of required data using select query;* B23 – *Creation of own calculations and use of functions in select query;* B25 – *Creation of simple reports in MS Access;* B26 – *Dynamic interconnection of data between MS Access and external applications.*

Although we present the main results of the pilot research only for three of the areas which the verified questionnaire consist of, the same statistical methods were applied also for the other two areas to test the total quality and reliability of the whole tool. The calculated values of Cronbach's Alpha for *What I want to learn* area $\alpha_B = 0.9570$, *My future profession* area $\alpha_C = 0.8405$, *What I would like to learn* area $\alpha_D = 0.9620$ and *My education in computer science* area a $\alpha_E = 0.9293$ indicates high internal consistency of the used measurement tool. In view of the analyzed items it can be considered as reliable, but low average correlation between items in different areas of investigation indicates that after removing some items we could increase the reliability of the questionnaire. Statistics have demonstrated us that all items of the questionnaire correlated with the total score range in the field, and after their removal the coefficient of reliability Cronbach's Alpha decreased. In some items we can see the opposite situation, in their cases coefficient of reliability increased. From the data tabulated in Table 3, we can see that after the removal of each of the items the value of the standard deviation was reduced (36.066; 11.420;

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33.247; 13.313). We can therefore conclude that all items increased overall variability of questionnaire score, but none significantly. Similarly, we evaluate the average indicator in the view of the mean rate.

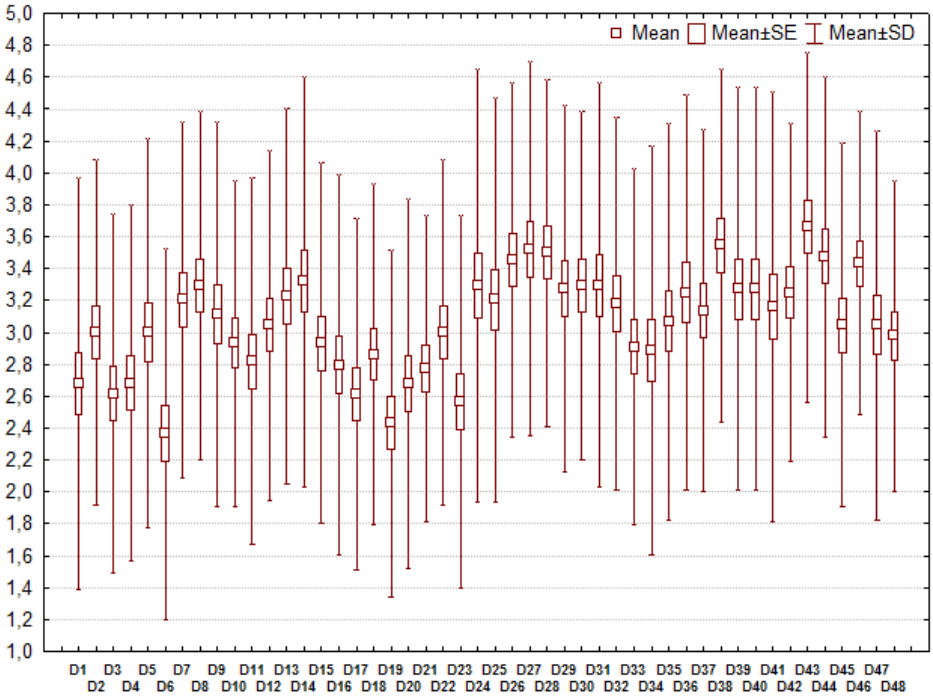


Figure 2: Box plot – differences in ratings of the items from the area *What I would like to learn*.

Explanatory notes: D1 – Object-oriented programming (Java, C#, JavaScript, PHP); D2 –Modelling and data visualization (animations, simulations); D5 – Design, development and implementation of information systems for companies and organizations; D10 – Application protocols and services in Internet; D11 – Data encryption, symmetric and asymmetric encryption principles; D12 – Computer security, digital signature; D15 – Administration and configuration of the operating system at the Windows platform; D16 – Creation of applications in MS Excel using VBA; D18 – Case studies focused on the automation of work with pivot tables in MS Excel; D20 – Case studies for application of macros in MS Access; D21 – Creation of database applications through programming in Visual Basic for Access; D22 – Safety and optimization of databases.

From the correlation matrices we identified suspicious items within each area of questionnaire that we investigated. Statistical significance of correlations between items we tested on the significance level 0.05. From the correlation matrices of the questionnaire, we found out that between the majority of the items the correlations are statistically significant ($p < 0.05$), what means that there is a degree of interdependence between these items. We identified also cases where measured values of the correlation coefficient are statistically highly significant ($p < 0.01$). Exceptions are items which do not correlate with some other items of the questionnaire ($p < 0.05$), from what we can conclude that values are changed independently. Following these results we can identify these items as suspicious, reducing the overall reliability of the created research tool. After eliminating these suspicious items in the particular surveyed areas (Table 4), in all cases, coefficient of reliability increased. This implies that the items reduce the overall reliability of the questionnaire. Based on the results of the pilot testing of the research tool we

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conducted a detailed analysis of suspicious items, i.e. items after removal of which we can increase the reliability of the questionnaire.

Table 3: Summary statistics of the questionnaire in the context of maximum and minimum values - after removal of the suspicious items.

Surveyed area	N	**Mean**	**Standard deviation**	**The average correlation between items**	**Cronbach's Alpha**
		Average after removal (min; max)	Standard deviation after removal (min; max)	Item-total correlation (min; max)	Alpha after removal: (min; max)
What I want to learn	53	**180.755** (176.925; 178.245)	**36.066** (34.848; 35.466)	**0.298** (0.252; 0.731)	**0.9570** (0.9553; 0.9575)
My future profession	58	**91.931** (87.3103; 89.293)	**11.420** (10.707; 11.120)	**0.217** (0.131; 0.686)	**0.8405** (0.8265; 0.8451)
What I would like to learn	44	**147.364** (143.705; 145.000)	**33.247** (31.908; 32.641)	**0.358** (0.227; 0.747)	**0.9620** (0.9604; 0.9624)
My education in computer science	57	**56.281** (52.421; 53.877)	**13.313** (12.317; 12.921)	**0.445** (0.206; 0.824)	**0.9293** (0.9211; 0.9348)

Note: In brackets there are presented minimal and maximal statistic values after the removal of the relevant questionnaireitems.

Table 4: Statistics of the questionnaire after removal of the suspicious items.

Surveyed area: number of suspicious items/total number of items	Average after removal	Standard deviation after removal	Item-total correlation	Alpha after removal
***What I want to learn*: 4/56**				
Internal computer architecture.	178.151	35.466	0.208	0.9575
Meaning of cybernetics in management.	178.019	35.411	0.280	0.9571
Historical development of management.	177.736	35.376	0.252	0.9574
Origin and evolution of money.	177.283	35.364	0.292	0.9571
***My future profession* 5/24**				
Work with animals.	89.069	11.078	0.167	0.8438
Work in area of modern technologies.	88.276	11.014	0.239*	0.8406
To do an easy and undemanding job.	88.431	10.994	0.227*	0.8418
To work with machines or instruments.	89.086	11.120	0.131	0.8451
To work artistically and creative in the arts.	89.293	10.934	0.214	0.8449
***What I would like to learn* 2/48**				
Financial analysis of the company.	143.932	32.641	0.227	0.9624
Health insurance.	144.318	32.420	0.354	0.9622
***My education in computer science* 1/18**				
Informatics subjects have challenging content.	52.544	12.921	0.206	0.9348

* > 0.216939

CONCLUSIONS

Following the results of the questionnaire verification in the pilot research we decided to reformulate the suspicious items B2, B38, B42, B51 and D47., while the items C7, C8, C9,

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C10, C11, D46 a E3 were left in their original form. The modified versions of the changed items were incorporated into the research questionnaire in following forms: B2 – Computer hardware, B38 – Cybernetic principles in management, B42 – Historical development of management its main theories, B51 – History of money development, D47 – Pension reform. As the results of the statistics analysis show, the modified questionnaire should be reliable enough to provide to our research subject relevant data.

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Uniform Information and Educational Space for Distance Learning of Ukrainian IT-Students

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Abstract

The paper presents the concept of creating a unified information and educational space of Ukraine implemented as integration of educational web portals of educational institutions throughout the country. Under the proposed concept there were developed the educational portal structure and components of the training unit using the example of training process of the specialists in the field of software engineering . The purpose of the educational portal usage is obtaining the theoretical knowledge, practical skills, as well as the quality assurance of the received knowledge. The paper describes a teaching method that specifies a way of explaining the new material and the scheme of learning within the selected area of education. During the development of the training unit the function of individualization of educational activities is implemented. Text educational materials and training multimedia of the web portal should be stored in the knowledge base, the model of which is developed by means of UML Database Diagram. This model reflects the structure and communications of the domain objects with attributes and their data types. The paper shows the prospects of development of this area through the implementation of the practical skills obtaining unit, as well as quality assurance unit of the acquired knowledge.

Keywords

Information space. Web portal. Knowledge Base. Distance education.

INTRODUCTION

The rapid development of information technology allows to use computers not only for the processing, storage or movement of information resources, but also as an area of human interaction. Persistent upward tendency of the students who combine studying with work, accompanied by the development and widespread usage of distance education (Sherry, 1995). The means to generate the distance education systems are information and communication technologies and multimedia. (Fisher, Exley, 2014).

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However the implementation of web-based information portals, learning systems, information systems of the distance education in Ukraine is fragmentary and imperfect. There is no unified information and education space. Also there is no use of experience and knowledge of universities in other countries in the scope of the convergence and harmonization process of higher education systems in European countries. Although the information and educational space could be used as a mechanism for distance education (Avraamova, Gyrkov, 2004).

The using of traditional teaching methods in higher education does not always allow to achieve the required level of specialists qualification (Harry, Magnus, 1993). Inability to fully take into account the individual characteristics of students, the complexity in the organization of the active work of the students and timely monitoring of the educational process results are significant drawbacks of traditional training methods (Bryancev, 2008).

The aim of this work is to develop the concept of a unified information and educational space in Ukraine as a network of educational institution web portals, the example is distance education of IT-students. Based on the goal the authors have the following objectives:

- to form and describe the concept of implementation of unified information and educational space;

- to develop a unified structure of the web portal as a part of the information and educational space;

- to introduce a model of the knowledge base which is used to store the learning material of the web portal.

METHODS

The generation and usage of the uniform information and educational space can be one of the possible ways to overcome the difficulties of traditional education (Merrill, 2001). Under the uniform information and educational space we understand the integration of educational web portals of educational institutions throughout Ukraine. Ideally, the use of educational web portals as a virtual education tools will create the conditions for:

- obtaining knowledge without interruption from the place of residence and during the working process;
- wide access to national and global information resources;
- self-education process organization in the most effective way and getting all the necessary resources for it;
- access to all kinds of educational resources to a growing number of people without age restrictions.

Efficiency of use the information and educational space can be achieved through the implementation of functions of two types: substantive and formal. Substantive function must ensure the achievement of the learning purposes, namely:

- obtaining the theoretical knowledge in the chosen subject within the selected areas of education;

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- practical learning of the proposed material;
- implementation of self-control by students;
- coordinated control of the knowledge acquired by the students from the teachers side;

Formal function must ensure the efficient organization of distance education activities with the ability to:

- expand the network boundaries of the information and educational space through involvement of new educational institutions, teaching staff, interested companies, etc.;
- to expand the information resource of the educational web portals by adding new areas of study, statutory curricula, new academic disciplines, adding of learning materials, test questions, test items;
- implementation of multimedia, communication and innovative technologies, methods and learning approaches.

RESULTS

Educational process in Ukraine is regulated by the curriculum with the separation of regulatory disciplines and disciplines of the variable part. On the basis of the curriculum having the approved lecture hours and hours of self-study, each teacher develops a working program of the discipline. The discipline can be divided into the substantial modules, in which the themes of the lecture material and practical (lab, seminar) classes are indicated. Each module ends with the module control work, by the results of which you can judge the quality of the knowledge acquired by the student. Toolkits of the distance education must comply with the existing regulations of education (Gricenko, Kydryavceva, Kolos, 2004).

We have developed the concept of creating a unified information and educational space in Ukraine, which structure is shown in Figure 1. Within each institution the educational web portal should be implemented (Yalovaya, Kramarenko, Zavgorodniy, 2010), which is integrated into the general information and educational space of Ukraine. The educational web portal is the web site in the computer network, which provides the user with a variety of interactive services in order to obtain new knowledge (Fisher, Exley, 2014).

Wide demonstration capabilities and high level of interactivity can not be the grounds for the educational web portal to be considered as a helpful one (Bryancev, 2008). Its effectiveness depends on how it ensures the achievement of the education goal. In addressing this issue the following learning objectives should be established to the forefront:

- getting theoretical knowledge in the frameworks of chosen discipline;
- getting of practical skills and abilities;
- self-monitoring and quality assurance of acquired knowledge.

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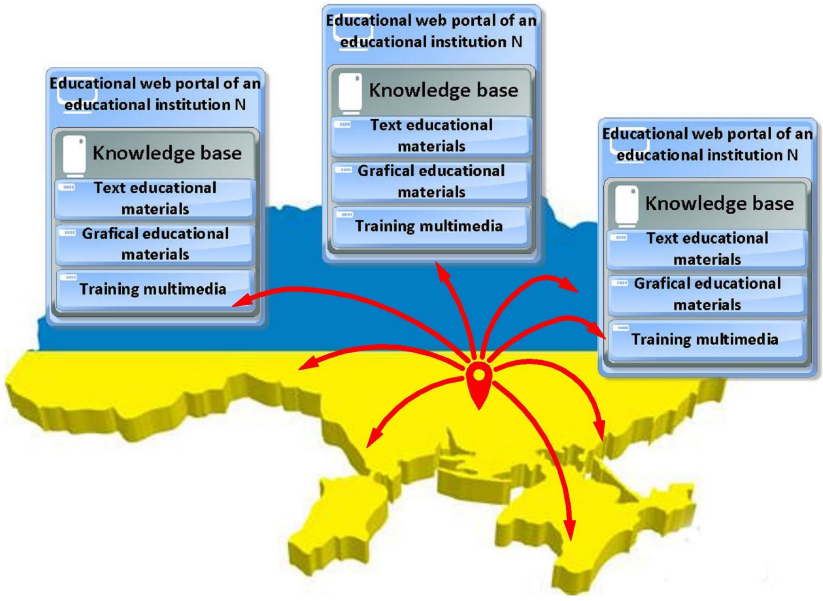


Figure 1: The structure of the uniform information and educational space in Ukraine.

The basis of acquiring new knowledge is the training method that defines as way of explanation the theoretical material, type of practical tasks, the process control scheme of acquired knowledge (Boyko, 2008). Also the learning method describes the organizational form of studying: individual or group.

Structural navigation within the educational unit of the web portal can be represented as a multi-level user menu (Figure 2).

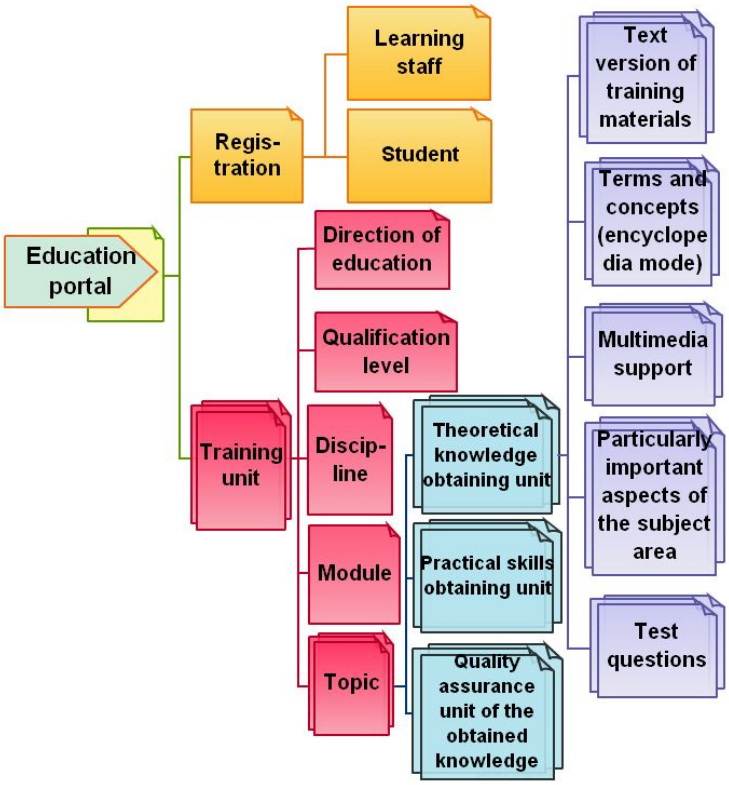


Figure 2: Structure of the educational web portal

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To begin the process of learning, the student must log in, choose a skill level and direction of education. Having the selected direction of education he has an opportunity to become familiar with the curriculum and the work programs of each discipline. Having the discipline selected, user is prompted to read the list of all the lecture topics. The scenario of software-controlled training implements by default. The system displays the technique, the method and the structure of materials presentation exactly as it was defined by the teacher on the basis of the training program. The technique of teaching is defined by the teacher and determines the sequence of presentation the educational material, the selection criteria of the next portion of information depending on the teaching results. However, the student may go into structural-control training scenario and set the sequence of topics by himself. This can be done in the case the student has successfully passed the test of the basic knowledge level. Within each theme of the discipline the theoretical material learning units, practical skills and quality assurance of acquired knowledge are provided.

Lets consider the process of learning the theoretical material. Level of its displaying is the subject-semantic, here the attention is paid to disclosure of the contents of educational material. For practical focus disciplines the presentation of the theoretical material goes beyond the descriptive narrative and contains explanations, patterns of development and functioning of the studied objects. When displaying a theoretical material the most attention is paid to the presentation and disclosure of new educational material, concepts learning, describing of their properties and relations, deployed and generalized description of the processes, data presentation about the quantitative and qualitative characteristics of objects and processes.

Within the developed conception the following method to obtaining the theoretical knowledge is suggested:

- learning of the theoretical text material;
- using the references to the description of each definition or concept from the lecture theme;
- using the multimedia support of the lecture material in the form of video lectures, the playing of the voice instructions and etc.;
- creation of the definitions or concepts list;
- formation of answers to test questions on each topic of the material;
- for disciplines which goal is to obtain knowledge about the programming language, the usage of the unit to check the knowledge of the programming language syntax. The unit has two modes: to give answer about the meaning of the specified keyword of the programming language and vice versa;
- learning of the correct answer and checking the references on theoretical material in the case of the incorrect answer to the control question on the topic.

For the studying of any theoretical material it is necessary to make a few mental actions with him. During the development of the learning unit the function of individualization of educational activities is implemented. It brings the availability of options for theoretical knowledge learning, namely:

- reading of the text learning material;
- watching video lectures;

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- using the encyclopedia and the automatic getting of definitions for the selected term or concept;
- using the voice support of the learning;
- forming of the own thesaurus from the most important aspects of the discipline;
- formation of answers to test questions on the subject.

Insufficient level of the distance education quality is often depends on ways of organizing the communication process (Gricenko, Kydryavceva, Kolos, 2004). During the building a dialogue within the educational portal the psychological principles of interaction between the student and the system were taken into account. In order to avoid unnecessary attention, which can cause a protest feeling of the student, an optimum level of the accompanying assistance was determined. At the same time it was taken into account that excessive frequency of the external dialogue violates the internal dialogue of the student. On the other hand, the implementation of tips and system assistance is sufficient to ensure that the student does not have the feeling of helplessness. The student has the possibility to refuse the offered tip. During the organizing the process of studying the theoretical material the meta dialog was minimized. To do this, before the studying of the theoretical material the student is issued a description of the theme, abstract for it and the purpose of the learning this theme. After receiving an affirmative response to the willingness for studying the theoretical material, the dialogue from the part of the web portal is not triggered, as it can break the thought process of the student. At the completion time of the studying of each topic the dialogue is resumed and the student tells if everything was clear to him, and whether he is ready to continue the studying of the new material.

For the implementation of an educational web portal the advisability of usage the combined type of distance education has been proved. On the one hand the interactive studying of students without a teacher is implemented, and on the other - a web portal should contain functional units that help teaching staff to coordinate and control the knowledge obtaining by students. Thus, it is expected the using of two profiles of the users, involved in the learning process: the teacher's profile of the student's one.

By creating a profile, the teacher should:

- analyze the data of the curriculum for the education direction. Curriculum forms the system of concepts for the first level discipline, mandatory for explaining by any teacher in any educational institution of the country;
- organize and structure the educational material, choose the form of its study (lectures, practical classes, etc.);
- prepare text, image, animation or multimedia materials for using in distance education;
- create a working program of discipline in accordance with the curriculum.

Working program of the discipline creates the system of concepts for thesecond level discipline. It should be noted that the result of the discipline working program creation depends largely on how the teacher understands the learning activities within the discipline, its scope and direction. Since the curriculum sets only the main points of discipline, working programs created by different teachers may differ significantly. Set of the themes, choice of the scope for their presentation affects the depth of student's

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knowledge. The advantages of educational web portal usage include unification of educational material between institutions.

Actions of the teacher within the web portal are as follows:

- identification of ways to provide the learning material to the knowledge base of the web portal (electronic manuals, interactive lectures, etc.);
- creating the scheme of the educational process, the separation of the discipline for substantial modules, determining the sequence of the studied topics, the structure and content of the test questions, key terms and concepts;
- filling the knowledge base of the portal with learning materials. The own methodological staff can be used as an educational resource, also the existing database and domain knowledge bases, external information resources can be used;
- set training mode – an individual or group one. For the disciplines of collective orientation (group dynamics, project workshop, etc.) the number of command groups, the global goal of discipline and purpose of collective learning are set. Each group gets its own profile, which is used to analyze the results.

From the side the educational portal a teacher has an opportunity to:

- get the list of the students' profiles who are studying a given discipline;
- if the discipline has an individual learning mode, each student's profile has information on:

a) the starting level of his knowledge (if he wanted to take the test);

b) the number and the list of topics learned, start date and time of their learning;

c) the results of the answers to test questions;

d) the points of access for virtual consultation;

e) the results of modular control;

f) the list of recommended topics for re-learning;

g) the resulting number of points within the 100 point system ECTS;

- if the group learning mode is specified for the discipline, the results are displayed for each group profile and for each student profile within the group also;
- construct ranking lists of students;
- to identify the theme with a minimum level of teaching quality. Then the teacher is proposed to amend the structure of learning materials, to add interactive media materials or to revise system and the criteria for evaluation of knowledge;
- to fill the knowledge base of educational materials;
- to make changes to existing learning materials.

Within the portal the student can make the following actions:

- to create own profile;
- to determine disciplines for distance learning;

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- to study the structure and of modules and the sequence of the studied topics. If the student has a desire to create his own sequence of topics to be studied, he is offered to pass the test to determine his starting level of knowledge;
- to proceed to study the theoretical material;
- to check the level of the acquired knowledge on the topic, answering the test questions at the end of each topic;
- to pass the resulting module test.

In addition to the concept of a uniform information and educational space, navigation scheme and building blocks of the educational web portal, the knowledge base model was created to store the of educational material. The knowledge base of educational web portal is the collection of facts, rules, events, describing the subject area (Bolnyh, 2009). The model of knowledge base, developed using UML Database Diagram tool, is shown in Figure 3.

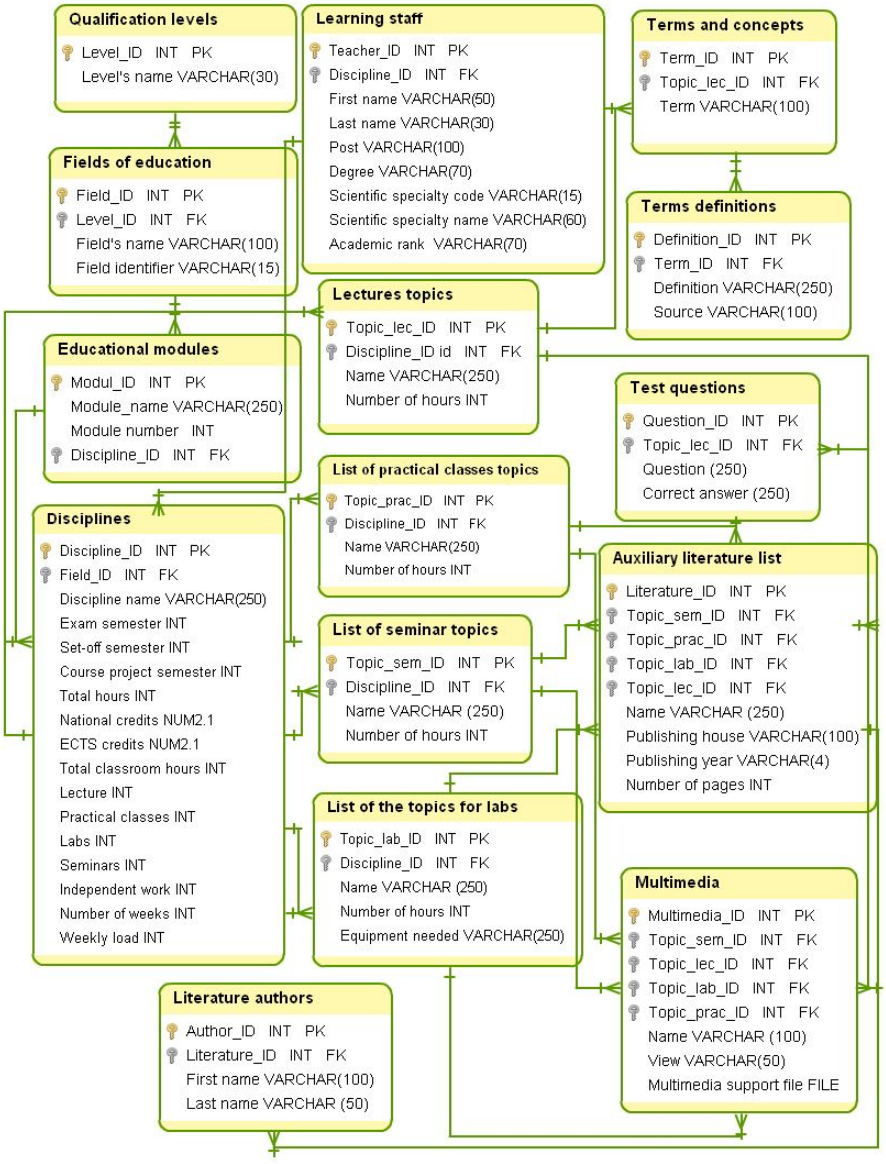


Figure 3: Model of the educational web portal knowledge base.

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Knowledge base with the mechanisms of information output must ensure the learning process with the help of information resources, which are: text teaching materials, terms and concepts with definitions, control and test questions with the correct answers, additional educational literature and educational multimedia materials. Knowledge base is supplemented by information on the organizational structure of the learning process, data on teachers, who coordinates the studying; and the students.

DISCUSSION

It must be emphasized that the proposed conception of the uniform information educational space can be applied to all areas of Bachelor and Master training of all the higher educational institutions of Ukraine.

The question of how effective the educational web portal is, can be answered only after its approbation.

Implementation of web portals on the basis of the presented conception will give the possibility to:

- to organize the distance education based on the basic principles of educational psychology and didactics;
- to apply different management tools for educational activities based on the discipline's specifics and studying purposes;
- stimulate various kinds of students' cognitive activity;
- to take into account the already acquired knowledge and skills in the content of learning material through the basic knowledge assessment;
- to encourage high motivation of students to learn using multimedia staff;
- to provide external and internal dialogue of the student;
- to accompany the student with the information about studying purposes, his progress in their achievement, basic errors and gaps in knowledge;
- to individualize the studying, to create an own studying schedule without forcing the speed time of learning the material;
- to use the student's profile for log in and log out from the portal, having saved the obtained results.

The prospective issues for the further research are:

- methods, techniques, tools and technologies of creation the virtual laboratories for distance getting of practical skills;
- assessment methods of the acquired knowledge quality;
- ways of implementation the modules of the coordinated and self control of the acquired knowledge quality;
- organization of distance improvement of professional skill of teaching staff of educational institutions;
- effective ways to store the graphical and multimedia data in the knowledge base of web portal;
- protection issues of the information and data.

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Section:
Intelligent Computing

Comparison of Approaches to the Data Analysis in the Virtual Learning Environments

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Abstract

We have been the witnesses of the exponential growth of data in the last few decades. In the educational field, the source of data is the learning and teaching processes realizing in the virtual learning environments. These environments store the data in persistent database layers. We can analyse these data using conventional statistical methods or utilizing the advanced data mining methods. In this paper, we focus on different ways how to analyse these data. We present pros and cons of commonly used approaches and analytical methods. We summarise the possibilities and weaknesses of integrated tools that can help us to analyse learning environments stakeholders' basic activity, behaviour or performance. Considering the direct data analysis, which is available on the application or database layer of the virtual learning environments, has strong limitations, we introduce relatively new, closely related, contemporary research areas – Educational Data Mining and Learning Analytics. We take a look at them from the perspective of the university environment. We conclude that both areas are very promising, but we have not been able to generalize our findings yet, because there has not been realised a systematic research on the application and impact of these research disciplines.

Keywords

Educational Data Mining. Learning Analytics. Data Analysis. Virtual Learning environment.

INTRODUCTION

Over the last few years, the data, as the minor product of using various information technologies, as well as human activities in the Internet, has grown exponentially. Thanks to the availability of data storages, these data are not lost, but rather constantly accumulating and waiting for any further use. We can analyse these data and get a lot of useful information. Advanced data analysis methods are called the Data Mining. We can meet two research approaches of data mining methods in the education: the Educational Data Mining (EDM) and the Learning Analytics (LA).

In this chapter, we focus on different ways how to directly analyse data, and we present pros and cons of commonly used analytics methods. Next we characterise relatively new research areas in this field and outline their use in the evaluation of the quality and effectiveness of the e-learning.

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DESCRIPTIVE ANALYTICS

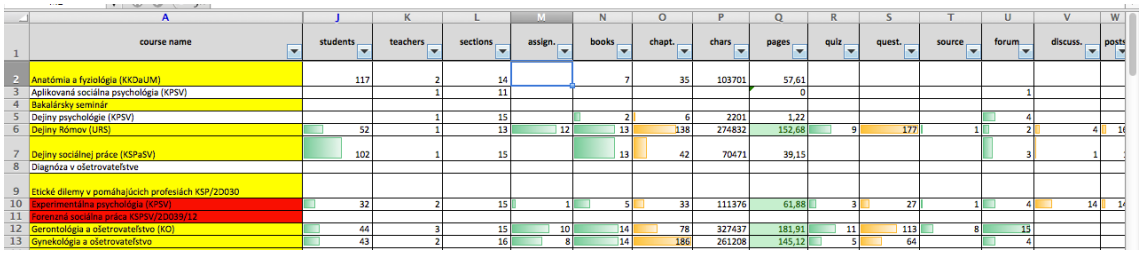
Before we get to the discussion about the possibilities of EDM and LA in the context of the effectiveness of the implementation of e-learning and evaluating its quality, let's stop for a moment in a simpler and most straightforward approach to data analysis, which is gathered in VLEs. This data can be accessed on two levels in principle.

The first level for assessing different aspects of efficiency and quality of e-learning courses (as elementary units constituting the content part of the e-learning implementation) is offered by most of the existing VLEs. Most of them offer direct access to display course logs and to display the usage of the course. We can combine access and usage data with objectively measurable outcomes of each student activity, e.g. grades from quizzes or points from assignments (Klocokova, 2011). This view can show what is well designed in the course, what resources are commonly used but on the other hand what the course is missing or what does not comply with the requirements of learners. If we look at the access log, we can identify the frequency a student attends the course, or we can identify what part of the day (part of the week, part of the term) are students most active (Magdin and Capay, 2012).

Data presented this way are a useful tool for a teacher who wants dynamically reacts to students' demands. The problem arises when we need to compare multiple courses or to assess the level of compliance with institutional or explicitly defined criteria. The educational institution or some supervisory body can assure some level of quality of course content implementing these criteria.

It is common that VLEs does not provide such tools directly. If we take the Moodle as an example, we need to install third party module that classifies courses based on the level of satisfaction using the criteria defined in the module itself. To carry out such an analysis using external tools, we have to export data from individual courses. This approach is, however, time consuming and is difficult to prepare.

Above-mentioned problems of the analysis of criteria fulfilment for individual courses or group of courses can be solved using direct access do VLE's data layer, thus utilizing prearranged database queries. Since most of the data is stored in a structured form in standard and normalized database tables, SQL is strong enough to get the result as fast as possible. Results gathered from the database can be compared according to referral values of each criterion. By using SQL, we are still limited to use basic statistical functions, summarization or aggregations. Sample output from such SQL queries is shown in Figure 1.



	A	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
1	course name	students	teachers	sections	assign.	books	chapt.	chars	pages	quiz	quest.	source	forum	discuss.	posts
2	Anatómia a fyziológia (KKDaUM)	117	2	14		7	35	103701	57,61						
3	Aplikovaná sociálna psychológia (KPSV)		1	11					0				1		
4	Bakalársky seminár														
5	Dejiny psychológie (KPSV)		1	15		2	6	2201	1,22				4		
6	Dejiny štátov (URS)	52	1	13	12	13	138	274832	152,68	9	177	1	2	4	16
7	Dejiny sociálnej práce (KSPaSV)	102	1	15		13	42	70471	39,15				3	1	
8	Diagnóza v ošetrovateľstve														
9	Etické dilemy v pomáhajúcich profesiách KSP/2D030														
10	Experimentálna psychológia (KPSV)	32	2	15	1	5	33	111376	61,88	3	27	1	4	14	14
11	Forenzná sociálna práca KSPSV/2D039/12														
12	Gerontológia a ošetrovateľstvo (KO)	44	3	15	10	14	78	327437	181,91	11	113	8	15		
13	Gynekológia a ošetrovateľstvo	43	2	16	8	14	186	261208	145,12	5	64		4		

Figure 1: The examples of statistical evaluation of the content of the e-learning courses (own work)

Evaluation methods based on SQL queries gives good results in the early stages of the creation of e-learning courses. At this stage, it is important to continuously monitor the process of the study content creation. We track types of study materials used by the

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author, types of motivating activities etc. Reconstruction of activities and behaviour of students in the course is less important at this stage.

On the other hand, as we use the e-course we can identify common deficiency of direct evaluation methods (amount of the content, traffic and usage rate). Using these direct method, we can consider just the content of course, the availability and amount of study material or the diversity of motivating activities. Behaviour of students, identification of their learning styles and preferences, or the presence of a teacher in a course, are problematic and are mostly dependent on the subjective evaluation based on the particular experience of the evaluator. Agudo-Peregrina et al (2014) presented three different classifications of student interactions based on: (a) the agents involved in the e-learning process; (b) the frequency of using activities, features and functionalities in the VLE; and (c) participation mode.

We can summarise the benefits of direct data analysis from the various stakeholders' perspective as follows:

- From the student perspective, these reports are for informational purposes only. She gets a list of study material and forthcoming activities. A student mostly does not pay attention about her traffic statistics. She has a precise idea of how often she visited the course, and how much time it spent. She is well motivated based on the graded activities, e.g. assignments or quizzes. We can consider the comparison with other students' statistics as another motivating factor.
- From the teacher perspective, those tools bring greater benefit. In the stage of creating a course, such a tool can inform the teacher about the amount of different learning materials and activities, which she added to the course as well as the approximate time that this process took. In the stage of teaching, those tools can inform the teacher about the activities and study materials use rate in different phases of the teaching process.
- From the perspective of the organization management, these tools can be useful to generate various basic reports about the readiness of e-courses. At the same time, the tool can inform the management about the number of students in different courses. With a little effort, such a tool can also provide information about the activity of students and teachers as well. In addition, we can use them to determine the level of the e-learning implementation in each study programme.

The summarization uncovers the weakness of direct data analysis of VLEs. From the perspective of all stakeholders, we can assess the current state, but we cannot say anything about the further activity of students, what form of feedback suits to students best, how many students are at the risk of dropping out, etc. We cannot also say anything about the order in which students prefer to study different learning materials, which questions in the quiz do not fit the "normal question definition". There are many other issues that would be a great benefit for the learning process.

As we can see, the direct data analysis necessary for the evaluation of various aspects of the e-learning implementation has serious limitations. The next logical step in huge data files analysis is to employ methods used in EDM and LA. This step gradually takes hold in many educational institutions that realize the possibilities of the e-learning and consider it

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to be equivalent to the classical method of education. We describe the EDM and LA in more detail in the next section.

EDUCATIONAL DATA MINING

The educational data mining (EDM) is a relatively new scientific field which arose as a natural consequence of the Internet penetration, modern statistical methods and e-learning itself. Since different VLEs gather an amount of data about their users, their work and practices, it seems to be a good idea to use advanced statistical methods for data analysis. We introduce options that the EDM brings in this chapter.

EDM can be characterized as a research area that deals with the development of new techniques and methods, testing new theories of teaching, finding patterns of different types of user behaviour in structured and non-structured data. These date are generated by VLE, educational software, intelligent and adaptive education system or by a specialised software for testing (Romero, Ventura and Pechenizkiy, 2010). We can find models that allow the adaptation of learning paths according to the student's "on–site" progress (Smyrnova-Trybulska and Grudzien, 2012).

Nowadays, the professional community focuses on concepts like "big data", digital footprint, adaptivity, business intelligence or data mining. The EDM arose as the consequence of using those concepts in education.

The main objective of EDM is to analyse data from VLEs, which collect an enormous amount of data, and find answers to difficult questions about the learning process as well as the entire e-learning. EDM aims to develop methods for better understanding of students' behaviour and the learning process itself, using VLE or any educational software respectively.

EDM as a research area is based on research from other research areas, such as technology of education, pedagogy, psychology, e-learning and web log mining. We must also mention that the formation and development of EDM methods are affected by the dynamic development of the Internet, learning management systems, intelligent educational systems as well adaptive educational hypermedia systems.

When we compare EDM to classical data mining the EDM differs in several aspects. Despite EDM uses standard data mining techniques (classification, clustering, association and sequence rules) it also uses more simple techniques or approaches (regression, correlation, etc.), which however are not considered as data mining techniques. On the other hand, EDM uses specific measurement techniques integrating psychometric or inquiring based on models.

At the first glance, it can appear that the results achieved by EDM may be interesting just for teachers, but it doesn't. A teacher can better manage the learning process, submit appropriate feedback or to can be able to provide appropriate educational materials to a specific group of students. All other groups of users involved in the teaching process and learning management can also benefit from EDM results (Greller and Drachsler, 2012).

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Typical Tasks of Educational Data mining

Previous research tasks of EDM were focused on the application of the data mining methods on the log files of VLEs, intelligent learning environments, OER or other educational software.

VLEs became more and more complicated, sophisticated and complex at present. Therefore, the amount of data produced by these systems has increased rapidly. It is important to mention several important and unique features of these data:

- Hierarchical structure (student's activity level, user's session level, level of students' class, course level).
- Temporal character, which allows measuring the duration of a particular activity or session.
- Sequences, which can be used as course building blocks and ordered in the best suitable manner.
- Context, which is very important for the explanation of results obtained.

The EDM focuses on solving problems, which arrive in different phases of learning process. These problems relate with primary application domains of the EDM:

- Data analysis and visualisation.
- Decision support of teachers, course developers and managers based on the feedback.
- Recommendation to students.
- Student performance forecast.
- Student modelling.
- Detection of student's undesirable behaviour.
- Study groups and teams creation.
- Student social network analysis.
- Conceptual maps development.
- Course content and structure design.
- Time table planning.

The research activity in above mentioned application domains is very high. We progressively obtain the answers to many questions related to the learning process. For example, we better understand, how to

- reorganize classes, assignments or order of the learning materials following their former using.
- identify students, which need specific feedback, help or guidance.
- choose the most effective form of guidance to the group of students.
- help students to find out the most suitable form of learning materials.
- classify or profile students using classification algorithms.
- find out the student's learning style.
- predictively model the student's performance or falling out.

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- create the groups of similar students considering their behaviour, performance or preferred type of the learning materials or tasks.
- find out though assignments using biclustering.
- optimize the order of the courses included in the study program using frequent pattern mining.
- discover evident differences in students' behaviour, which passed and failed the exam utilizing the methods of emerging pattern mining.
- recommend the learning objects considering the results of collaborative filtering and recommendation.
- visualize the students' cooperation.
- understand the optimal path through the study program using process mining methods considering the students' behaviour and study outcomes.

Current Trends of EDM

EDM represents modern and widely used approach of the contemporary data analysis from the VLEs as we can see from a variety of available publications. The effort of authors of these publications has resulted in many proposals of specific methods, experimental plans and conceptual frameworks. These works are well reviewed in Peña-Ayala, who reviewed 240 EDM works and compile profile to describe 222 EDM approaches and 18 tools (Peña-Ayala, 2014). On the other hand, this heterogeneity of methods caused the absence of the widely accepted and sufficiently robust methodology (Romero and Ventura, 2010). In our opinion, further development of the EDM depends on simplification of the EDM tools, design of user-friendly GUI, integration to the VLEs, modification and further improvement of the data mining methods for the educational domain.

LEARNING ANALYTICS

Learning Analytics (LA) represents a new research discipline, which is focused on other topics and issues as aforementioned EDM. We can define learning analytics as a research discipline, which (a) applies modern statistical techniques and methods on the system level of the learning process, (b) targets the institutional level and (c) tries to support the decision-making processes of the educational institutions.

The authors of publications try to combine the research approaches and methods, which are typical for the different research fields such as computer science, psychological science, and sociology with the aim to improve the learning process on the institutional level considering the technical, pedagogical and social aspects of education.

In different words, LA deals with measuring, collecting, analysing and reporting of the data, which were created during the stakeholders' activity in the VLEs, for the purpose of the understanding, optimization or improvement of the learning process. At the same time, LA utilizes the same activities in order to optimization of the learning environment (Siemens and Baker, 2012; Balogh and Turcani, 2011)

LA focuses on the interpretation of the wide range of data with the aim to evaluation of the learning progress, future student's performance, or potential study problems identification. The LA outcomes can be applied not only on the evaluation of the student's

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performance, but also more widely. The LA outcomes can help to review the study programs, syllabus, even the educational institutions (Johnson et al., 2011).

The students' activity represents the typical data source of the LA methods. It includes, for example, assignment uploading; posts sent to discussions, test and questionnaires attempts, but also the relationship between the students (Bienkowski, Feng and Means, 2012). After pre-processing of these data, we obtain the models, which teachers and managers can use for improvement of student's learning path or study program optimization.

The meaningful utilization of the LA methods at educational institutions assumes the cooperation of six essential dimensions (Drachsler and Greller, 2012): stakeholders, internal limitations, external constraints, objectives, data and instruments (Figure 2).

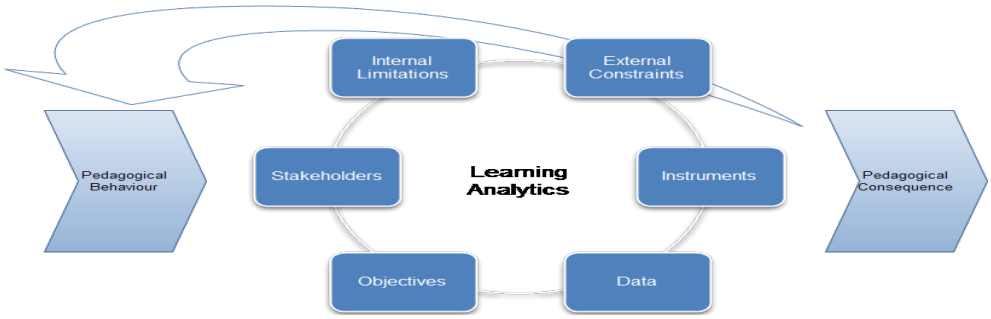


Figure 2 Dimensions of Learning analytics in the context of the learning process (Greller and Drachsler, 2012)

We can see the most frequent representative of each dimension. It is necessary to emphasize that the successful and meaningful using of LA methods conditional on the existence of at least one representative in each dimension.

The modification of the individual parameter or representative, which characterize given dimension, has influence on the other dimensions. This modification can cause changes of the observed outcomes. It means that only the balance between the various dimensions leads to the optimal utilization of the LA methods.

The relationship between LA and other pedagogical approaches has not been described in detail yet. We can see that the LA methods are useful for data analysis, which have been obtained during the application of a particular pedagogical or didactical approach or teaching strategy. It is evident that such data depend on the chosen approach. Even though the correct interpretation of the results can be useful, and can help the teacher to find out many ways, how she/he can intervene to the learning process and how she/he can guide it appropriately. Subsequently, the final pedagogical intervention of the teacher influences the behaviour of the students. It results in the source data modifications, which serve as input to the LA methods. The whole lifecycle of the LA methods using in the learning process is closed (Drachsler and Greller, 2012).

We can find out a lot of unanswered questions, which relate to the technical, ethical and legal issues of using the LA methods. The application domains of the LA overlap the application domains of the EDM particularly in user knowledge, behaviour and experience modelling, user profiling, educational domain modelling (learning blocks, their relations

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and order optimization), learning objects and components analysis, trend analysis, adaptation and personalization.

Each of the particular application domains tries to find out the answers to specific questions, which regard different data sources.

Differences between EDM and LA

The common application domain of the aforementioned research fields is user modelling, modelling the students' knowledge, behaviour or experience during the learning process, user profiling, domain modelling, effectiveness measurement, trend analysis, recommendation and improvement of the learning process.

However the EDM and LA have similar application domains and objectives, use the same data sources, suppose the same knowledge of research methods, the technical, ideological and methodological background are different (Siemens and Baker, 2012).

The preferred approach of knowledge discovering represents the first difference between EDM and LA research fields. EDM prefers automation of knowledge discovering steps, i.e. the straightforward integration of EDM methods into the learning environment. On the other hand, LA prefers and supports the decision-making processes managed by the people.

We can consider the different understanding of adaptation and personalization as the second important difference between the EDM and LA. EDM models are often used as the basis for automatized adaptation, adaptivity or user model creating. By contrast, the LA models are developed mainly for the purpose of the better awareness of teachers and students about the results or issues of the learning process.

The researchers in the EDM prefer the top-down approach. They usually divide the observed problem into several smaller parts, which consequently they analyse in detail. The researchers in the LA provide the holistic approach, they try to see the whole complexity if the observed phenomenon.

As we mentioned earlier, the origin of EDM and LA is different. EDM is closely related to the educational software and VLEs development. It focuses on the students modelling and forecasting of their performance and successfulness in learning goals achievement. LA originates in the semantic web, it tries to design and develop intelligent managed study programs.

Finally, we can shortly mention, that the EDM and LA use different methods and techniques. EDM often uses classification, clustering, Bayesian networks, visualization, discovering by models. LA prefers social nets analysis, sentiment analysis or influence analysis.

ADVANCED APPROACHES

In the previous section, we summarized the possibilities and trends of the two most popular areas of processing the increasing data from VLEs. In this section, we want to take a look at this trend from the perspective of our university environment. We do not want to

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generalize considerations to all universities in the region, as there was no systematic research on the application of EDM and LA realized.

The first prerequisite for successful deployment of EDM or LA tools is functional and long lasting model integrating e-learning into regular education. The main penetration problem of the EDM or LA tools in the Slovak region is weak acceptance and widespread of VLEs. Used VLEs usually serve only as a supplement to traditional forms of teaching, as a repository of study materials or as a platform for uploading students' assignments. It is common that there are no criteria that could define form and amount of e-materials, number of motivating activities or the frequency of a student or teacher visits in the course.

Implementation of indicated rules, criteria or recommendations, is another prerequisite for using EDM and LA, as the amount of gathered data from the VLE raise. If there is increasing the rate of data, we have sufficient amount of input data for further analysis.

Another assumption for employment of EDM an LA is the wide acceptance of the e-learning by all stakeholders. Students, teachers and managers, should be identified with opportunities and responsibilities that the e-learning brings. The fulfilment of these assumptions can be greatly affected by the educational institution itself. There are also many ethical and legal aspects of using EDM and LA that we should consider. Wider application of both methods of VLEs data analysis is still waiting in the wings. However, their interdisciplinary nature leads to expect that sooner or later it can address a wider range of interested.

The implementation of EDM and LA methods applies more bottom-up approach as in the process of the e-learning implementation. Thanks to this state, we can find in the literature amount of papers that present interesting results obtained by applying EDM methods and approaches. As an example, we can mention the papers incurred by projects implemented at the UKF (Drlik and Skalka, 2011; Munk and Drlik, 2011a, 2011b; Munk, Drlik and Vrabelova, 2011; Skalka, Drlik and Svec, 2013; Skalka, Svec, and Drlik, 2012).

We are now in the process of employment and further development of the graphical interactive student monitoring and tracking system (GISMO) created by the eLearning laboratory (eLab) of the University of Lugano in Switzerland as part of the "AAA/SWITCH – e-infrastructure for e-science". GISMO is a graphical interactive monitoring tool that provides useful visualization of students' activities in online courses to instructors. With GISMO instructors can examine various aspects of distance students, such as the attendance to courses, reading of materials, submission of assignments. GISMO provides comprehensive visualizations that give an overview of the whole class, not only a specific student or a particular resource (Figure 3).

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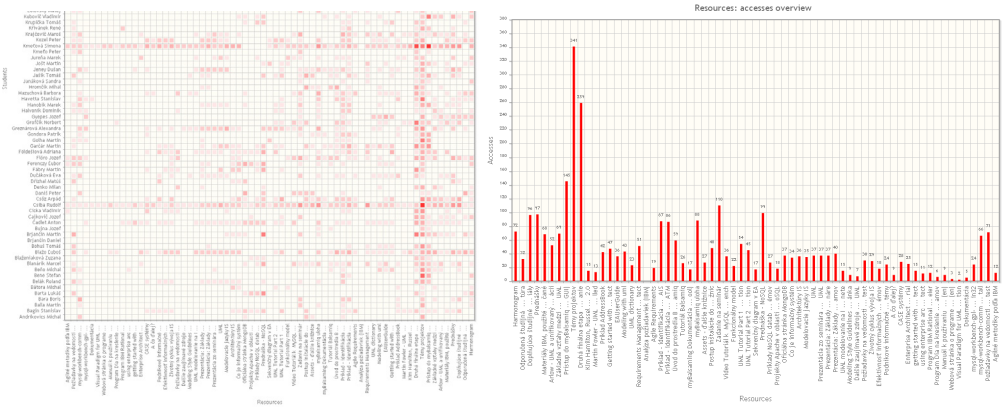


Figure 3 Outputs of GISMO analytical module from VLE

CONCLUSION

The implementation of EDM and LA approaches into the university environment is only at the beginning. We can identify many factors, which defend to the wider use of the EDM and LA methods: unfamiliarity with EDM and LA methods, the absence of standards, non-existence of widely accepted models or frameworks, mistrust towards the results, and also known ethical, legal and personal protection issues (Bienkowski, Feng and Means, 2012). Moreover, it is necessary to accept several recommendations by all the groups of stakeholders.

We are convinced that the EDM and LA methods may be beneficial to stakeholders, if teachers will accept the opportunities, which both approaches provide; teachers and managers will provide students explanation of the usefulness of the EDM or LA methods, administrators and IT departments will prepare conditions for systematic harvesting of data generated during the interaction of stakeholders with the virtual learning environments and researcher will simplify the tools and techniques, which provide to other stakeholders to make decisions in real time.

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Test Design for Knowledge Evaluation with Regard to Dynamic Changes in Society Based on Swarm Intelligence

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Abstract

The motivation for the given topic is dynamic changes in society and the development of information technology (IT) that bring a demand for better adaptability of learning. The problem is about the optimal structure and sorting of educational materials and study activities by student priorities and social needs. The approach for solving this problem is based on object-oriented access and inspiration from swarm intelligence. An active influence of interest about needed structured knowledge and skills brings testing with a stress on adequately sorted questions. The presented results are applied on the test design based on preference indicators in the role of pheromones. The defined preference indicators use assigned priorities (numbers) for individual questions in the test. The reason is that some students prefer to try a test and complete the needed knowledge in case of a wrong answer. Conclusions about the practical usefulness of such a solution support experiences from lectures and realized surveys among students of the Data warehouse course. The benefit of such a test design brings the ability of dynamic sorting of individual questions with regard to existing changes in society with relations to standard knowledge and additional skills of students. The resulting number (preference indicator) is defined as a standard or weighted average from individual preferences of questions. The aim is to enforce student interest about needed themes in a suitable structure. This work is oriented on IT lecture, but the approach is also useful for other lectures in general.

Keywords

Education. Swarm Intelligence. Test design. Quality concepts.

INTRODUCTION

Modern technologies create faster and dynamically new products, services, and also new approaches for the active resolution of existing problems. The modern information society influences lifestyle and the speed of change is increasing. (Mannermaa, 2005) This reality causes an uncertain future with needed ideas of sustainable development and searching classified contexts in order to prevent unexpected events. Interest is oriented on overcoming differences within society and respect for security of needed resources. The reason is that living conditions of previous generations were influenced by natural disasters, plague and famine. (Stuber, 2003) In our modern society, people must resolve

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other difficulties such as unemployment, background for business activities, or competitiveness. (Egger, 2012) Increasing global problems bring questions about the ability of their resolution based on information technologies.

Many scientists search for reasons why there is an increasing speed of existing changes in society in the last several years. There are standard factors that influence such development like economy and culture. (Harrison, 2006) Development of science and new ideas in the cultural framework hold an important place. Both (science and ideas) have close links to innovations and modern approaches to world development. Existing processes of change affect the way of thinking and content of ideas. (Rachna, 2014) General topic consists of the interest about information and its use based on knowledge in the future. Benefits from information technologies (IT) influence people's lives. People have more freedom in innovation and new ideas. There is an infinite amount of knowledge and there are many values and orientations. (Grobstein, 2008) The modern global society is highly pluralistic based on many changes.

Information technologies have successful implementation in all operations, processes and fields of human activities. These good results bring a merge of information technology with nature based on swarm intelligence. Swarm intelligence uses approaches that are inspired by swarms, such as ants, birds, bacteria, and fish. There are a number of optimization models, such as Particle Swarm Optimization, Ant Colony Optimization, and Glowworm Swarm Optimization. (Panigrahi et al., 2013) The main idea is common, the described behaviour of these swarms to apply on realized activities, with an aim to offer optimal resolutions to a given reality. For information technology, interest is important about the optimal implementation of information technology in practice. This reason leads to the highly valued computing support that removes differences between information technology and the user.

LEARNING REACTION TO EXISTING CHANGES IN THE GLOBAL INFORMATION SOCIETY

The information society is more complex, with many separate companies, organizations, and individuals. (Kotler, 2011) Information and communication systems bring a specific influence on the speed of changes. The entry of modern information technology into everyday activities is an important change. Information technology influences people's behaviour, their positions in society, opinions, and views of the world. Information technology brings many positive benefits like free choice of identity, freedom of expression, and ways of creating social groups with a person's identification. (Pokorny, 2005) In this situation, it is natural, that the highly-valued features are adaptability, communication, decentralization, diversity, internationalization, and mobility.

Learning must respond to existing changes in society and IT development. The reason is market demand for effective skills based on actual knowledge. The question is how to define ongoing changes in society with links to the market and IT field, and then to find an optimal method for effective reactions in learning. (Zeleny & Popelinsky, 2011) IT experts must understand technical solutions of realized projects according to the specified profession. They must also know other contexts of implemented tasks like customer preferences with regard to defined goals or the existing environment; therefore,

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communication competences, orientation in customer needs, reaction to competitive activities and many other skills are highly valued. Information technology currently offers such services that respect existing conditions, integrate and consolidate realized processes with the aim to obtain needed information. (Souter & Kelly, 2014) The trend of changes in information technology is defined by the number of analyses and surveys. For example, the well-known Gartner society publishes that in 2015:

- 20% of the 500 largest non-IT firms will offer services via cloud,
- 50% of business activities via web services will use social networks and mobile applications,
- 90% of firms will implement their own applications on personal mobile devices. (Gartner Summary Report, 2010)

There are continuous requirements on actual IT knowledge. Information technology is one of the very dynamic fields of development. There are numbers of applications, systems, and other tools. The focus is also oriented on the method of analysis, design, and implementation. New software, methods and approaches are created every day, and usually default requests of IT experts are divided into two areas:

- Standard professional knowledge.
- Additional skills. (Lee & Reichgelt, 2005)

Professional knowledge must respect IT orientation, and additional skills are focused on the same topics:

- Communication.
- Presentation.
- Cooperation.
- Orientation in management.
- Analytical thinking.
- Creativity.
- Additional knowledge from needed fields (such as economics, ecology, chemistry, biology, physics and many others).
- Multicultural perception.
- Orientation in services.
- Knowledge of standards.
- Empathy for contact with customers. (Zeleny & Popelinsky, 2011)

For the optimal development of needed skills and knowledge, students must get the optimal composition of the education process based on theory and practical examples. The traditional books (e-books) are not popular. Who will read many rows of text? It is better to apply animations and discussions. Some students prefer to try available tests and then they resolve existing mistakes via further study. The optimal test structure has an important influence on such preferences. Teachers must design the necessary construction, question type, and other characteristics, such as evaluation method, number of attempts, or generate a sequence of questions. (Chlebek, 2008) The overall complexity also increases actual diversity in learning between students according to individual priorities.

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DIVERSITY BETWEEN STUDENTS IN LEARNING

The diversity of access to lectures and the following testing is also visible in learning dedicated to information technology. It is natural because every student has an individual approach to a given topic. Personal experience, interest about the theme, and of course, needed time for familiarization with the necessary volume of theory and practice exercises all play an important role. This fact also demonstrates a realized survey on lectures dedicated to data warehouse with links to Business Intelligence (BI). The mentioned survey was realized for the Data warehouse course in a master's study programme for System Engineering and Informatics, specialization Managerial Informatics. 15 students participated in the survey.

BI lectures are focused on data warehouses and practical analyses from stored data in a data warehouse. Individual lectures are oriented on the multidimensional approach, tools for administration, data warehouse creation, ETL (Extract, Transform, Load) phase, OLAP (Online Analytical Processing) analysis, and data mining. Practical examples are realized in products such as the JasperSoft Suite, Pentaho, PerfectForms, and MS Office for classic analyses via queries and context tables. Students were asked a few questions about satisfaction with the presentation and usefulness of lectures, the presented structure of learning, and practical examples. Further questions were dedicated to missing themes, the introduction of other study activities into learning, and the sorting of individual lectures. The results were the following:

- Satisfaction with learning was about 67 % (Yes, or Rather Yes), 16 % of answers indicated that students Do Not Know, and 17 % of students said Rather No.
- Validation of lecture structure was more or less similar: 83 % of students evaluate structure as corresponding (Yes, or Rather Yes), only 17 % of students say they Do Not Know.
- Unfortunately, suggestions for further innovation of study activities were not mentioned. Similar for missing themes.
- Some interesting suggestions were defined for sorting individual themes.

Furthermore, some students prefer:

- More information dedicated to preparing the data and the ETL period before the section for OLAP analysis.
- More details to say about OLAP analysis before its own interpretation of data warehouse creation methods.
- More clarification regarding the data mining theme with links to available BI systems.
- More information about models of data mining in last theme.

This survey shows the diversity in preferences and think maps for understanding a selected topic. The teacher has the initialization role; he or she offers various study activities and educational documents for easier acquisition of new skills and knowledge. Students have access to standard PDF files, PPT presentations, video animations, as well as wiki, glossary and tests. The wiki part is dedicated to students, where they insert interesting information on a BI topic according to their own opinion. A glossary is used for rapid repetition of important terms. Students received video animation the best because

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the learning method is based on an easy start via a player. Students can stop the animation at any time and return to a needed sequence for repetition. A good starting point is that students choose from various study activities and educational documents according to priorities, but it is not enough in the modern and dynamic world. The question is about optimal structure and sorting needed themes via lectures. An appropriate solution is available testing; therefore, an incorrect answer leads a student to needed educational documents and study activities for better knowledge of the theme.

TESTING DESIGN FOR MODERN LEARNING BASED ON SWARM INTELLIGENCE

Optimal knowledge about a given theme is verified, by default, through a test with test questions. Education has several types of test questions (Frost, 2005) for correct verification of needed knowledge. There are standard questions with pre-defined answers and students select the correct opinion (one is correct or more correct). Teachers also use questions with fields for the answer of a student's word or words (to add a word or words). Other types offer the ability to select from Yes/No or to assign answers to questions. A number of analyses and studies are dedicated to test design and its necessary quality. Some are oriented on the administration of the test case with the help of defined features:

- The identifier that defines a unique identifier for reference from other documents.
- The purpose that describes the specified aim of the test.
- The conditions that determine the list of required data and environmental factors for optimal test usage.
- The specification of required steps and inputs that define the list of all steps (questions) and associated input data needed for test implementation.
- The expected results that specify the volume of information in order to determine whether the test is successful or not. (Page & Johnston, 2009)

For suitable resolution of test design, there are some well implemented ideas about extended elements of the question objects, extreme programming, and swarm intelligence from nature:

- The design extended elements of the question objects are based on definition of the question type prototype, question formulation, answers, scoring, and feedback conditions with extended properties settings. (Hruby, 2013)
- Extreme programming merges testing and its quality via responsibility. This approach defines the customer, developer and tester roles. Customers are responsible for the verification of defined stories. Developers must implement tests. Testers are advisors that help with test creation (environments), risk assessment, and quality requirements. (Buchalcevová & Kučera, 2008)
- Swarm intelligence is a field that is oriented on the description of swarm behaviour in ants, birds and fish. (Das et al., 2008) Nature is a unique source of innovations and inspirations. There are studies and analyses that monitor realized activities of swarms. These swarms have intelligent behaviour in order to overcome barriers in their everyday life. An important feature is auto-

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> organization of a swarm based on pheromones. (Dorigo & Stützle, 2004) For example, these pheromones define a suitable route to food. An individual animal does not need knowledge about how to resolve a given situation, but a collective approach defines the right solutions. (Lim et al., 2009)

The above-mentioned ideas bring an inspirational starting point for testing design in learning. There are also customers = students and testers = teachers, they must cooperate with practice for better education via assigned roles. Teachers are responsible for optimal test design and its quality. Necessary tests are defined by study activity, or with help from the administrators of a given education platform, such as Moodle. (Moodle, 2014) A default test contains a volume of questions for the evaluation of needed knowledge and skills. Other suitable benefits may come from a view of questions, such as objects with extended elements. Based on inspiration from nature, there are also other elements, such as pheromones for the definition of optimal testing. The problem is regarding their composition with regards to the actual demands from practice and the suggested knowledge collection, gained by experience from learning. The reason is the ability to shift student interest to an optimal theme for better knowledge and skills.

For dynamic auto-sorting of themes in test design, pheromones are required as indicators of the best interest about the given theme. If test (T) is created via a given number of questions (Q_i, for i=1, …, n), there are preference indicators needed (in the role of pheromones) for every question. Consequently, test (T) needs the same number of preference indicators (PI_i, i=1, …, n) like it has questions (every question has its own preference indicator). These preference indicators PI_i define the important question in the test for given theme in the form of a number. This number is defined as the standard or weighted average based on individual preferences IP_{ij} (i=1, …, n; j=1, …, m) that are assigned for the required knowledge and skills. The optimal selection of the number of suitable individual preferences (m) is now important for every question Q_i. The reason is the link to priorities from practice, students, and IT development.

The good starting point is created based on standard professional knowledge and needed additional skills; therefore, individual preferences are created by standard professional knowledge (P_1), communication (P_2), presentation (P_3), cooperation (P_4), orientation in management (P_5), analytical thinking (P_6), creativity (P_7), multicultural perception (P_8), orientation in services (P_9), knowledge of standards (P_{10}), and empathy for contact with customer (P_{11}). For example, a question about the importance of a data warehouse is standard knowledge of IT experts in this area; therefore, the priority for standard professional knowledge is $P_1 = 1$. Similarly for the knowledge of standards (P_{10}= 1) and presentation (P_3= 1), because IT experts must describe the benefits of data warehouse well. Other individual preferences are set to 0. The resulting number (preference indicator) is defined as the standard or weighted average from the assigned priorities. The following relation is defined for a standard average:

$$PI_i = \sum_{j=1}^{m} IP_{ij} \Big/ m, \qquad (1)$$

where PI_i defines the total priority of the question Q_i (i=1, …, n) based on individual preferences IP_{ij} (for j=1, …, m) with links to priorities in society, IT development, and students. For actual evaluation, a preference monitor is important based on contact with practice, students, and IT experts.

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The final test design is influenced by sorting available questions on the basis of the assigned number (total priority of question PIi) like pheromones in a swarm of ants. Teachers define initial values for individual preferences, and students and cooperating experts from practice influence these numbers via assigned roles. They can increase or decrease the current priority from their own experience and need. The aim is to support interest about actual themes and needed knowledge and skills. Further work will focus on the optimal selection of individual preferences IPij (i=1, …, n; j=1, …, m) for test questions, and practical implementation in learning management systems via standard settings of necessary items for realized study activities. The question is about the needed number of such individual preferences and methods for their actualization. For a better link to practice, it would be appropriate to suggest an auto-search method for individual priorities and their evaluation.

CONCLUSION

The search for fixed relationships between practice and learning is a current topic with regards to dynamic changes in society and IT development. Similar changes are visible in student preferences and their perception of the presented structure of educational documents and study materials. Existing changes are very dynamic and an optimal solution is not easy to specify. There is no golden ratio like in typography. Learning must reflect actual needs in society based on contact with all partners and co-operators. Student opinion and teacher experience is also very important.

A good method brings the dynamic sorting of test questions based on defined preferences like pheromones from swarm intelligence, extended elements of the question objects, and extreme programming. Important and needed themes are placed first. The reason is the fact that some students prefer to go immediately to the test and try their luck. If the wrong answer is inserted, they usually search for the correct answer in educational materials and study activities. Such test design helps in routing optimal student interest toward needed knowledge and skills.

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User Session Identification Using Extended Href Method

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Abstract

One part of web log mining covers the process of discovering web users' behaviour patterns. This process employs user session identification techniques based on the web structure. There are some common heuristic methods which use referral URL from the web server log file. Using the referral URL is an alternative technique for the user session identification. We identified possible deficiencies of the common used h-ref methods and propose its extension. We applied the extended h-ref method on the web server log file and thus identified the user session in a different way. Next we compared basic characteristics of extracted user behaviour rules using the descriptive statistic methods among different h-ref methods. Results of the experiment show that the extended h-ref method does not affect session identification, only affect the inclusion of page visits into existing sessions. The new h-ref method is as effective as the generic one.

Keywords

Web Log Mining. Session Identification. Href method.

INTRODUCTION

Main source of information for web log mining is web server log file. A common web server keeps accesses of user in the log file and logs basic information about user's computer (e.g. IP address, date and time of referring page, browser version). Logs provide basic data as they record page accesses, not interaction with the page, and cannot make relevant distinctions such as that between the time a user spends reading and the time they spend away from the screen (Thomas, 2012). Data of outstanding quality requires rigorous data gathering as the data pre-processing. Data preparation is probably the longest and most time-consuming phase in the process of web usage mining because of incompleteness of accessible data as well as irrelevant information present in the collected data (Balogh & Koprda, 2012; Petr, Krupka, & Provaznikova, 2010a; Petr, Krupka, & Provaznikova, 2010b; Škorpil & Šťastný, 2009; Turcani & Kuna, 2012; Turčínek, Šťastný, & Motyčka, 2012) .

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SESSION IDENTIFICATION METHODS

In the following section, we describe methodologies how to reconstruct the activity of every user, how to detach his activities from activities of other users while preserving his anonymity. This is demanding procedure from the perspective of the theory, time and technical realisation. Different aspects of data preparation can be found, for example, in work by Chitraa and Davamani (Chitraa & Davamani, 2010), Liu, Mobasher and Nasraoui (Nasraoui & Saka, 2007) or Liu (Liu, 2007). We also try to improve methods of session time threshold as this is key variable in session identification.

The separation of the user session on the basis of IP addresses is the simplest solution. But we must note the fact that IP addresses are not suitable in general for mapping and identification of individual site visitors. Currently it is not rare that several users share a common IP address, whether they are situated under a certain NAT (Network Address Translation), or proxy equipment. Another problem raise the situation where one user access the content using more than one computer (multiple IP address regarding one session) or using more than one browser at the same time.

User session identification using time threshold

By using the user session identification, we can differ users sharing one computer (classroom, library, etc.) and we can eliminate NAT and proxy devices. The option for the user session identification using time threshold (STT) are as follows:

- We can consider the session to be a set of user's clicks during the selected period, for example, during 30 minutes, 10 minutes etc. (Berendt & Spiliopoulou, 2000). It follows the duration of the session cannot be greater than $\boldsymbol{\theta}$. Define $\boldsymbol{Date_1}$ to be the access time (recorded in the log file) of the first page of session *S.* Next page with the access time $\boldsymbol{Date_k}$ can be added to session *S* only if $\boldsymbol{Date_k} - \boldsymbol{Date_1} \leq \boldsymbol{\theta}$. All other records of the log file with timestamp greater than $\boldsymbol{Date_1} + \boldsymbol{\theta}$ belong to the next user session.
- The second, more effective, method expects that the session is identified on the basis of sufficiently long interval of time among two recorded visits of the web page. Define σ to be selected time interval and $\boldsymbol{Date_i}$ to be the access time of the page added to session *S*. Next access to page with the access time $\boldsymbol{Date_{i+1}}$ can be added to session *S* only if $\boldsymbol{Date_{i+1}} - \boldsymbol{Date_i} \leq \boldsymbol{\sigma}$. If this condition is not true for two consecutive records of log file, these records belong to two different user sessions.

Heuristic method using the Referer and website map

We can get another view for the session identification if we take into account the website structure. Regular user browse the website using the hyperlinked structure among website pages. Each access to webpage is in the log file identified by the URL of accessed page and the prior webpage, so called *Referer*. Using the *Referer,* we can identify the session using the heuristic methods. In addition to *Referer* field, heuristic method uses also the website map. If we find two consecutive records with the same IP field, which are not directly connected with a hyperlink, we can say that we found access of two unique visitors sharing same IP address.

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Heuristic method h-ref

The h-ref method, as another heuristic method for user session identification based on the structure, takes into account the duration of the session and the referral page. (Spiliopoulou, Mobasher, Berendt, & Nakagawa, 2003).

Define *i* and *i+1* to be the consecutive request, $Date$ to be time of the request, URI to be requested page and $ReferURI$ to be referral page. For the defined time threshold σ, two consecutive requests fit one session if it is true that

$$ReferURI_i = URI_{i-1}, \quad (1)$$

Or two consecutive requests fit one session if (1) is not true or $ReferURI$ is not defined and it is true that

$$Date_i - Date_{i-1} \leq \sigma, \quad (2)$$

We can describe the problem of the page assignment into the session on the example in the Figure 1. When we reach request for the page *E*, two separate sessions have to be created. The first one is represented by the sequence *A-B-C-D,* and the page *A* represents the other one. The page *E* fits the first session as the referral page *D* was accessed in the first session either. The request for the *B* page (13:09) fits both sessions as the referral page *A* belongs to both sessions. According to (Liu, 2007) the page *A* fits the second session as it was created later.

Log file:

Request time	IP address	URI	RefererURI
12:00	194.160.10.10	A	-
12:01	194.160.10.10	B	A
12:04	194.160.10.10	C	B
12:08	194.160.10.10	D	C
13:00	194.160.10.10	A	-
13:04	**194.160.10.10**	**E**	**D**
13:09	194.160.10.10	B	A
13:12	194.160.10.10	C	B

Session 1

Request time	IP address	URI	RefererURI
12:00	194.160.10.10	A	-
12:01	194.160.10.10	B	A
12:04	194.160.10.10	C	B
12:08	194.160.10.10	D	C
13:04	**194.160.10.10**	**E**	**D**

Session 2

Request time	IP address	URI	RefererURI
13:00	194.160.10.10	A	-
13:09	194.160.10.10	B	A
13:12	194.160.10.10	C	B

Figure 1: Example of two sessions creation

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The value of time threshold is also important. We use the 60 minutes threshold time as suggested in (Seco & Cardoso, 2006). They assigned page into the session if at least one of the following condition were true. The page wasn't referred in previous sessions or the time interval between adjacent records was less than 60 minutes.

MODIFICATION OF THE H-REF METHOD

Let us assume a situation in the Figure 2. The last page added into session *S3* was the page *J*. The forthcoming page *Y* can be added into all three sessions, as the page *X* referenced it. According to (Cooley, Mobasher, & Srivastava, 1999; Liu, 2007) the page *Y* should be added to the session S3, as the lastly opened session. We propose to add the page *Y* into the session *S2* as the referral page *X* is "closer" to page *Y* in this session.

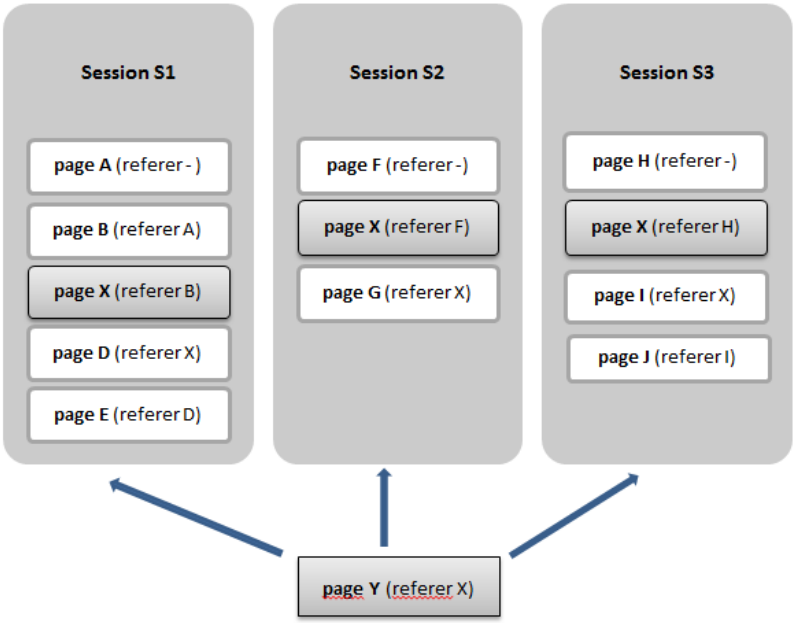


Figure 2: Sessions created using H-ref method

We add the page Y into that session which contains least requests for pages in the interval starting with the Y page and ending with the X page.

To verify the success of this method, we created an algorithm that identify session using the h-ref method. As the web server log file was in plain text format, we imported it into SQL database. In the first step, the algorithm creates sessions based on the IP address field. In the next step, it splits those session using the h-ref method.

Define row_i to be exactly one record of the log file, $S = \{s_1, \dots, s_n\}$ to be analyzed sessions and s_{actual} to be the session with the last analyzed page ($row_{i-1} \in s_{actual}$). If there is no *Referer* for the row_i or the referer is outside the analyzed domain, we have to create new session $s_j (s_j \in S)$. The row_i is the first record of the s_j session. If there is a referer for the row_i we have to create set of session S_T, where $S_T \subseteq S$ and S_T contains sessions, which are able to hold row_i.

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We can assign the row_i to actual session s_{actual} if following conditions are met:

- The URL of the last record row_{i-1} assigned to s_{actual} equals to *Referer* of row_i
- $S_T = \{s_{actual}\}$; The actual session is the only one session to which we can assign the row_i
- $S_T = \emptyset$; We cannot assign row_i to any session based on the *Referer*.

Above mentioned cases are identical for all modifications of h-ref method. If we cannot assign row_i to S_{actual} using above cases, we can try to consider following options, we tried in our experiment:

- If $s_{actual} \in S_T$ we assign the row_i into s_{actual}, otherwise we assign it into the first session s_1 ($s_1 \in S_T$). This step follows the origin method.
- We assign the row_i based on the closest page access.
- We can randomly assign the row_i into the session from the set S_T.

As the amount of data is quite big and in later experiments can be bigger, the performance of the algorithm can be the bottleneck. As the sessions are created based on the IP address, we can use this parameter as the unique pool ID for the parallel computation. The parallel algorithm is as follow:

```
Group_IP_addresses();
Get_list_of_grouped_addresses();
Calculate_the_portion_of IP_pool_based_on_the_number_of_threads();
For I = 1 to number_of_threads {
    Fork_child();
    Call_href_method(i-portion of ip pool)
}
```

Each thread takes records from log file based on the IP field. Consider we want to have eight threads as computing power. We assign the first eighth of IP pool to the first thread, second eighth to the second thread etc. It doesn't matter that in the web server log file records are not sorted based on the IP address, because we transformed the log file into the SQL database.

EXPERIMENTAL VERIFICATION OF EXTENDED H-REF METHOD

Appropriateness and effectiveness of extended method h-ref has been verified by experiments. Data source for the experiment is the commercial bank web server log file of the 2010 year acquired as part of our research VEGA project. We used standard methods for cleaning data from unnecessary data (requests for images, style sheets, etc.) and crawlers' accesses.

We have to take into account extreme cases, so we define following heuristic: If there is a time difference between two consecutive records in the log file higher than 60 minutes, the second record is considered as a new session (Seco & Cardoso, 2006). We

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consider that 60 minutes pause doesn't mean that the user is reading one page for one hour. This consideration is of course disputable, but due to the calculation of other real values for the time threshold for the identification of sessions, it is very important. Log file with identified session is the starting point for an application of h-ref method. We identified session more precisely using following methods:

- Href-ACTIVE: Session identification using the origin h-ref method.
- Href-SEARCH: Session identification using extended h-ref method.
- Href-RANDOM: Session identification using random assignment into multiple possible sessions.

Experiment Results

If we use the path-competition method, the numbers of records in the log file increase. The number of identified sessions depends on the method of identification. In case of h-ref method, a new sessions are created only in case that the *Referer* is empty or the *Referer* contain URL outside domain.

Table 1: The count of visits and count of sessions

	Href-SEARCH	**Href-ACTIVE**	**Href-RANDOM**
Number of records	938497	938497	938497
Number of visits (identified sessions)	378435	378435	378435
Average length of identified sessions	2	2	2
Frequent sessions (s = 0.5 %, c = 0.5 %)	110	109	110
Frequent sessions (s = 1 %, c = 1 %)	49	49	49

The session identification based on the extended h-ref method does not have a significant impact on the quantity of extracted rules (Table 1). There is also no difference when we consider results (support, confidence) of sequence rule analysis.

Next step we have to consider evaluating the quality of identified session is the categorization of extracted rules based on the level of usefulness into three categories (*useful, trivial* and inexplicable rules) and intercomparison among all three dataset. As the rating of the rule is the same in all three methods, it doesn't matter the rating is subjective. We weight the trivial rules at zero, as trivial rules represented with association rules do not bring a new view on users' behaviour. If we consider the amount of useful rules, the method, which discovers more useful rules, is better. On the other hand, if we consider the amount of inexplicable rules, the method, which doesn't generate inexplicable rules, is better.

Using the Href-Search and Href-Random we discover one extra rule missing in the Href-Active. The extra rule had similar values of support and confidence (Table 2).

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Table 2: Extracted rule missing in the Href-Active

Body	=>	Head	Support(%)	Confidence (%)
(/about/contacts/write-to-us.html)	=>	(/about/branches-and-atms.html)	0.4989	7.5712

We can interpret the rule as follows: From all visits at the portal, the portion of 0.5% view the */about/contacts/write-to-us.html* page. From all these visitors, just 7.57% visitors continued to page */about/branches-and-atms.html*. Even if we can consider this rule as useful, the values of support and confidence are negligible.

The difference between all three methods can be the length of identified sessions. We detected most differences between Href-Active and Href-search method (1190 sessions, but this represents only 0.31% of all sessions). Comparison of the two methods against Href-Random method was almost the same (889 in case of Href-Active and 878 in case of H-ref Search).

CONCLUSION

The experiment did not show a significant difference in results between the examined methods. Improved efficiency of extended h-ref method has not been proved. The main causes of this finding might include the fact that we made just a small improvement which does not affect the creation of new sessions. It only affects the assignment of visits to existing sessions.

We analysed 938,497 records and just in case of 2,611 records the algorithm had to determine the correct open session. This represents only about 0.29% of all cases.

The original idea for extension of h-ref algorithm was focused on the optimization for the path completion method. This is applied as the last method of preparing data for sequence analysis. In the next experiment, we plan to use this method on the same dataset and compare generated sessions and extracted rule based on their quantity and quality.

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Modelling of Associations in Students' Characteristics by Web Site Use as Learning Resources

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Abstract

Students prefer to study not only different forms of education (a full-time study, a part-time study and e-learning) but also different forms of study materials (e.g. printed or electronic). The use of readers such as tablets, smartphones and for example laptops relates to study of materials in electronic form. Common student studies from textbooks, notes and other available learning resources. Currently, the Internet provides a quick and easy way to get many study materials. This article deals with discovering of associations in the data by Generalized Rule Induction regarding the web sites use by the students for gaining the electronic study sources. We searched association rules by gender, by the most used web sites as Wikipedia, Google and Primat etc. Discovered association rules were described and commented. Models were designed in the software SPSS Clementine.

Keywords

Learning sources. Web sites. Association rule. Generalized rule induction.

INTRODUCTION

Universities represent institutions that implement an information and communication technologies (ICTs) into their life for a relatively long time. They have been pioneers of an ICT implementation in an education. Recently, new trends in using of Internet are beginning to strongly promote and to fund (Poulová and Maněnová, 2010). Platforms and applications are commonly available at the Internet. They allow users to communicate, cooperate and share different types of information (Zounek, 2011). Social networks are another trend in this area (Barabási, 2005; Panuš, Jonášová and Michálek, 2012).

University students are represented full-time students, part-time students and students with special needs (students with sense or other disabilities). They come to university from different schools or social environment and they have often a very different ICT experience or skills. ICTs represent an important tool for all students in their learning. However, the use (and ideas of using) of various ICT tools can be different for individual student groups. Students could freely choose tools of modern technologies. It depends on students' needs, importance of study information, user-friendly tools etc.

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(Zounek, 2011). On the basis of the international comparison the student use of the Internet across European countries is almost equal proportions. In the Czech Republic 92% of students use the Internet (CSO, 2013).

The easy availability of resources and information in the Internet or in the online faculty learning environment is one of the most important motives for the use of technologies. This is not just a simple use of various search engines during looking for some general information, but the search for specific resources related to the study field (Zounek, 2011). Student work with different types of documents, whether in paper or electronic form. Documents are according to their main communication function divided into (Nováková et al, 1995) scientific, educational, popular science, political and administrative documents.

Study source (Kašparová, Horčička and Křupka, 2013) is able to be understood as a document where we can gain the information for studies. Generally it can be divided into printed study sources (e.g. books, scripts, research papers and thesis) and electronic sources. Among the electronic study sources belong books, scripts, lectures and others in electronic form. They are accessible via the Internet or other media for distribution of digital data (e.g. DVD, USB Flash disc). They also could be magazines, thesis of students, contributions from the proceeding papers and others, which students can gain e.g. from the university library, electronic encyclopedia (ASCR, 2013) and dictionaries (Nováková et al, 1995). The common user gets the information usually via web sites. However, there could be a problem in their order or lucidity or even in their veracity (Kašparová, Horčička and Křupka, 2013).

This article deals with searching of association in students' characteristics in context of web site use as learning resources. It is follow-up to article (Kašparová, Horčička and Křupka, 2013), where were analysed three key questions on the basis of data from survey. The content of these questions were the following: the frequency of Internet use for independent gaining study sources (it is not related to the links and files (e.g. specialized articles), which were provided by the lecturers for self-study); the use of learning resources from foreign websites and the view that there are enough authentic web sites related to studies, which the student can gain the study materials (documents). Following that the objective of this article is to search association rules in context of web site use as learning sources by gender; by the most used web sites as Wikipedia, Google and Primat and by opinion of students, if the searching for study materials leads them to the greater independence by study.

PROBLEM FORMULATION

The searching of students' characteristics by association rules is content of this article. We worked with data gained from the questionnaire. Data were collected in January, February and March 2013. The questionnaire (Kašparová, Horčička and Křupka, 2013) was placed on the social network Facebook into groups, which associate the students of the University Pardubice. It was also published within the Learning Management System (LMS) Moodle at the Institute of System Engineering and Informatics. Interactions between students and LMS Moodle were modelling in (Balogh, Turčáni and Burianová, 2010).

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The questionnaire consisted of twenty questions. Examples of the questions are: Q3: Which study source do you find the best for studying? Q8: What is an approximate ratio of web sites visits related to your studies to the visit of web sites for leisure time? Q12: What are your most used web sites for searching for study sources? O14: Does it happen to you that the found study sources on the Internet are misleading? Q15: Do you verify the content of the study materials gained independently on the Internet in the specialized literature (related to study materials which were not provided by the lecturer)? Q16: Do you think that searching for study materials on the Internet leads the students to the greater independence? (Kašparová, Horčička and Křupka, 2013).

In total 203 men and 197 women took part in the survey. We worked with 400 completed questionnaires. Respondents aged 19 to 28 were divided to five age groups. The age group 3 (aged 23 to 24, 43.5%, 174 respondents) and then the age group 2 (aged 21 to 22, 35.5%, 142 respondents) were the most frequent groups of respondents. There were four respondents older than 28, too. More about respondents and data analysis is in (Kašparová, Horčička and Křupka, 2013).

Obtained data was evaluated and then processed to the data matrix of the range (400×54). It contented 54 nominal variables (attributes) with values 0 and 1. The sample list of variables is in the Table 1 (the complete list of attributes is in (Kašparová, Horčička and Křupka, 2013)). On the basis of this data we searched association rules by gender; by the most used web sites as Wikipedia (it is the free encyclopedia that anyone can edit; there it is possible to find many topics in different foreign languages (http://www.wikipedia.org/)), Google (it is the full text search engine but in this page we can find range of other services (http://www.google.com)) and Primat (it is the information portal for students; it offers study sources to download, study information, advices and help to students etc. (http://www.primat.cz)); and by opinion of students, if searching for study materials leads them to the grater independence by study.

Table 1: The sample list of variables

ID attribute	Description of an Attribute	Values
a_1	Q2: Use of the Internet: Very often	{0, 1}
a_2	Q2: Use of the Internet: Often	{0, 1}
a_3	Q2: Use of the Internet: Sometimes	{0, 1}
a_4	Q2: Use of the Internet: I don't use it	{0, 1}
…	…	…
a_{15}	Q7: Enough authentic web sites related to your studies	{0, 1}
a_{17}	Q11: Use of the translator: http://translate.google.com	{0, 1}
a_{23}	Q12: Most used web sites for searching for study sources: http:// www.primat.cz	{0, 1}
…	…	…
a_{54}	Q20: Accommodation: I study in town where I have my place of residence	{0, 1}

MODELLING OF STUDENTS' CHARACTERISTICS BY GRI

We focused on searching for characteristic of students in view of web site use by the application of generalized rule induction (GRI), which extracts a set of rules from the data.

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Association rules (Berka, 2003; Witten and Frank, 2006) are statements in this form (1) (Clementine®, 2006):

If antecedent(s) Then consequent(s). (1)

Each rule in the final rule set has associated instances, support, confidence, and lift. Instances are calculated as the number of records for which the antecedent is true (Clementine®, 2006a). Rule support m_{RS} (in %) and confidence m_C (in %) are two measures of rule interestingness. They respectively reflect the usefulness and certainty of discovered rules (Han and Kamber, 2001). Confidence m_C (Clementine®, 2006a; Han and Kamber, 2001) displays the ratio of rule support to antecedent support. It indicates the proportion of IDs (Rule ID displays the rule ID assigned during model building) with the specified antecedent(s) for which the consequent(s) is/are also true (Clementine®, 2006). Equation (2) of confidence m_C is the following:

$$m_C = m_{RS} / m_S, \quad (2)$$

where support m_S displays antecedent support; rule support m_{RS} displays the proportion of IDs for which the entire rule, antecedents, and consequent(s), are true (Clementine®, 2006). Lift is simple correlation measure (Han and Kamber, 2001). It displays the ratio of confidence for the rule to the prior probability. Rules with lift different from 1 will be more interesting than rules with lift close to 1 (Clementine®, 2006). We can see an application of GRI for example in (Haeri and Tavakkoli-Moghaddam, 2012; Jirava, Mandys, Křupka and Kašparová, 2010; Mirabadi and Sharifian, 2010; Theodoraki et al, 2010).

We worked only with 37 attributes (i.e. without attributes that informed about services of the university library, because these variables were very specific). Default setting of the GRI was the following: maximum antecedent support is 0%, minimum rule confidence is 50%, maximum number of antecedent is 3 and maximum number of rules is 100. All results of modelling were sorted by rule support m_{RS} (i.e. antecedent and consequent of rule are fulfilled; within this arrangement we can see the most frequent combinations of variables – i.e. of antecedent and consequent) and are arranged in tables and figures (Kašparová, Horčička and Křupka, 2013). Values of column "Instances" in all tables (the Table 2, Table 3, Table 4, Table 5, and Table 6) are numbers of records for which the antecedent is true. Values calculated from the rules support m_{RS} and from the total number of answers within a given attribute are used in the text to description of rules.

Association rules by gender are in the Table 2. It shows the first five examples of rules from gender point of view. For 118 men (a_{31}= 1) study materials in the web sites which they use for study are the adequate tool for successful course completion (a_{28} = 1) and information and materials in the Internet were correct (a_{38} = 1). The same goes for 76 women (a_{31}= 0). 114 men and 54 women prefer electronic study sources (a_{40} = 1). 111 men and 78 women use study sources from the foreign web sites (a_{16} = 1). 100 men and 57 women verify the content of the study materials gained on the Internet in the specialized literature (a_{29} = 1) and materials in Internet were correct (a_{38} = 1). They did not run into misleading study sources on the Internet. And for 98 men and 49 women, which prefer electronic study sources (a_{40} = 1), study materials in the web sites are the adequate tool for successful course completion (a_{28} = 1).

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Table 2: Five rules by GRI (gender)

Consequent	Antecedent	Instances			m_{RS} Men/Women	m_C	Lift
		Total	Men	Women			
a_{31}= 1	a_{28} = 1 and a_{38} = 1	194	118	76	29.50/19.00	60.82	1.198
a_{31}= 1	a_{40} = 1	168	114	54	28.25/13.75	67.26	1.325
a_{31}= 1	a_{16} = 1	189	111	78	27.75/19.50	58.73	1.157
a_{31}= 1	a_{29} = 1 and a_{38} = 1	157	100	57	25.00/14.25	63.69	1.255
a_{31}= 1	a_{28} = 1 and a_{40} = 1	147	98	49	24.50/12.25	66.67	1.314

The Figure 1 shows the first five examples of rules from gender point of view by the antecedent support m_S and rule support m_{RS}. It shows given supports m_S and m_{RS} for the first rule If a_{28} = 1 and a_{38} = 1 Then a_{31}= 1. It means antecedent is fulfilled for 194 students (48.5% of students in the data set) and relates to 118 men (58.13% of men in data set, i.e. 203 men) and 76 women (38.57% of all women, i.e. 197 women).

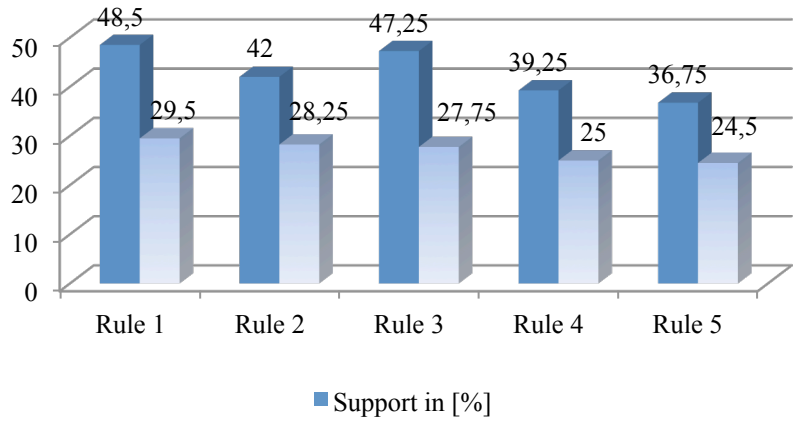


Figure 1: Support m_S and Rule Support m_{RS} of rules by gender

Association rules by use of web site Wikipedia.com are in the Table 3. Interpretation of them is the following: 8 students which use Wikipedia (a_{24} = 1) prefer electronic study sources (a_{40} = 1) and sometimes run into misleading study sources on the Internet (a_{37} = 1). These students live in lodgings (a_{52} = 1). 6 men have experience with misleading study sources on the Internet (a_{37} = 1), that they use only sometimes for searching study sources (a_3 = 1). 4 students in age 19 or 20 years (a_{45} = 1) and live in lodgings (a_{52} = 1) use Wikipedia for searching study materials (a_{24} = 1). Next 4 students (in the same age and the same type of an accommodation) use the on-line translator http://translate.google.com (a_{17} = 1). And again 4 students which use Wikipedia (a_{24} = 1) have an experience with misleading information (a_{37} = 1) and study sources on the Internet, that use only sometimes in view of study (a_3 = 1) and live in lodgings (a_{52} = 1). In the Figure 2 we can see antecedent support m_S and rule support m_{RS} of given association rules.

Table 3: Five rules by GRI (Wikipedia)

Consequent	Antecedent	Instances	m_{RS}	m_C	Lift
a_{24} = 1	a_{37} = 1 and a_{40} = 1 and a_{52} = 1	13	2.00	61.54	6.154
a_{24} = 1	a_{31}= 1 and a_{37} = 1 and a_3 = 1	11	1.50	54.55	5.455
a_{24} = 1	a_{45} = 1 and a_{52} = 1	5	1.00	80.00	8.000
a_{24} = 1	a_{17} = 1 and a_{45} = 1 and a_{52} = 1	5	1.00	80.00	8.000
a_{24} = 1	a_{37} = 1 and a_3 = 1 and a_{52} = 1	6	1.00	66.67	6.667

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Characteristic of students that use web site Google for searching study sources (a_{22} = 1) by association rules is the following: In the Table 4 we can see that students in all five rules rather use printed study materials for study then electronic (a_{41} = 1). The best for them are the text books or for example printed PDF files. 57 students use foreign web sites by study (a_{16} = 1). Next 54 students with the same characteristic use the on-line translator http://translate.google.com (a_{17} = 1). 53 students think, that the use of the Internet for study leads them to the greater independence (a_{30} = 1). These number of students uses of electronic services of the university library (a_{42} = 1). 46 students have the same opinion relative to the Internet use by study and greater independence (a_{30} = 1) as the previous group of students and also verify the content of the study materials gained on the Internet in the specialized literature (a_{29} = 1).

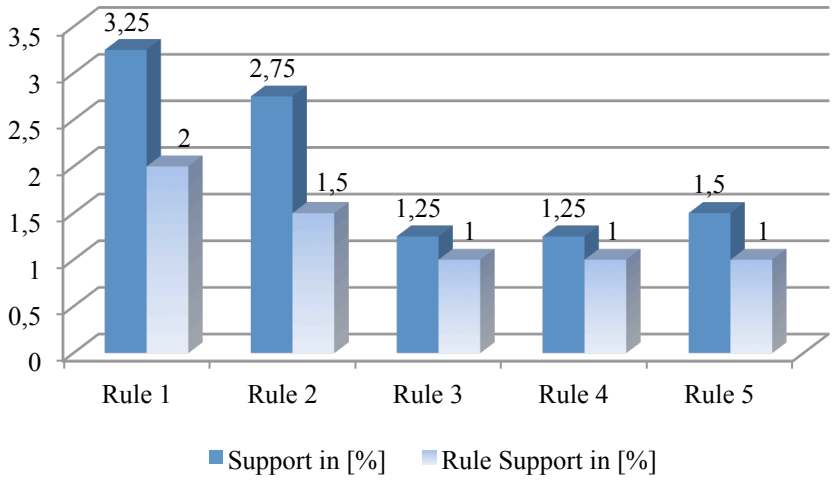


Figure 2: Support m_S and Rule Support m_{RS} of rules by Wikipedia use the Internet in the specialized literature (a_{29} = 1).

Table 4: Five rules by GRI (Google)

Consequent	Antecedent	Instances	m_{RS}	m_C	Lift
a_{22} = 1	a_{16} = 1 and a_{41} = 1	112	14.25	50.89	1.330
a_{22} = 1	a_{16}= 1 and a_{17} = 1 and a_{41} = 1	105	13.50	51.43	1.345
a_{22} = 1	a_{30} = 1 and a_{41} = 1 and a_{42} = 1	105	13.25	50.48	1.320
a_{22} = 1	a_{29} = 1 and a_{30} = 1 and a_{41} = 1	90	11.50	51.11	1.336
a_{22} = 1	a_{15} = 1 and a_{30} = 1 and a_{41} = 1	85	10.75	50.59	1.323

In the comparison with the previous group of students, next 43 students do not verify the content of the study sources and think that there are enough authentic web sites related to their studies (a_{15} = 1). The Figure 3 represents antecedent support m_S and rule support m_{RS} of association rules from the Table 4.

Characteristic of students using use web site Primat for searching study sources by association rules is the following: by these five rules all groups of students regard this web site as adequate tool for successful course completion (a_{28} = 1). 108 students have opinion that there are enough authentic web sites related to their study on the Internet (a_{15} = 1). For 103 students the approximate ratio of web sites visits related to studies to the visit of web sites for leisure time is 1:2 (a_{33} = 1). The group of 82 students uses electronic services of the university library and think, that to their study enough authentic web sites exist. The

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last rule informs of an approximate ratio of web sites visits related to studies to the visit of web sites for leisure time. This ratio is 1:2. By this rule 80 students also use electronic services of the university library. Confidences of these five association rules we can see in the Table 5. Antecedent support m_S and rule support m_{RS} are shown in the Figure 4.

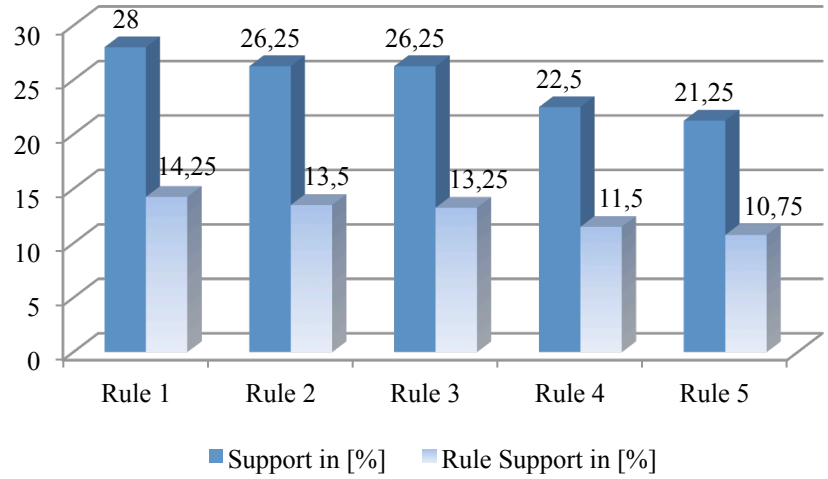


Figure 3: Support m_S and Rule Support m_{RS} of rules by Google use

Table 5: Five rules by GRI (Primat)

Consequent	Antecedent	Instances	m_{RS}	m_C	Lift
$a_{23} = 1$	$a_{28} = 1$	297	40.00	53.87	1.122
$a_{23} = 1$	$a_{15} = 1$ and $a_{28} = 1$	192	27.00	56.25	1.172
$a_{23} = 1$	$a_{28} = 1$ and $a_{33} = 1$	181	25.75	56.91	1.186
$a_{23} = 1$	$a_{15} = 1$ and $a_{28} = 1$ and $a_{42} = 1$	139	20.50	58.99	1.229
$a_{23} = 1$	$a_{28} = 1$ and $a_{33} = 1$ and $a_{42} = 1$	135	20.00	59.26	1.235

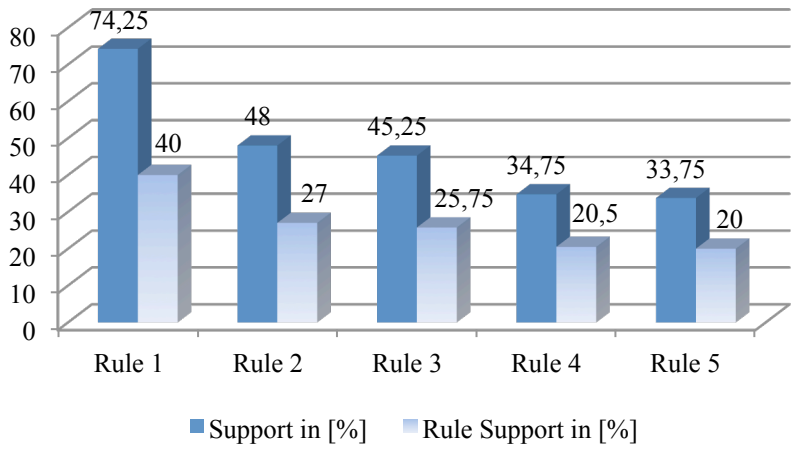


Figure 4: Support m_S and Rule Support m_{RS} of rules by Primat use

Found association rules in view of student's opinion if searching for study sources on the Internet leads them to the greater independence ($a_{30} = 1$) are in the Table 6. We can see that students largely use the on-line translator http://translate.google.com ($a_{17} = 1$) and prefer printed study materials ($a_{41} = 1$). By the first rule it is 129 students. By the forth

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rule students also prefer searching information on the Internet regarding leisure time (the approximate ratio is 1:2). 77 students that use web site Google also use on-line translator http://translate.google.com. Values of the antecedent support m_S and rule support m_{RS} of these association rules are shown in the Figure 5.

Table 6: Five rules by GRI (web sites and greater independence by study)

Consequent	Antecedent	Instances	m_{RS}	m_C	Lift
$a_{30} = 1$	$a_{17} = 1$ and $a_{41} = 1$	179	32.25	72.07	1.211
$a_{30} = 1$	$a_{15} = 1$ and $a_{17} = 1$	143	25.75	72.03	1.211
$a_{30} = 1$	$a_{37} = 1$ and $a_{41} = 1$	113	20.25	71.68	1.205
$a_{30} = 1$	$a_{17} = 1$ and $a_{33} = 1$ and $a_{41} = 1$	102	19.5	76.47	1.285
$a_{30} = 1$	$a_{17} = 1$ and $a_{22} = 1$	106	19.25	72.64	1.221

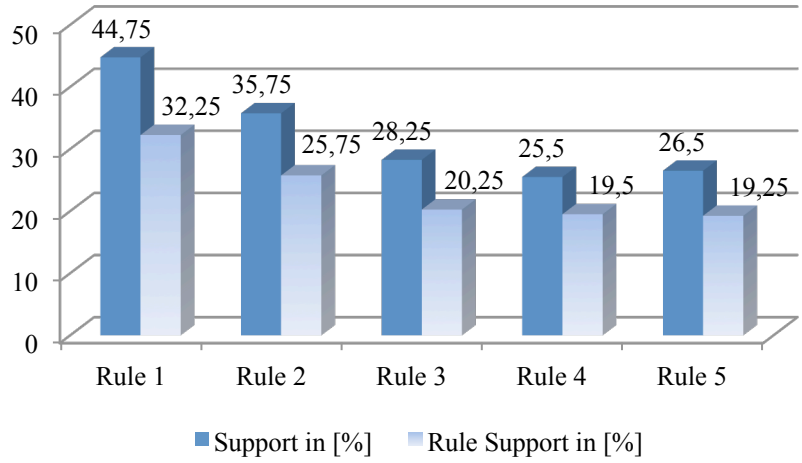


Figure 5: Support m_S and Rule Support m_{RS} of rules (by web sites use and greater independence by study)

CONCLUSION

The work with teaching materials in electronic form is one of the ICT benefits. The possibility of very fast search in electronic materials, whether in terms of resources in the Internet or offline stored materials can be considered for large positive. The question is whether much comfort and easy availability of materials in electronic form (it can also be materials from teachers) does not lead to a superficial study of problems or certain reluctance to put more effort into finding other sources that are not available in electronic form (Zounek, 2011).

In this article we dealt with the searching for characteristic of students in view of web site use by the application of GRI algorithm. We searched association rules by gender and by the most used web sites as Wikipedia, Google and Primat. We focused also on characteristics of students with opinion that searching for study materials leads to the grater independence by study. We worked with data matrix of the range (400×54). It was created on the basis of questionnaire among mainly students of University Pardubice. It was obtained 400 fully answered questionnaires. Examples of discovered association rules sorted by rule support m_{RS} are in the Table 2, …, Table 6.

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Whether the data volume is sufficient for rule extraction, is the question. The rule may be worthless for a very strong correlation among the observed variables if the model makes with a small sample of data. In our work 400 objects were used and it is possible to talk about their applicability in context of the solved topic. A problem of an impact on the quality of extracted rules using of a different algorithm is described in (Munk, Kapusta and Turčáni, 2010).

We can state that association rules are easy to interpret. The algorithm GRI it is possible to apply for the searching of characteristic for example in this area of the analysis web site use as learning sources. By discovered association rules we can describe students in view of given attributes. It follows that we can consider association rules as an unusual data analysis tool. Software SPSS Clementine 10.1 was used for modelling.

In the future we will apply Apriori algorithm (Witten and Frank, 2006; Clementine®, 2006; Sasikala, Premalatha and Logeswari, 2011) (application of this algorithm we can see e.g. in (Chan, Lee and Kwang, 2007)) and we will search differences and compare discovered rules. And also we will deal with an application of selected methods of the cluster analysis (Fu, 2008; Han and Kamber, 2001, Maimon and Rokach, 2005; Petr and Kašparová, 2006; Witten and Frank, 2006) in order to find groups of students with similar characteristics.

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Language Learning in Adaptive LMS

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Abstract

There have been many attempts to use Information and Communication Technologies in a language learning in a form of either online or offline projects. However, all of these attempts share one attribute and that is applying the same didactic approach in their projects as we can see in traditional classrooms. This didactic approach is based on curriculums taking account of traditional form of education which means to distribute the same amount of information and the same form of information to each student. This approach, however, hasn´t appeared to be effective enough in a language learning. When talking about individualized instruction and Information and Communication Technologies there can be a tool coming into existence to facilitate a language learning process and to improve students´ language knowledge and language skills. This contribution will introduce a proposal of a language learning instruction in adaptive LMS whose structure was presented at DIVAI 2012 conference. In relation to the DIVAI 2012 conference contribution this contribution introduces identical elements in adaptive LMS for general subjects instruction and a language learning. After there is a different approach in static and dynamic student´s characteristics diagnostics explained. Last but not least there is a mechanism of matching adaptive instructional support in a language learning outlined with some examples of algorithms that match adaptive study materials with a particular student. In comparison to the current attempts to utilize Information and Communication Technologies in a language learning our approach in the field of individualized language instruction seems to be unique.

Keywords

Adaptive LMS. Adaptive isntruction. Language learning instructio., Diagnostic placement test (abbr. DPT). Sensory modalities. Information and Communication Technologies (abbr. ICT). Second language acquisition (abbr. SLA). Static characteristics. Dynamic characteristic. Virtual student. Language learning. Author module. Student modu. Virtual Teacher module.

INTRODUCTION

The idea of adaptive LMS system originated from the need to make study process more effective for students in a way of deeper understanding of a presented knowledge and as a result to be able to put this knowledge into practice in case there is a practical outcome of this knowledge. We believe that such a result can be achieved by a modification of current LMS systems whose functions are currently (year 2014) limited to a storage of study materials, control of instruction, evidence of students, evidence of students´ activities and their results. The topic of adaptive instruction has been mainly

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discussed abroad. The authors like Peter Brusilovsky has been doing research for almost 20 years in the area of adaptive systems. From his many publications it is obvious that the area of adaptive hypermedia systems started to be oriented on learning styles. Web adaptive systems and the third "mobile" generation are other forms of adaptive systems. (Brusilovsky, 2008; Sosnovsky, 2009; Hsiao, 2010; Hsiao et al, 2011) are solving partial problems. In their articles they are focused on possibilities to unify a student´s profile for various web adaptive systems. They were also creating manuals for users of adaptive systems and interface for students´ communication.

A survey above shows adaptive instruction has been solved only partialy so far. The current findings must have been taken into account when designing a model of adaptive LMS. In comparison to adaptive hypermedia systems that are based on observation of student´s behaviour while operating in a system, our approach of adaptive environment will be based on students´learning styles.The model itself is based on finding initial student´s characteristics, creating adaptive study support and defining adaptive algorithms (in Kostolányová, 2012).

Parallely with our attempt of creating an adaptive LMS other attempts has been made to adapt a learning process to a student.

In so called "Flexible e-learning" the authors try to accommodate the individual learning style of a student within the ICT supported process of instruction to increasing the level of student´s knowledge (Poulová and Šimonová, 2012).

Further, on the base of their findings they designed an IT application generating appropriate types of study materials, assignments, testing methods and related activities towards tailoring the learning to student's needs. Finally, the whole approach has been piloted and the results has been summarized in didactic recommendations (Šimonová and Bílek, 2012).

Even in 2009 an eLearning module has been described in theory to run adaptive e-courses at Mendel University in Brno. The eLearning module has been designed to a set of basic components as a teaching model, domain model, user model, adaptation engine and user monitor (Malo, Dařena and Motyčka, 2009).

Concerning of an individualized approach in a language learning we haven´t found a research dealing with this issue yet (year 2014). There has only been terms like "Mobile assisted language learning", "Computer assisted language learning" or "Intelligent computer assisted language instruction".

In the field of a language knowledge testing there has been terms like "Computer based language assessment" or "Computer assisted language testing". The adaptivity in a language knowledge testing can be seen in so called "adaptive test". The adaptive test detects a language level of a student in a way of submitting an easier or more difficult tasks on the base of student´s answers (Fulcher, 2010).

To create the adaptive teaching materials for a language learning a theoretical basis for creation of multimedia language projects can be used. The core of adaptive teaching materials is the Second language acquisition model (abbr. SLA model). This SLA model is based on Krashen´s idea who defines entries when learning a target language and how this entry to be processed by a student to influence his language skills positively (Long, 1996). The model of a language learning in adaptive LMS could prove the assumption that

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it is useful to place students in different study groups not only according to their grammar language level but also according to their initial language skills such as listening, reading, writing and speaking skills. What´s more, it´s also useful to place students according to their prefered sensory modality. The beneficial effect of this approach is mainly seen in findings if students placed in different language level groups together with their preferred sensory modality will learn faster and with knowledge better retained. If the idea above will not be proved to be of some benefit for language learning students other approach must be explored to accomplish the goal.

METHODS

To design the model of a language learning in adaptive LMS the current model of adaptive LMS must have been slightly adjusted regarding the specifics of a language learning in comparison to general subjects´ instruction.

To start with, there will be the current model of adaptive LMS for general subjects presented together with the model of adaptive LMS for a language learning.

Firstly, the identical elements of both models will be shown. Secondly, the different elements of both models will be presented pointing out the adjustments of the original model of adaptive LMS to serve a language learning in adaptive virtual environment. Next, these adjustments of the original model will be explained in more details, particularly in a Student and Author module. Finally, there will be the mechanism of matching adaptive study materials with a student in a language learning outlined.

As you can see in Figure 1 the adaptive LMS elements for general subjects as well as for a language learning are shown. There are three basic modules in both models: Student module, Author module and a Virtual Teacher module.

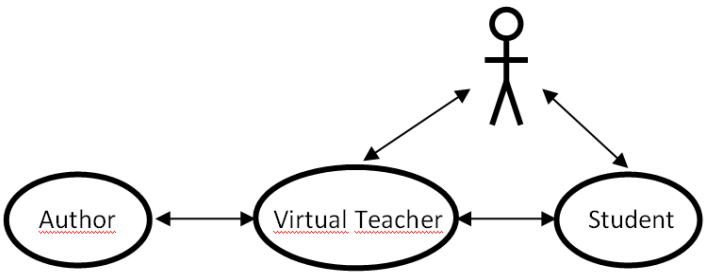


Figure 1: Adaptive education model.

The Student module contains, aside from personal attributes of students, records of their characteristics determining the learning style of each student. The Author module is to create learning supports in such a manner as to allow selection of creation of different variations of educational procedures, easily handled in the form of e-learning and corresponding with the ascertained characteristics of students.

The Virtual Teacher module is represented by a system of adaptive algorithms, which, on the basis of the knowledge of the individual type of student, selects the optimum study materials and the optimum teaching style for the student. All modules will be applied in a

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newly designed and implemented adaptive LMS (Kostolányová, Šarmanová, Takács, 2011b).

As we can see in Figure 1 there isn´t a difference on basic level between the model for general subjects and the model for a language learning.

Comparing both models for general subjects and a language learning

However, when we look at both models in more details we can see some difference. In Figure 2 we can see the approach of student´s diagnostics and an adaptable study support structure in original model for general subjects.

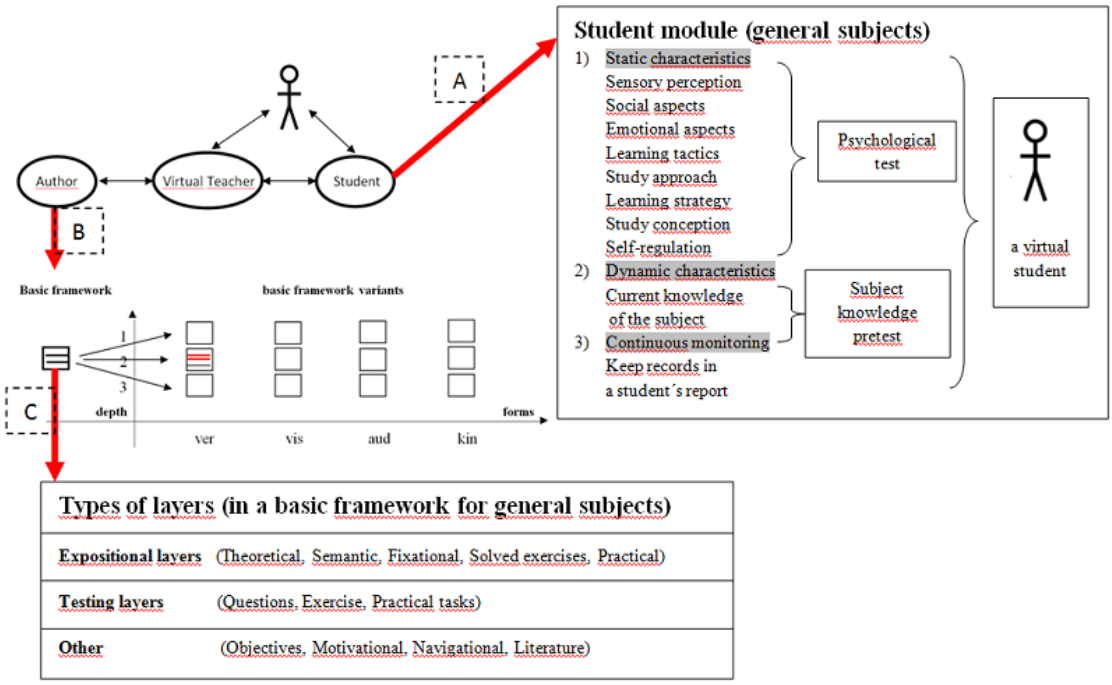


Figure 2: Student and Author module in adaptive LMS for general subjects.

In Figure 2 (see A) we can notice that static characteristics are acquired by a psychological test (Novotný, 2010) and dynamic characteristics are acquired by a subject knowledge pretest.

Even when generally deliberating over differences of instruction for students with different learning styles, it is not possible to take into consideration all of the theoretically possible types of students. For the purpose of initial deliberations we determine so-called *virtual students*, in other words often occurring types with characteristics defined by only a few rounded values. Virtual students can be determined by several methods (Kostolányová, Šarmanová, 2011b).

- *Manual definition of "theoretical types",* their number and typical characteristics; student types are defined by experienced and long-time pedagogues, and this method we use only for our initial deliberations;
- *Clustering questionnaire results* from students; when having acquired data about a larger set of students, it is possible to adjust theoretical types both from their number point of view and their typical characteristics; we get real student clusters which can be considered the virtual types;

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- *Analysis of feedback information about the process of learning*; from the protocol about a real instruction process we get among other things information about the variants being suitable for the student or he often chose different variants – quasi he was not correctly tested; furthermore the analysis can uncover if the virtual types are correctly set up and if not, they can be adjusted again.

When talking about the adaptable study support structure presented in Fig. 2 (see B) it should be designed very carefully to provide students with a suitable selection of presented variants in a suitable order according to the depth of explanation. The depth of explanation defines the level of explanation detail. All of this ensured by a virtual teacher and its algorithms to distribute a study support to a student.

The basic framework is only one element of the whole structure of the adaptive study supports. We can see its role in Figure 3.

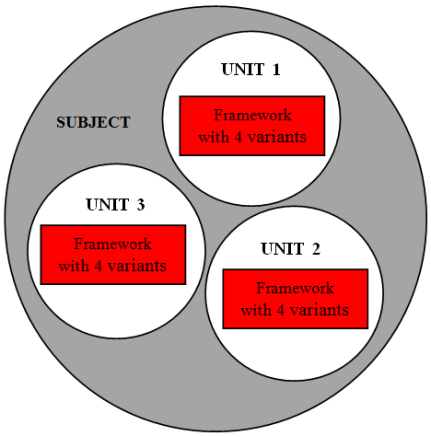


Figure 3: The structure of adaptive study supports

Subject is the top unit of a study support. Then there is an instructional unit corresponding to one school class. A unit is further divided into frameworks and the frameworks into 4 variants.

Framework variants are different ways of presenting the same curriculum. There are 4 sensory perception forms as:

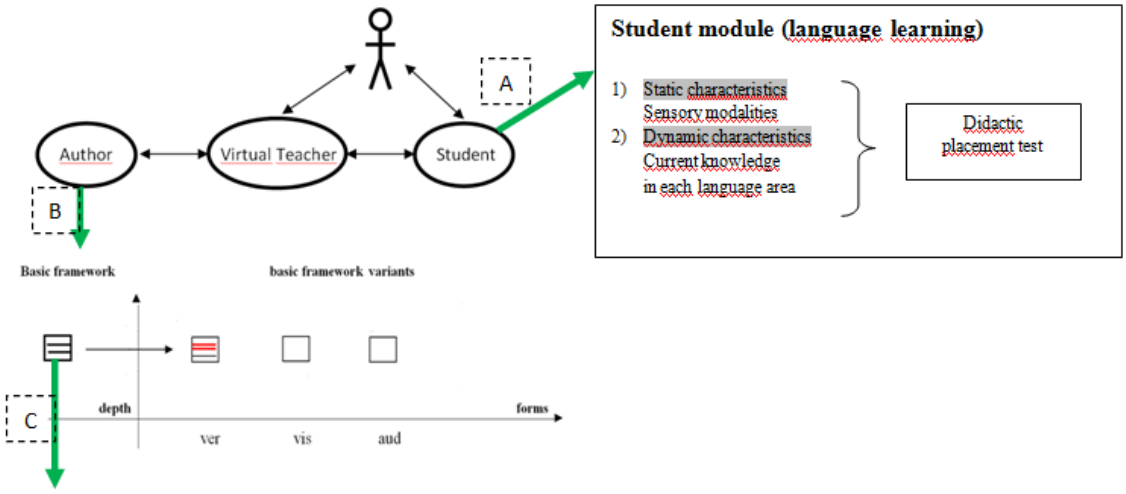
- Verbal – variant contains mostly text,
- Visual – variant contains a number of images, graphs, animations, etc.
- Auditive – variant contains a large amount of spoken word, sounds, etc.
- Kinaesthetic – variant contains a number of interactive learning objects, etc.

A variant of a strictly one form is very rare. Usually it is a combination of forms about a percentage ratio of which it is decided by the author (Kostolányová , 2012).

There are also 3 levels of a framework variant as presented in Figure 2 (see B). These levels of explanation are aimed to adapt the presented curriculum to student´s comprehension speed. Last there are layers of a basic framework presented in Figure 2 (see C). The layers of a framework are meant to be particular phases of a teaching proces (theory explanation, explanation, consolidation, testing, motivation and teaching) (Kostolányová, 2010). They were designed as expositional layers, testing layers and other.

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However, for a language learning the original Student and Author module must have been adjusted to correspond with specific attributes of a language learning. The adjustments has been concerning of student´s characteristics and structure of the adaptive study supports, specifically the structure of a basic framework as you can see in Figure 4.



ESA model = SLA model	Types of layers (in a language learning)
Engage (Motivational)	Other (Motivational)
Study (Present, Practice)	Expositional layers (Theoretical)
Activate (Produce)	Expositional layers (Fixational)
Language knowledge test	Testing layers (Questions, Exercise, Practical tasks)

Figure 4: Student and Author module in adaptive LMS for a language learning.

In the Student module in Figure 4 (see A) a diagnostics of student´s characteristics was divided in two parts. Static characteristics are called sensory modalities (Barbe, Swassing, 1979; Dunn,1978). These modalities include visual, auditive and kinaesthetic type of a student. However the kinaestetic type of a student was replaced by a verbal type of a student as this type seems to be more relevant for a language learning (Felder, Henriques, 1995). Next, dynamic characteristics include initial knowledge of a students in the area of grammar, reading, listening, writing and speaking.

A didactic placement test was designed to acquire static as well as dynamic characteristics of a student in a language learning. It was decided not to use the psychological test to get static characteristics of a student as psychological tests returns subjective responses. This claim validates the research carried out in 2011 where sensory modalities were tested by a psychological test together with didactic knowledge test. It was possible to do so as the didactic knowledge test included language areas and it was that´s why possible to compare answers from a psychological test and from a didactic test to find out sensory preferences of a student. Detailed research results are available on request.

On the base of these findings sensory modalities are acquired together with initial language knowledge of a student in each language areas as: listening, reading and writing. The speaking language area was omitted as it was considered to be very complicated to practice speaking with the absence of a real language teacher. To improve speaking skills

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requires interaction between too individuals. To improve productive language skills on some level a language area of writing was retained.

Concerning of a basic framework structure of a language learning in Figure 4 (see B) there is only one level of explanation in each variant as the main help for a student is seen to be adaptive study support chosen on the base of his dominant sensory modality.

Also there are layers of a basic framework for a language learning presented in Figure 4 (see C). These layers were designed taking international standards for a lesson language strucrure and designed layers of a basic model for general subjects into account. Saying in more details, the SLA model (Second language acquisition) together with ESA model (Engage – Study – Activate) was found to choose particular layers from the original model for general subjects. As you can see in Figure 4 (see C) in Figure 3 (see C) the original layers must have been rearranged. These layers are:other (motivational), expositional layer (theoretical), expositional layer (fixational) and a testing layer (questions, exercise, practical tasks).

RESULTS

Summary on difference between original model and a language learning model

When looking at both models for adaptive learning we can see the difference in Student module on what information to acquire and how to acquire static as well as dynamic characteristics of a student. Next difference is seen in the Author module in basic frameworks structure, levels of explanation and layers´structure in basic frameworks.

Virtual Teacher module in a language learning

Results on a Virtual Teacher module design in a language learning is given in this part of the contribution. The Virtual Teacher module can be defined as a managing program whose main role is to load datas from Student module and from Authors module as you can see in Figure 5. Having all this information the managing program can start defining optimal way of a lesson instruction.

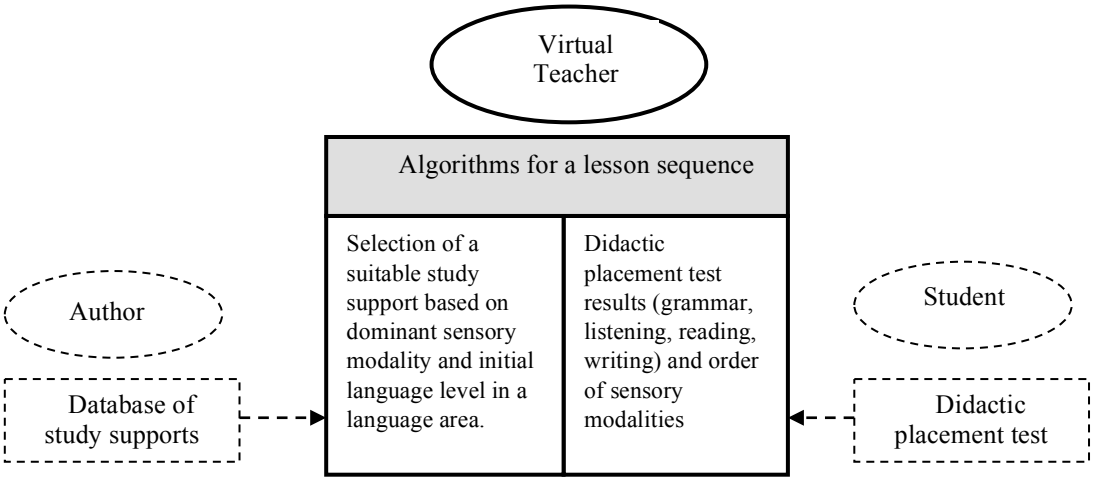


Figure 5: Virtual Teacher Module

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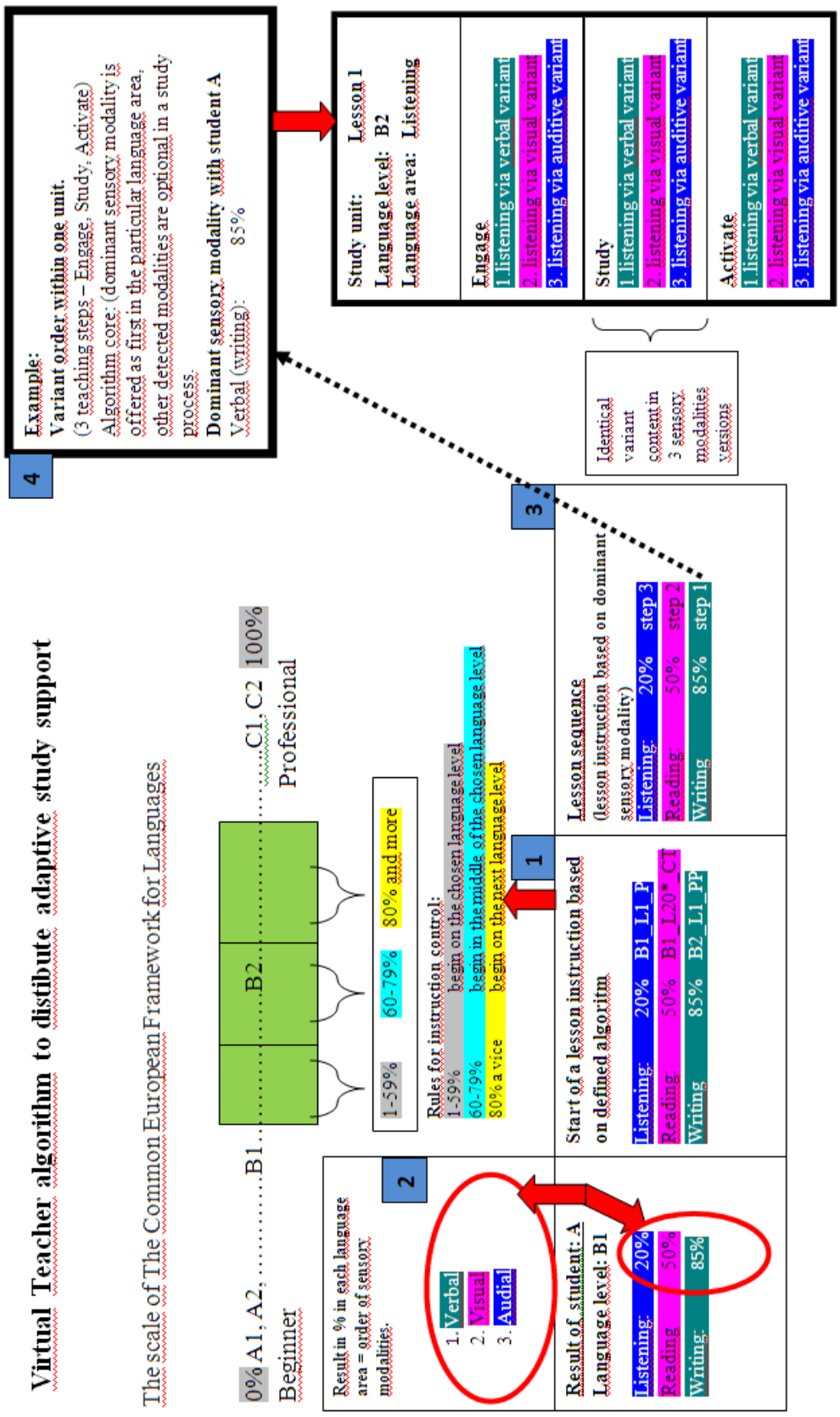


Figure 6:Virtual Teacher algorithm

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In Figure 6 you can see the algorithm of the Virtual Teacher to match study materials to a student according to his dominant sensory modality and initial language knowledge detected by a didactic placement test.

In this figure (see model 1) according to the test result the student will begin his study in each language area at defined level. Next (see model 2) from test results sensory modalities can also be detected. Further (see model 3) the lesson instruction will begin with dominant sensory modality. In model 4 in Figure 6 there is an example of variant order within one unit. This unit includes 3 layers (Engage, Study, Activate). The core of the algorithm is as follows: the most dominant sensory modality is applied on a language area as "obligatory" modality. Other sensory modalities are optional for a student. In other words student can see his adaptive study support only in one of his dominant sensory modality. Other modalites are optional.

This model for a language learning in adaptive LMS has been designed for a group of Germanic languages as this group of languages is widely spread within Europe and the outcomes of this research could help people to learn languages in a more easy way. To verify the model for a language learning in adaptive LMS an English language has been chosen as it is the most widely spoken language in the world, and the most widely taught foreign language.

DISCUSSION

As the adaptive LMS model has been developed to be used for general subjects some necessary adjustments must have been done to prepare the adaptive virtual environment for further testing.

There have been both models, either for general subjects or a language learning compared and main adjustments in the original model for a language learning has been highlighted and explained in details. The adjustments of the original model have been done on the base of analysis of relevant information sources and the research carried out in 2011 concerning of static and dynamic student´s characteristics diagnostics. Finally, there has been the mechanism of matching adaptive study materials with a student in a language learning designed.

In this stage samples of adaptive language study support for adaptive LMS must have been designed and their function must be tested. To exclude the unrequired complexity of the whole testing, one language level has been chosen and within this language level 48 sheets of adaptive study support has been made. The sheets are divided in 3 language areas as listening, reading and writing at intermediate language level. This language level has been chosen to define a language knowledge of a pupil to pass Maturita exams successfully. In relation to this fact, secondary school pupils have been considered to be a relevant target group to verify the effectiveness of adaptive language study support as they are meant to be motivated to pass Maturita exams. However, even there is a supposition from our perspective that pupils will be willing to take part in a research, there can be a problem with their discipline to finish the whole process of testing as the work to be done in the research can´t be done at school due to an individual approach to each pupil and there is no real penalty for the pupils in case they don´t participate. For this reason, students at higher vocational schools or university students at their first year of

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study seems to be more relevant target group as there are more effective evaluation tools set by law for a standard tuition. These evaluation tools can be used to motivate students for full participation in the research project to get more relevant results. These effective tools are meant to be not getting credits in case they refuse to participate in a research.

When testing the effectiveness of adaptive language study support 3 possible outcomes can result from the research. First, the adaptive language study support will not make any positive contribution to a student´s knowledge or there will be some but not significant contribution or there will be significant contribution to a student´s knowledge. The contribution to a student´s knowledge is suggested to be tested after online tuition of one language area in adaptive LMS in comparison to study results of the same language area in a standard school lesson. Both study results, either in adaptive LMS and in a standard school lesson will belong to one identical student.

CONCLUSION

As a well known fact when learning a foreign language the most important thing is to acquire language skills via language knowledge to be able to use a foreign language in real life situations. This aim can be gained by mixture of appropriate teaching methods like drill methods or suitable motivational strategies. Last but not least we believe that a dominant sensoric modality of a student with the help of information and communication technologies can have some kind of influence on effectiveness of a language learning which is a subject of our research effort.

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Smart Learning Environments - A Multi-agent Architecture Proposal

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Abstract

Smart environments for learning can be considered being a new level of computer enhanced learning, with a number of new interesting facilities. The famous IST Advisory Group (ISTAG) Report started from 2001 a decade of various research initiatives in the rapidly growing area of ambient intelligence. It introduced also a smart environment example in the form of a scenario – Scenario 4: Annette and Solomon in the Ambient for Social Learning. That was a vision of a learning environment, based on a position that learning is a social process. The scenario certainly was a nice incentive for a number of new initiatives focused on more or less successful attempts to design and introduce various types of smart environments capable to support different aspects of learning process. As multi-agent systems are the most frequently used approach towards smart environments design in general, we are convinced that a really systematic approach towards reflecting all desirable functionalities of smart learning environments must be based on a well-designed multi-agent architecture. In the paper we intend firstly to map the recent state of the art in the area of smart environments designed for learning. Further on we wish to list the desirable functionalities of a smart environment for learning, and propose a multi-agent architecture capable of reflecting the functionalities of a smart environment similar to that described in the above mentioned scenario.

Keywords

Computers and education. Collaborative learning. Ubiquitous computing. Multi-agent systems.

INTRODUCTION

Without any doubts any Ambient Intelligence (AmI) application bringing new ideas and approaches into educational process at every level of education deserves a special attention. Smart environments for learning, as a result of intensive research in the area of Ambient Intelligence, deserve also attention of the large community oriented on e-learning and technology enhanced learning. Smart environments could be naturally considered a new degree of computer enhanced learning, with a number of new facilities. The area of Ambient Intelligence can be studied from several perspectives. As (Bures, Cech, and Mls, 2009) pointed out, besides its technological perspective, social perspective, or ethical perspective, we can also identify an educational perspective. The educational

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perspective deals with problems and challenges related to proper education in relevant Ambient Intelligence areas.

A more general overview of the Ambient Intelligence possibilities in education brings our recently published book chapter (Mikulecky et al., 2011). The objective of the paper is to identify and analyse key aspects and possibilities of Ambient Intelligence applications in educational processes and institutions (universities), as well as to present a couple of possible visions for these applications. A number of related problems are discussed there as well, namely agent-based Ambient Intelligence application architectures. Results of a brief survey among optional users of these applications are presented as well. The conclusion of this research was that introduction of Ambient Intelligence in educational institutions is possible and can bring us new experiences utilizable in further development of Ambient Intelligence applications.

The famous ISTAG Report (Ducatel et al., 2001) started in 2001 a decade of various research initiatives in the rapidly growing area of ambient intelligence. It introduced also a smart environment example in the form of a scenario – *Scenario 4: Annette and Solomon in the Ambient for Social Learning.* That was a vision of a learning environment, based on a position that learning is a social process. According to the original description in the ISTAG report, *the Ambient for Social Learning (ASL) is an environment that supports and upgrades the roles of all the actors in the learning process, starting with the roles of the mentor and the students as most concerned parties. The systems that make up the ASL are capable of creating challenging and interacting learning situations that are co-designed by the mentor and students in real-time. Students are important producers of learning material and create input for the learning 'situations' of others. In other words, the ASL is both an environment for generating new knowledge for learning and a 'place' for learning about learning.*

The scenario certainly was a nice incentive for a number of new initiatives focused on more or less successful attempts to design and introduce various types of smart environments capable to support different aspects of learning process. However, these attempts have not been too systematic and some of the environments designed are not smart environments in the full meaning of this word.

As multi-agent systems are the most frequently used approach towards smart environments design in general, we are convinced that a really systematic approach towards reflecting all desirable functionalities of smart learning environments must be based on a well-designed multi-agent architecture. Therefore this paper is devoted to an analysis of some recent solutions of smart learning environments based on agent or multi-agent approaches. We propose a new multi-agent architecture aiming at achieving the "ideal" architecture inspired by the ISTAG Report (Ducatel et al., 2001) scenarios.

As already mentioned above, according to (Ducatel et al., 2001), the *Scenario 4: Annette and Solomon in the Ambient for Social Learning* was a vision of a learning environment – the *Ambient for Social Learning* (ASL), based on a position that learning is essentially a social process. It is a vision of an intelligent classroom supporting and upgrading roles of all the actors in the learning process, with a special accent on the roles of the mentor and students as the most important roles in the whole process. The systems that make up the ASL are supposed to be capable of creating challenging and interacting learning situations that are co-designed by the mentor and students in real-time. One of

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basic assumptions here is that students are important producers of learning material and create input for various learning 'situations' of other colleagues. From this point of view, the ASL is both an environment for generating new knowledge for learning and a 'place' for learning about learning. Of course, the ASL is also a physical space (a room or a group of rooms) together with all of its ambient facilities, including many linkages with similar places. Its layout and furnishing is flexible and diverse, so that it can serve the learning purposes of many different kinds of groups and individuals.

An important assumption about the ASL is, that the system must not only be user-friendly; the main criterion for their development is 'usefulness' (cf. Ducatel et al., 2001). In this case with a very complicated set of goals, however, it is not obvious how this usefulness has to be evaluated beforehand. The *Ambient for Social Learning* is therefore conceived as a 'learning system' that is growing and improving simply by using it.

As (Ducatel et al., 2001) pointed out, a number of specific technologies would be needed for the ASL implementation, among others the following ones:

- Recognition (tracing and identification) of individuals, groups and objects.
- Interactive commitment aids for negotiating targets and challenges (goal synchronisation).
- Natural language and speech interfaces and dialogue modelling.
- Projection facilities for light and soundfields (visualisation, virtual reality and holographic representation), including perception based technologies such as psychoacoustics.
- Tangible/tactile and sensorial interfacing (including direct brain interfaces).
- Reflexive learning systems (adaptable, customisable) to build aids for reviewing experiences.
- Content design facilities, simulation and visualisation aids.
- Knowledge management tools to build community memory.

Of course, some other technologies, not so important for the sake of this paper would be needed. For a detailed description see the original ISTAG report (Ducatel et al, 2001). Our description here is just a review of issues that are necessary for our further contemplation.

RELATED WORK

There is a vast of various solutions aiming to develop a really smart learning environment and introduce it into the practice. We published already an analysis of several possible solutions in (Mikulecky, 2011), (Mikulecky, 2007), or even (Mikulecky, 1986). However; the aim of this paper is somehow different: we wish to concentrate on agent-based solutions, more precisely, on solutions, based on exploitation of multi-agent architectures.

An important problem in each smart environment is the problem of how the environment evaluates users' needs and how it assigns preferences to them. Actually, when many users are involved in a ubiquitous environment, the decisions of one user can be affected by the desires of others. This makes learning and prediction of user preference

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difficult. To address the issue, Hasan et al. (2006) propose an approach of user preference learning which can be used widely in context-aware systems. The approach based on *Bayesian RN-Metanetwork*, a multilevel Bayesian network to model user preference and priority is used here.

With a somehow similar aim our papers (Mikulecky, 2010) and (Tucnik and Mikulecky, 2010) are focused on decision making of agents in multi-agent environments, with a special accent on multi-agent based modelling of smart environments. The on-going research related to that is oriented on further study of multi-criteria decision making in autonomous decision making, especially when multiple entities (users or agents) are present at the same time. Solution of conflicts, negotiation, settings of user preferences, multiple objectives, setting priorities, etc. are the main areas of interest in our further research.

When the necessity of user preferences appears, usually new location-based services can be adapted to accomplish this task. For this the ubiquitous system needs to know user profiles, likings, and habits. But in the case when the user moves, this information must be made available at the new location of the user. Either the user carries the data on wearable or portable computers or the smart environment takes responsibility for transporting them. Related to this, it is proposed in (Bagci et al., 2007) that a smart environment takes care for storing and sending the personal information. The person in this approach is always accompanied by a mobile virtual object in the smart environment. So location based services adapted to personal profiles can be offered. The paradigm of mobile agents, used in this approach, ideally fits into the decentralized approach. The mobile agent constitutes a virtual reflection of the user and carries personal information which enables the agent to perform various services for the user. Additionally the mobile agent can use the environmental information which is provided by the local ubiquitous system. Moreover, the movement of the mobile agent should be in this approach faster than the movement of the person. This fact helps to solve a couple of related problems.

An idea of recognition of a current situation and behaviour of a user, as well as an unobtrusive satisfaction of his needs underlies the *Ambient Intelligence*. Integration of diverse computation, information and communication resources into a united framework is one of the important issues at design of ambient intelligence and it identifies the modern tendency to transition from smart devices to an ambient intelligent space. Multimodal interfaces provide natural and intuitively comprehensible interaction between a user and intellectual devices, which are embedded into the environment. All the means should be hidden, thus the user can see only the results of intellectual devices activities and concentrate attention on her/his work.

One of the basic concepts in agent-based approaches seems to be that of pedagogical agents. According to (Fenton-Kerr et al, 1998), pedagogical agents are program modules that make use of artificial intelligence approaches to provide timely, contextual help or instruction to a learner. The reason behind is, that learners accessing educational software programs can be overwhelmed by the amount and complexity of the content, which can have a negative impact on the learning process. Therefore, they could need assistance in navigating and understanding the information such programs present. Pedagogical agents are used for composing intelligent tutor schemes, which may employ multiple agent modules, each given a unique task that satisfies part of an overall learning objective.

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As Serçe (2008) pointed out, pedagogical agents are autonomous agents that support human learning by interacting with students in the context of the learning environment. They extend and improve upon previous work on intelligent tutoring systems in a number of ways. They adapt their behaviour to the dynamic state of learning environment, taking advantage of learning opportunities as they arise. They can support collaborative learning as well as individualized learning, because multiple students and agents can interact in a shared environment.

Anyway, there is many various implementations of pedagogical agents, a concise review can be found in (Serçe, 2008). As an example, pedagogical agents are used in a solution, published recently by Mhiri and Ratté (2009). The authors proposed an intelligent environment for human learning (called the *AARTIC* project) that assists software engineering students in their assignments. The system resolve real problems: for the students, too much time to complete each assignment, for the teacher, too many students to offer any personalized help. Moreover, because students find themselves in a precarious situation (the concepts are new and complex), they rely on old primary reflexes: zero collaboration or planification. The proposed system aims to help the student in the understanding of concepts by suggesting examples. Two pedagogical agents compose the adaptive aspect of the system. The first monitors students' activities in the environment. The second allows the teacher to observe the performance of each student and of the class as a whole. The environment also emphasizes collaboration.

Turgay (2005) proposed a multi agent system based distance learning architecture modelled using object oriented Petri net. The system has flexible, agile, intelligence and cooperation features. The system components are teachers, learners, and learning resources. Inter component relations are modelled and reviewed using the Petri net method. In the architecture, the following four types of agents are proposed: student agent, teacher agent, course agent, and resource agent. The suggested activities are perception, modelling, planning, coordination and task or plan execution. The agents provide system execution and coordination. The resulting architecture is only sketched in the paper, describing just a couple of basic features.

The paper (Viccari, Ovalle, and Jiménez, 2007) presents a description of the environments of individualized learning, based on the *Intelligent Tutoring System*, the *Computer Supported Collaborative Learning*, *Multi-Agent Systems* and the artificial intelligence techniques called *Instructional Planning* and *Case-Based Reasoning*. Further on, a *Multi-Agent System* environment is presented, that aims to support the teaching/learning process including all previous artificial intelligence elements.

Another example of agent based architecture of a smart environment for e-learning is the system *ISABEL* described in (Garruzzo, Rosaci, and Sarné, 2007). The *ISABEL* is a sophisticated multi-agent e-learning system, where the basic idea is in partitioning the students in clusters of students that have similar profiles, where each cluster is managed by a tutor agent. When a student visits an e-learning site using a given device (say, a notebook, or a smart phone), a teacher agent associated with the site collaborates with some tutor agents associated with the student, in order to provide him with useful recommendations. Generally, these systems use a profile of the student to represents his interests and preferences, and often exploit software agents in order to construct such a profile. More in particular, each student is associated to a software agent which monitors her Web activities, and when the student accesses an e-learning site, his agent exploits the

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student's profile interacting with the site. In this interaction, the site can use both content-based and collaborative filtering techniques to provide recommendations to the student's agent by adapting the site presentation.

The just described idea of students' clusters is very much similar to the idea of grouping students with the similar level of study results, as proposed in the original scenario *Annette and Solomon* (Ducatel et al., 2001). We shall use a similar mechanism also in our solution below.

An interesting solution was presented in the form of a PhD Thesis by Serçe (2008). Her thesis presents a multi-agent system, called *MODA*, developed to provide adaptiveness in learning management systems. The conceptual framework proposed in the thesis is based on the idea that adaptiveness is the best matching between the learner profile and the course content profile. The learning styles of learners and the content type of learning material are used to match the learner to the most suitable content. The proposed system uses seven learning agents: *LMS Interface Agent, Learning Agent, Content Adapter Agent, Course Profile Agent, Learner Profile Agent, Researcher Agent,* and *Agent Manager*. They were developed in JADE in conformity with the FIPA standards for intelligent agents.

In this chapter, we presented just a few of agent-based solutions published recently. Other approaches can be found e.g. in (Neji and Ben Ammar, 2007), (Virvou and Kabbasi, 2002), (Wang and Wu, 2011), (Webber and Pesty, 2002), or (Yang, 2006). Related material can be found also in our recent papers (Mikulecky, 2012a, 2012b) or (Mikulecky, Olsevicova, and Cimler, 2012).

POSSIBILITIES FOR A MULTI-AGENT SOLUTION

As Virvou and Kabassi (2002) stressed, agent-based solutions have been widely used in learning environments playing different roles or perform certain specific tasks, such as capturing the user's characteristics. However, the majority of agent based architectures consist of a single agent. The main disadvantage of such an approach is that the agent's knowledge, computing resources and perspective is limited. These problems can be avoided by multi-agent systems.

The *Annette and Solomon Scenario* (Ducatel et al., 2001) is a vision of a sophisticated smart learning environment, but it is hard to imagine it without large utilisation of ambient intelligence technologies and approaches. One of the popular approaches in deploying smart environments is that of multi-agent system applications. There is good experience with architectures of smart environments, based on multi-agent systems and their advantages. Therefore we consider such an approach to be quite naturally applicable also in the case of the *Annette and Solomon Scenario*.

Further on, we firstly present a list of issues for our proposal, and then we suggest a number of agents and their functionalities, concluding the chapter with some open problems that are awaiting a solution. Our proposal will be purely conceptual, postponing the more detailed and elaborated solution to further research activities.

Let us recall the short description of the *Ambient for Social Learning*: the *Ambient for Social Learning* (ASL) is an environment that supports and upgrades the roles of all the actors in the learning process, starting with the roles of the mentor and the students as

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most concerned parties. Therefore the basic conceptual design of the ASL architecture will be based on the following logic: the system will identify each student entering the ASL, then it will recognize his/her actual study results, it will look for other students on the similar level of actual study achievements and try to create a cluster of those students. Further on the most adequate content for the actual study tasks fulfilment will be found and suggested to the students' cluster as their study program for the following couple of hours (according their study programme). A mentor assigned to the particular students' cluster will follow the students' progress and achievements; he/she will be consulting possible adjustments in the actual study tasks with the ASL.

With regards to this short characteristic, we propose a multi-agent architecture of the underlying system as composed from the following three layers:

- *Individual Learners' Layer* (ILL)
- *Social Learning Layer* (SLL)
- *ASL Resources Layer* (ARL)

The *Individual Learners' Layer* (see Fig. 1) will take care about the students enrolled into the programme that is performed using the *Ambient of Social Learning*. For each individual student a *LearnerAgent* will represent that student in the system. It will identify the student, manage his/her contacts with other students via their *LearnerAgents* and communicate with the *MentorAgent* (MenAg), representing the mentor, assigned to that individual student. It is worth to stress, that a number of students can be assigned to one mentor; therefore one *MentorAgent* can be assigned to whole group of *LearnerAgents*.

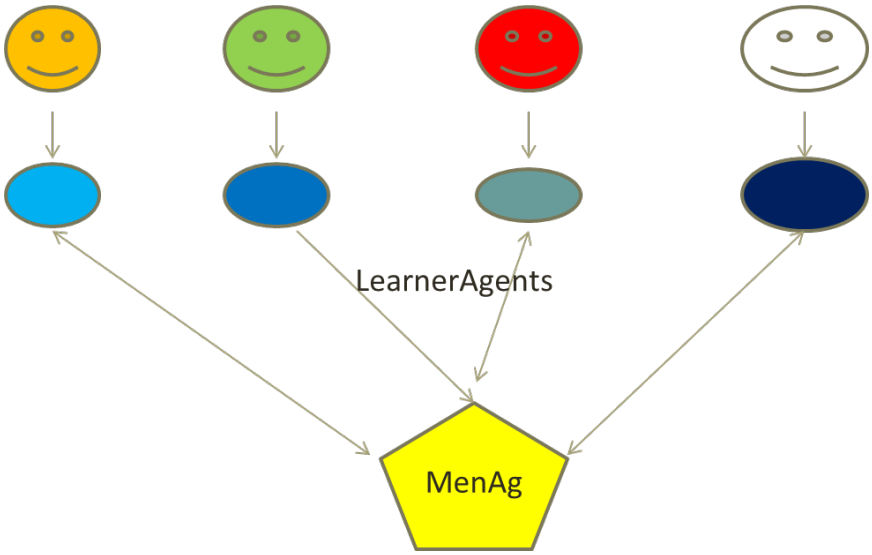


Fig. 1: Individual Learner's Layer

The *Social Learning Layer* (see Fig. 2) is responsible for the social learning facility of the *Ambient of Social Learning*.

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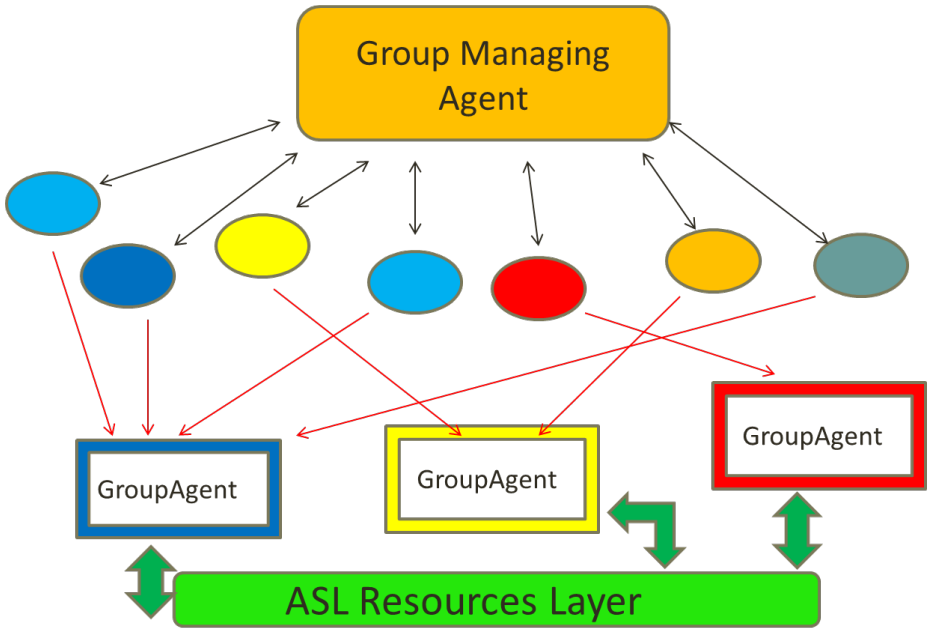


Fig. 2. The Social Learning Layer

It means that the *Social Learning Layer* will try to evaluate individual students' study achievements and their competencies, and on this basis the layer will organize suitable clusters of the students. We suggest here to have a number of *GroupAgents* representing suitable clusters (or clusters, which are likely to be created after evaluation of students' tracks). The *GroupAgents* will communicate with the *GroupManagingAgent*, which, after communication with individual *LearnerAgents* (coloured circles), will recommend composition of the particular cluster to the most suitable *GroupAgent*. The *GroupAgent* will then coordinate all the relevant activities of the particular students' cluster (group), ensuring them access to all the necessary resources that are offered by the *ASL Resources Layer.*

The *ASL Resources Layer* is taking care about all the ASL resources, especially appropriate learning contents, but also all the technical resources (computing and communication facilities, presenting and recording facilities, etc.). This will be done through specialized agents as well, but this layer is very much dependant on the particular resources that are to be used in the particular learning environment.

As we mentioned above, this is just a conceptual suggestion of a possible multi-agent architecture for the ASL. The further elaboration is inevitable and is in progress recently.

CONCLUSION

The multi-agent architectures for smart learning environments are very popular and frequently used recently. In our paper we present a review of several existing papers related to multi-agent solutions of smart learning environments. Finally, we present a conceptual proposal of a three layered multi-agent architecture for a smart learning environment, based on the famous *Annette and Solomon Scenario* proposed in the classical ISTAG Report (Ducatel et al, 2001). It is clear that our proposal is just a conceptual

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one. Three layers of the agent architecture seem to be a reasonable top level of the architecture; however, it is necessary to elaborate lower levels more carefully and in a detail. The proposal needs further discussion and critics; it will be elaborated and deepened soon.

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Comparative Analysis of Quantitative Indicators of Normal and Knowledge Texts

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Abstract

Content analysis, measuring the information density of texts as well as determination of other various indicators and parameters of texts are the standard techniques applied as a part of text mining, textbook analysis and several other issues. However, all indicators and parameters are designed for the level of information, not knowledge. Our aim is to design an original one for knowledge. Before that, we have to determine, which ones could be used as the base of new indicators, because they are directly connected to explicit knowledge codified in the text. The objective of this paper is to make a comparative analysis of quantitative indicators of two types of text documents. The first one is a standard piece of a text document (normal text), the other one is the document created by the use of the particular representation of knowledge: knowledge unit. Even though no representative sample of the documents is used, the comparative analysis confirms most assumptions of significantly different values of selected indicators and parameters among the texts. It allows us to formulate more advanced hypotheses on the importance of the indicators for identification of explicit knowledge in documents and measuring of knowledge content of the documents.

Keywords

Knowledge. Text Mining. Information Density. Knowledge Unit. Knowledge Text. Document Analysis. Biogas Production.

INTRODUCTION

Measuring the information density of texts is one of the important issues in the content analysis of the texts. The first class of the approaches represented e.g. by (Maeda, 1981) were focused on the analysis of the text structure and acquiring important information included there. The other class of the approaches represented e.g. by (Paice, 1990) were aimed at the construction of new pieces of the text using computers, for instance abstracts of scientific papers.

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In parallel, general procedures of data mining techniques have been developed. Throughout the years, text mining methodology has been established as a specific part of data mining (Punitha and Punithavalli, 2012). Due to a number of particular algorithms of the text mining, the authors dealt with performance analysis of selected semantic-based and ontology-based text document clustering techniques (TDCT). Their research confirmed the hypothesis on the influence of the assignment "type of the task – TDCT" on the efficiency of data processing measured by the time of processing and the accuracy of clustering.

Practical applications and case studies from different domains have been also published. In medicine, (Pereira, Rijo et al., 2013) used the text mining approach to decrease the complexity of classifying the epilepsy processes. In university environment, Rábová (2012) presents her approach, how to extract business roles from different sources to be accessible for further processing.

Sustainable development is one of the most important issues of the world today. As stated in (Liew, Adhitya et al., 2014), companies and other institutions publish reports of their contribution to achieving sustainability goals and targets. In their work, authors used text mining methodology to identify sustainability trends and practices in the processing industries such as oil/petrochemicals, bulk/specialty chemicals, pharmaceuticals, and consumer products.

Another interesting application, content analysis used for automated analyzing unstructured software project data, was presented by (Noll, Seichter et al., 2013). Using a large sample of documents, the authors formulated and confirmed the hypothesis on reducing the labour and improving the speed of the content analysis if carried out automatically. Only one exception was found; the authors noticed that even though automated classifiers could be used to filter a sample to identify common categories, the human researchers should examine the remainder for more difficult categories.

In connection with text mining and content analysis of documents, there is another issue worth solving: how to measure (ideally through quantitative characteristics) information content of the documents. Several approaches to measuring these characteristics of the documents have been developed in education, where some properties and parameters of textbooks and their influence on the results of education are measured (Mikk, 2007). Also (Duric and Song, 2012), (Asaishi, 2011) or (Kahveci, 2010) focused on the analysis of educational texts. The aspects that were evaluated and measured included, among others, the extent of having the textbook equipped from the didactics point of view, the extent of the difficulty of the text, the analysis of terms, the extent of the information density, and so on. The objective is to make the sources for education smarter. Even though the term "Smart Learning" is commonly connected with the educational process as the whole and it support with information and communication technologies (Mikulecký, 2012), it also worth dealing with the content of the educational sources and the rate of their smartness in the sense of covered knowledge.

To our best knowledge, no such metrics for measuring the knowledge content in the text (knowledge density, number of pieces of knowledge, etc.) have been developed and published. Our aim is to develop them. As the first step, the objective of this work is to compare quantitative indicators and parameters of two types of texts: normal text without any corrections and knowledge text created using the methods of Knowledge Engineering;

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see Houška and Rauchová (2013a) how to develop the knowledge text and Rauchová and Houška (2013) how to measure the efficiency of knowledge transfer through normal and knowledge texts. In particular, the knowledge unit as the representation of knowledge in natural language is used. When the differences in quantitative indicators are identified and described, we can formulate more advanced hypotheses on the influence of the indicators on measuring the knowledge content of the text as an input for further research.

MATERIALS AND METHODS

Knowledge Texts

In this work, we understand "knowledge text" as a specific form of the text, which contains knowledge in an explicit form. Based on our previous research (Dömeová, Houška et al., 2008), we see production rules and their advanced version, knowledge unit, respectively, as the most suitable form to represent explicit knowledge in the text. Formally, we suggested to record knowledge unit as (Dömeová, Houška et al., 2008)

KU = {X, Y, Z, Q}, (1)

where X stands for a problem situation,
Y stands for the problem being solved in the X problem situation,
Z stands for the objective of solving the elementary problem,
Q stands for a successful solution of the elementary problem (result).

Even though there is no unique way to create sentences based on the production rules (Kendal and Creen 2007), we may always express the knowledge unit in the following textual form (Dömeová, Houška et al., 2008):

"*If we want to solve an elementary problem Y in the problem situation X to reach the objective Z, then we should apply the solution Q.*"

Quantitative Characteristics of Texts

In this part, we present the most commonly-used metrics characterizing different aspects of the texts (e.g. difficulty, communication ability, etc.) in quantitative indicators. Further on, the following parameters are used.

Complex text difficulty rate (Arya, Hiebert and Pearson, 2010)

$$T = T_S + T_P \quad (2)$$

where Ts is the syntactic difficulty rate,
Tp is the semantic difficulty rate.

Syntactic difficulty rate (Arya, Hiebert and Pearson, 2010)

$$T_s = 0,1\frac{N^2}{U \cdot V} \quad (3)$$

where N is the number of words,

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U is the number of werbs,

V is the number of sentences.

Semantic difficulty rate (Hrabí, 2012)

$$T_p = 100\frac{P}{N}\cdot\frac{P_1 + 3P_2 + 2P_3 + 2P_4 + P_5}{N} \tag{4}$$

where P1 is the number of common terms,

P2 is the number of technical terms,

P3 is the number of factographic terms,

P4 is the number of figures,

P5 is the number of recurring concepts,

P is the total number of terms in the text,

N is the total number of words in the text.

The following indicators are taken from (Hrabí 2012).

Coefficient of density of scientific and factual information per noun

$$h = 100\frac{P_2 + P_3 + P_4}{P} \tag{5}$$

Coefficient of density of scientific and factual information per word

$$i = 100\frac{P_2 + P_3 + P_4}{N} \tag{6}$$

Average number of adverbs per sentence

$$ADV_A^V = \frac{ADV}{V} \tag{7}$$

where ADV is the number of adverbs (adverbs of time, place, manner and cause),

V is the number of sentences.

Average number of adverbs per complex of sentences

$$ADV_A^S = \frac{ADV}{S} \tag{8}$$

where ADV is the number of adverbs (adverbs of time, place, manner and cause),

S is the number of complexes of sentences.

Hűbelová (2010) has used some basic formulas for describing the structure of text, e.g. average number of sentences per complex of sentences and average number of complexes of sentences per sentence could be one of them.

Average number of sentences per complex of sentences

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$$V_A = \frac{V}{S} \tag{9}$$

where S is the number of complexes of sentences,
V is the number of sentences.

Average number of complexes of sentences per sentence

$$S_A = \frac{S}{V} \tag{10}$$

where S is the number of complexes of sentences,
V is the number of sentences.

RESULTS AND DISCUSSION

Particular Analysis of a Small Piece of Text

In this part, we demonstrate how to calculate the above-mentioned characteristics of the text. For this purpose, we select a small piece of the text analysed later in the complete version. One paragraph of technical text (on biogas production, see Kára et al., 2007) follows:

"Cogeneration is the name for the simultaneous production of electricity and heat by heat transfer medium. If you are looking for a suitable technology for the use of biogas for energy gain in order to achieve high conversion efficiency (80 – 90%), cogeneration is the right solution method. When a gas engine, resp. turbine and electric generator, is used for cogeneration, about 30% of biogas energy is converted into electrical energy, 60% into heat energy, and the remainder are heat losses."

Semantic Analysis

In cooperation with an expert on the biogas production (see Acknowledgement), we pre-process the text manually in order to identify its parameters for semantic analysis. We focus on:

- concepts (**in bold**),
- factographic terms (underlined),
- common terms (highlighted),
- figures (underlined),
- technical terms (underlined),
- verbs (underlined) and
- recurring concepts (*in italics*).

The text after pre-processing follows:

"Cogeneration is the name for the simultaneous production of electricity and heat by heat transfer medium. **If** you are looking for a suitable technology **for the use** of *biogas* for *energy*

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gain **in order to achieve** high conversion efficiency (80-90%), *cogeneration* is the right solution method. **When** a gas engine respectively turbine and electric generator, is used for *cogeneration,* about 30% of *biogas energy* is converted into electrical *energy*, 60% into heat *energy,* and the remainder are heat losses."

The parameters of the semantic analysis are summarized in Table 1.

Table 1: Parameters of the semantic analysis

Parameter	Value	Parameter	Value
Number of verbs (*U*)	7	Number of technical terms (*P2*)	7
Number of adverbs	4	Number of factographic terms (*P3*)	6
ADVva	0.57	Number of figures (*P4*)	4
ADVsa	2	Number of recurring concepts (*P5*)	8
Number of concepts	4	Total number of terms in the text (*P*)	32
Number of common terms (*P1*)	7		

Syntactic Analysis

Syntactic analysis aims at the structure of the sentences. During pre-processing, we distinguish:

- simple sentences (single underlined) and
- complex sentences (double underlined).

The text after pre-processing follows:

"Cogeneration is the name for the simultaneous production of electricity and heat by heat transfer medium. If you are looking for a suitable technology for the use of biogas for energy gain in order to achieve high conversion efficiency (80-90%), cogeneration is the right solution method. When a gas engine respectively turbine and electric generator, is used for cogeneration, about 30% of biogas energy is converted into electrical energy, 60% into heat energy, and the remainder are heat losses."

The parameters of the syntactic analysis are summarized in Table 2.

Table 2: Parameters of the syntactic analysis

Parameter	Value
Total number of words (*N*)	79
Number of complex sentences (*S*)	2
Total number of sentences (*V*)	7

Synthetic Indicators

Based on the previously-determined parameters of the text, we can calculate synthetic indicators of difficulty and information density of the text (see Table 3).

Table 3: Indicators of difficulty and information density of the text

Indicator	Value
Semantic difficulty rate (*Ts*)	12.73
Syntactic difficulty rate (*Tp*)	70.87
Complex text difficulty rate (*T*)	83.62
Density of technical and factual information per noun (*h*)	53.13

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Density of technical and factual information per word (*i*)	21.52
Average number of sentences per complex of sentences (*Va*)	3
Average number of complexes of sentences per sentence (*Sa*)	0.67

Results for the Complete Texts

Even though the absolute values of the indicators could provide basic information about the text, their main advantage lies in their ability to compare two or more particular pieces of text. Therefore, we calculate them for two versions of the same text, i.e. normal form and knowledge form, as specified in Materials and Methods. The documents analysed (in Czech) are available at:

- http://pef.czu.cz/~houska/divai-normal.pdf and
- http://pef.czu.cz/~houska/divai-knowledge.pdf.

Firstly, we present the sentence structure of the documents (see Figure 1), i.e. the percentage of simple sentences and compound sentences consisting of 2 - 7 sentences.

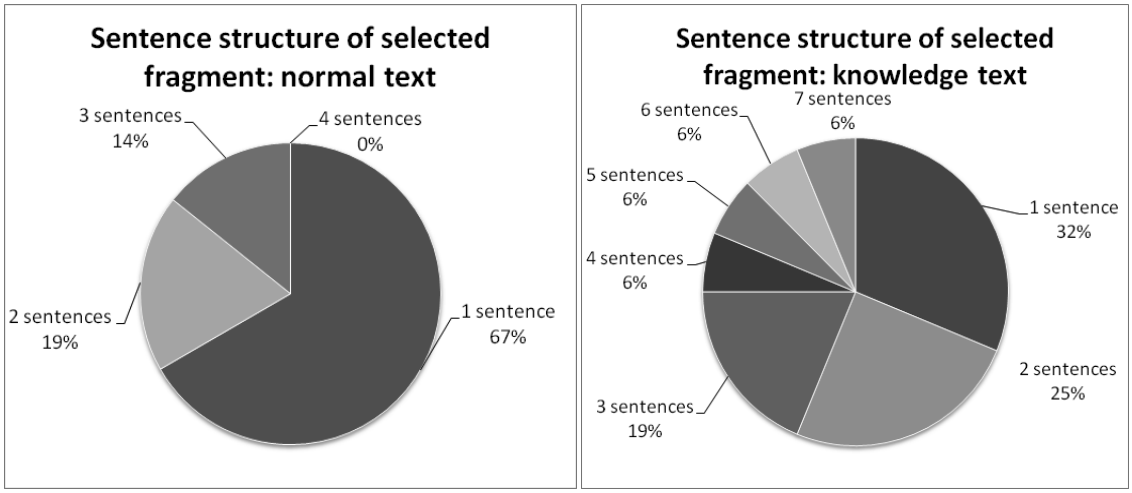


Figure 1: Structure of the analysed text in normal and knowledge

Complete comparison of parameters and indicators for both forms of the documents is presented in Table 4.

Table 4: Comparison of values calculated for normal and knowledge texts

Indicator	**Type of text**	
	Normal	**Knowledge**
Semantic difficulty rate (*Ts*)	20.00	13.69
Syntactic difficulty rate (*Tp*)	107.56	70.94
Complex text difficulty rate (*T*)	127.56	84.63
Density of technical and factual information per noun (*h*)	46.53	37.50
Density of technical and factual information per word (*i*)	57.58	16.67
Average number of sentences per complex of sentences (*Va*)	2.50	3.18
Average number of complexes of sentences per sentence	0.46	0.69
Parameter	**Type of text**	
	Normal	**Knowledge**
Number of verbs (*U*)	44.00	40.00
Number of adverbs	8.00	7.00

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ADVva	0.26	0.16
ADVsa	0.67	0.64
Number of concepts	3.00	23.00
Number of common terms (*P1*)	106.00	111.00
Number of technical terms (*P2*)	73.00	46.00
Number of factographic terms (*P3*)	19.00	20.00
Number of figures (*P4*)	22.00	12.00
Number of recurring concepts (*P5*)	20.00	19.00
Total number of terms in the text (*P*)	245.00	208.00
Total number of words (*N*)	397.00	468.00
Number of complex sentences (*S*)	14	30
Total number of sentences (*V*)	31	44

Now we compare indicators and parameters in order to determine the ones with the biggest differences in values and justify the differences. In text below, the superscripts "N" and "K" are used for distinguishing the indicators and parameters of Normal and Knowledge text.

Semantic difficulty rate: $Ts^N > Ts^K$. There could be identified a significant difference between the values, but surprisingly, the difficulty of the normal text is higher than the knowledge one. More authors estimating the semantic difficulty rate of text in textbooks (e.g. McCrory and Stylianides (2014) or Miller (2011)) state that the more difficult text (covering wider spectrum of knowledge), the higher value of *Ts*.

Syntactic difficulty rate: $Tp^N > Tp^K$. The difference could be significant. It arises from the different structure of the sentences in normal and knowledge text. The frequency of complex sentences is 2 times higher in knowledge text than in normal text. Moreover, the average number of single sentences in the complex sentences is also higher in knowledge text (3.80) than in normal text (2.50), as determined from the numbers of complex sentences ($S^N = 14$ vs. $S^K = 30$).

It is natural that the Complex text difficulty rate (*T*) is also significantly higher for normal text than for knowledge text. It is influenced by differences in the indicator *Tp*.

Density of technical and factual information per words: $i^N > i^K$. Even though the Density of technical and factual information per nouns (*h*) is very similar for both types of text, the information density per word is significantly higher for normal text. It is caused by lower number of words in the normal text and, similarly, the same number of technical and factual terms in both versions of the text.

In parameters, there is obvious difference in the number of concepts. In this case, it results from a specific structure of the knowledge unit. In order to express the knowledge unit in a natural language, we have to use statements from a relatively limited set of feasible statements (concepts).

Finally, there is one assumption, which has not been confirmed by this analysis. The parameter $ADVsa^N$ is approximately of the same value as $ADVsa^K$. We assumed (based on the results by Crowder (2011)) that far more adverbs should be used to express knowledge than simple information, but the analysis does not confirm it. Probably, the concepts play more important role than adverbs as the input parameter of the text for estimating its density of knowledge.

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CONCLUSION

In this paper, we present the comparison of indicators and other characteristics of text documents in order to find out which ones could point to the rate of knowledge content of the documents. The following indicators arise from this preliminary research to be denoted as "potentially relevant":

- complex text difficulty rate (*T*),
- density of technical and factual information per word (*i*),
- average number of sentences per complex of sentences (*Va*) and
- number of concepts.

The hypotheses on the influence of the above-mentioned indicators on distinguishing the type of the text (normal or knowledge, in continuous scale, of course) will be verified in further research. The necessary conditions for such a research are:

- sufficient sample of texts in the same sense, but in different forms and
- automated processing of the text documents using appropriate software.

After the conditions have been fulfilled, we focus on formulating original metrics for the determination of knowledge content in a general document.

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A Simulation Application for Educational Purposes

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Abstract

The paper presents an enhanced software prototype of a framework based on agent-based trading company control loop. The main purpose of the framework is to improve existing decision support systems with the use of a simulation and to contribute to teaching of managerial skills already during the education process. The Enterprise Resource Planning system (ERP) using the Resources, Events, Agents (REA) ontology approach is used as a measuring element in the framework. The system has been developed in cooperation between Silesian University in Opava, School of Business Administration in Karvina, Czech Republic and REA technology Copenhagen, Denmark. After the tests at the end of the year 2011, the prototype was presented at the beginning of 2012 for the first time. Firstly, the enhanced framework with several types of agents and negotiation possibilities is described. Secondly, a brief look on the graphical user interface and main parts of Multi-agent REA framework (MAREA) simulation monitor is provided. Brief results of the structure validation performed by means of Framework for Process Mining (ProM) software are presented to show the possibilities of MAREA use in the educational process and in other domains. To conclude, MAREA is a software application with simulation possibilities, which can be used to present trading behavior of a company for decision support as well as for educational needs.

Keywords

Framework. Simulation. REA. Multi-agent. Business company. Education application. Process mining.

INTRODUCTION

The turbulent global markets pressure companies to ensure the flexibility of their behavior, speed of decisions, and customer satisfaction in order to preserve their optimal market share, profits and other key performance indicators (KPIs). Due to the speed of the market changes, such decisions should be made rapidly at all levels of management. In the decision support domain, simulations of expected decision effects became a standard tool recently. However, simulations can improve not only existing decision support systems. Moreover, they can contribute to the teaching of essential managerial skills already during the education process. If simulation models could be placed into the corresponding IT infrastructure of the educational institution, they could be used also in the distance learning environment.

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Simulations in decision support systems are typically based on business process modeling treated by many researchers (Axenath, Kindler and Rubin, 2007; Davenport, 1992; Eriksson and Penker, 2006; van der Alst, 2004; Bucki and Suchánek, 2012; Šperka et al., 2013; Šperka and Spišák, 2013). Alternative enterprise modeling methods - value chain oriented models have garnered much attention both among researchers in the accounting and later, from enterprise modeling. Value chain modeling concentrates on the value flows both inside the enterprise and on the value exchange with the environment. Currently, the most popular value chain enterprise methodologies are e3-value (Gordijn and Akkermans, 2003), and the Resources, Events, Agents (REA) (Resources, Events, Agents) ontology (McCarthy, 1982; Hruby, Kiehn and Scheller, 2006; Dunn, Cherrington and Hollander, 2004). REA was proposed by McCarthy (1982) with the aim to resolve issues specific to the double-entry bookkeeping. It was later expanded by Geerts and McCarthy (2006) into the enterprise ontology. The REA ontology presents an application neutral data model with the potential to be implemented within the design of new ERP systems (Van den Bossche and Wortmann, 2006), supply chain management (Huňka et al., 2012) and recently also to auditing (Weigand and Elsas, 2012).

Both process and value chain modeling methods often meet difficulties in modeling complex environments, when some social behavior like negotiation, management specific methods, market disturbances and others come into consideration. In this case, introduction of some local intelligence based on artificial intelligence within a business process model seems to be of advantage. This is probably the main reason, why a new software modeling paradigm came into existence – namely the multi-agent modeling approach. Modeling and simulation using multi-agent systems (Agent-based modeling and simulation) can be seen as a new approach to system modeling, especially for decision-making support systems (Macal and North, 2006; Wooldridge, 2009). This is also the basic motivation of our research. In (Vymětal and Scheller, 2012; Šperka and Vymětal, 2013) we presented a general agent-oriented simulation framework Multi-agent REA framework (MAREA).

Using this framework, further research focusing on a possibility to define models to be used in education went on recently. The result of this research is a prototype based on the REA value chain and multi-agent modeling approach. The prototype can be used both in standalone PC environment and in distance learning. The aim of this paper is to present the developed prototype, its general structure, the graphical user interface and also to present some methods of the model validation. The paper is structured as follows. First, a general model structure is presented. Next, graphical user interface is introduced. Based on the typical simulation run, the results of business negotiations and output validation using simplified Petri net and social network are presented and discussed. Conclusion sums up the results obtained and outlines of the next research targets.

BUSINESS MODEL STRUCTURE

The model implemented in simulation framework simulates a virtual business company using the REA value chain and the multi-agent system as the active element. The general model structure is presented in Fig. 1. The model uses the control loop paradigm. The internal parts of the company are represented by several agent types such as sales representative, purchase representatives and marketing agents. The outputs of the

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company are measured by the REA based Enterprise Resource Planning system (ERP). The communication among the agents is carried out with a set of defined messages and corresponding message handlers. These activities are recorded in a special log file. The market environment is represented by customer and vendor agents. Note that all the agents mentioned exist in a large number of instances. The difference between measured outputs and targets is sent as a feedback to the management agent, who takes necessary actions in order to keep the system in the proximity of the targets.

The interaction between the customers and sales representatives and also between the vendors and purchase representatives is a typical negotiation. This is modeled by the classical contract net protocol. The customer agent and the purchase representative agent decide whether they should accept the quotation. For this decision, a special decision function presented earlier in e.g. (Šperka and Vymětal, 2011) was defined. If the proposal is not accepted, the sales representative or the vendor changes the price accordingly (this is one of the parameters that can be changed by the students.). As the logic of the decision function is the same both for the customer and for the purchase representative, we present here only the customer decision function.

The decision function for *m*-th sales representative negotiating with *i*-th customer is represented by formula

$$c_n^m = \frac{\tau_n T_n \gamma \rho_m}{O \nu_n} \tag{1}$$

c_n^m - price of *n*-th product offered by *m*-th sales representative,

τ_n - market share of the company for *n*-th product $0 < \tau_n < 1$,

T_n - market volume for n-th product in local currency,

γ - competition coefficient, lowering the success of the sale $0 < \gamma \leq 1$,

ρ_m - m-th sales representative ability to sell, $0.5 \leq \rho_m \leq 2$,

O - number of sales orders for the simulated time,

ν_n - average quantity of the *n*-th product, ordered by *i*-th customer from *m*-th sales representative.

Similar decision function is used in the vendor – purchase representatives negotiation. The aforementioned parameters represent global simulation parameters set for each simulation experiment. Other global simulation parameters are: lower limit sales price, number of customers, number of sales representatives, number of iterations, and mean sales request probability. The more exact parameters can be delivered by the real company, the more realistic simulation results can be obtained. In case we would not be able to use the expected number of sales orders *O* following formula can be used

$$O = ZIp \text{ where} \tag{2}$$

Z – number of customers
I – number of iterations,

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P – mean sales request probability in one iteration.

The presented decision function is generally based on the overall market balance for each product. However, quite another approach can be used for the customers decision whether to buy or not. This approach is based on the utility theory and needs data for the preferences and budget constraints. (see e.g. Vymětal and Ježek, 2014). The utility-based approach is out of scope this paper and an object for further research.

The management agent can change the purchase limit price, and can decide upon a sales representative or purchase representative education, marketing campaign, and others. So e.g. in case of a sales representative the education changes his ability to sell (ρ_m). This again helps to achieve a better negotiated price, (see equation 1). The parameters of management actions can be set by the students. With such general structure, the students are able to configure the agent types, the management actions and others and to observe the behavior of the system reacting to the state of the environment generally. The whole simulation system was given the name MAREA (Multi-Agent REA).

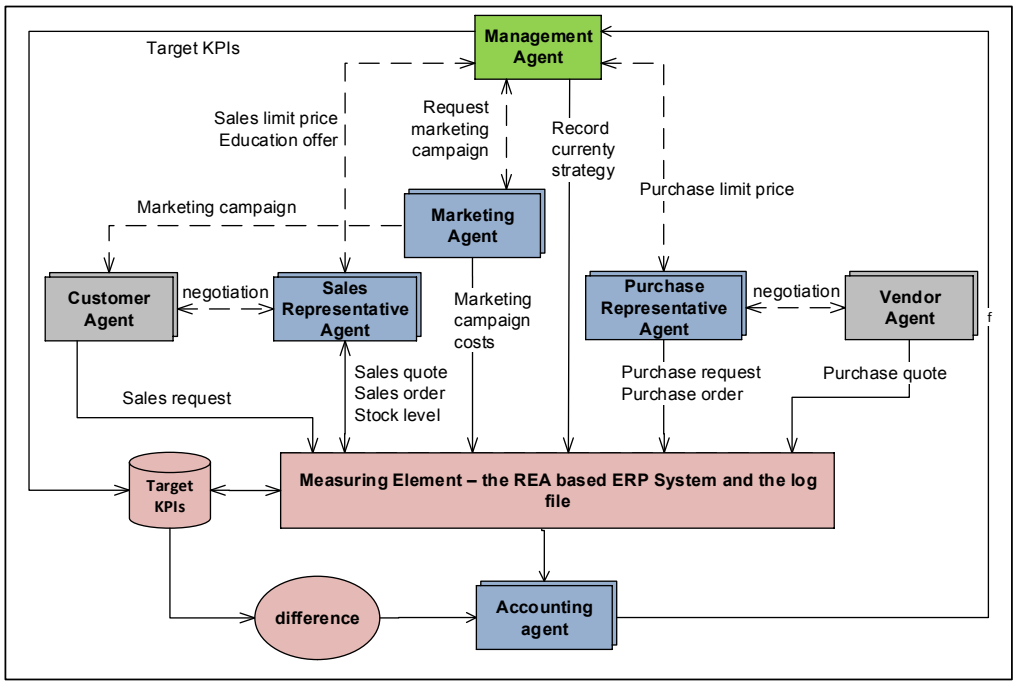


Figure 1: General simulation model structure. Source: adapted from Šperka and Vymětal (2013).

MAREA OVERVIEW

The application consists of two main components, the Simulation of a multi-agent system (MAS) and the REA based Enterprise Resource Planning system (ERP). The simulation designer can interact with the system by means of a Graphical user interface. The general overview is presented in Fig. 2. Next important elements of the application, hidden within the ERP system are the Message viewer and the log file. A simulation designer can either use the ERP system directly, or can program intelligent agents to perform the same activities that a human user can perform. For example, a simulation designer can use the ERP system directly to create initial data for a simulation, then start the agent platform to run a simulation, then using the ERP system to inspect the

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simulation results, and even adjust the data (within the rules implemented in the ERP system) and then start the agent platform to continue running the simulation. Both agents and a human user can read data from the ERP system, write data to the ERP system, and perform actions, such as sending a purchase order.

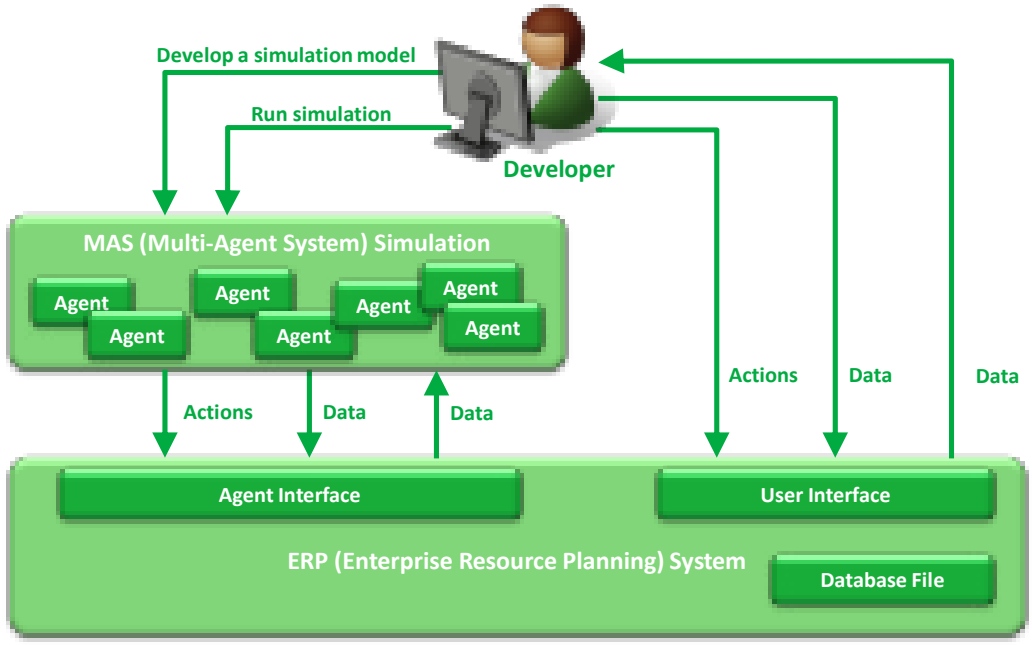


Figure 2: Application overview. Source: REA Technology official documentation.

MAREA application enables users to set up trading company parameters (see the example in Table 1) and run trading simulation for a specific time to interpret the development of KPIs of this company.

Table 1: Basic simulation parameters.

Parameter	Example	Remark
Number of iterations	365	52 weeks also possible
Number of customers	100	Up to several thousand
Number of vendors	5	typically
Mean quantity in one sales order	5 units	
Probability of sales order request	0,01	
Number of sales representatives	2-3	One for e-business modeling
Sales representative ability	0,7	For start

The main screen called Simulation monitor (Fig. 3) consists of five panes:

- Logo pane with sponsors of the project. You can hide the logo by clicking it. Clicking the upper area of the window shows the sponsor's logo again.
- Simulation properties. These properties are determined by the agent simulation model, and different simulation models might contain different simulation properties.

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- ERP system menu. Within the ERP system menu, two very important buttons can be seen: the Export to XES button and the Message viewer button. The functions and usage of these two buttons will be described in the next section.
- Simulation menu.
- A graph of the cash level of the company, indicating the progress of the simulation. Please note that this graph is updated by ERP transactions that influence cash level. That is, if the simulation runs but none of these transactions occur, the cash level graph in the Simulation monitor will not be updated.

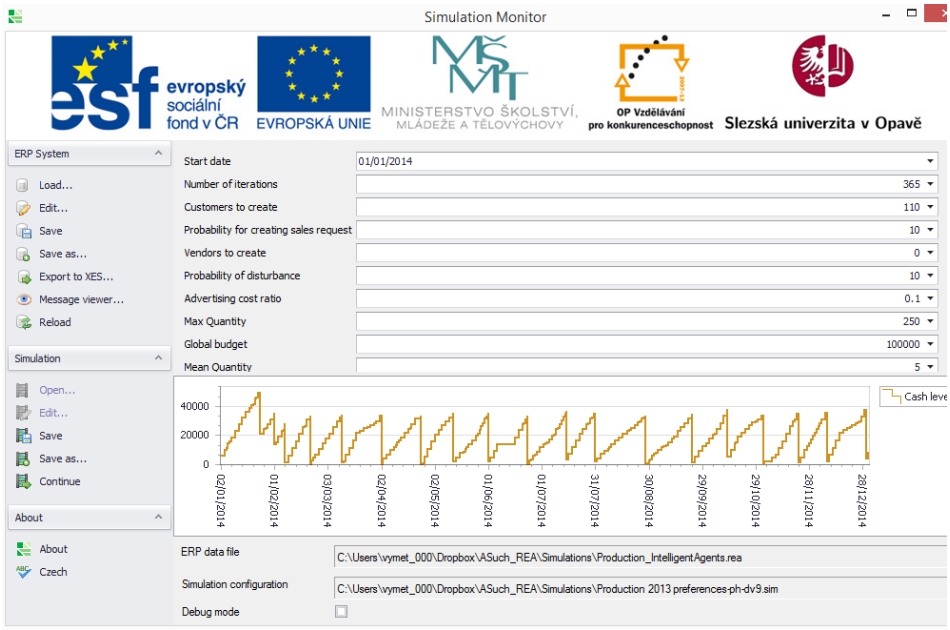


Figure 3: Description of the simulation monitor. Source: own.

The ERP system has been configured to calculate several key performance indicators (KPIs) by summing up other values. For example, Cash level is calculated as a total of all transactions that change Cash level – payments for purchases, income from sales, payment of bonus, initial cash, etc. Turnover and Gross profit is calculated as a total of gross profits and turnovers of specific product types.

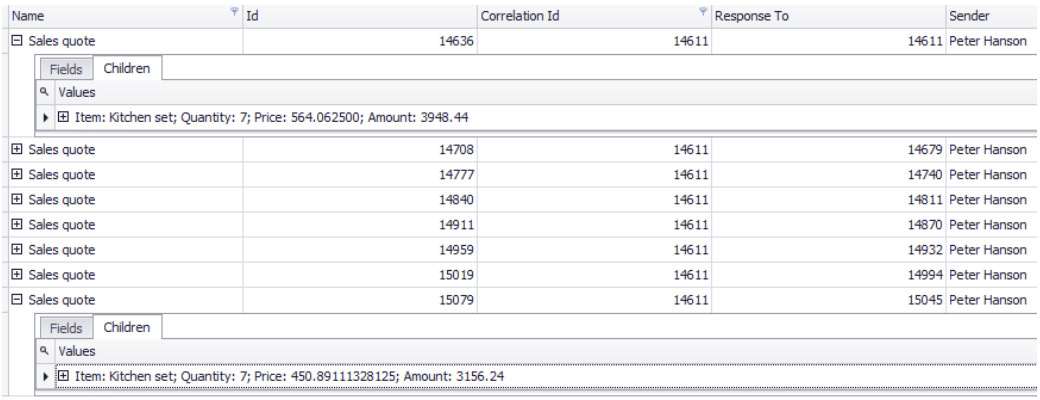


Figure 4: The example negotiation. Source: own.

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All messages sent among the agents including the messages the agents send to each other during negotiation are recorded in a message log file. They can be seen by means of the Message viewer and can be also filtered on the message type. The example negotiation between sales representative agent and the customer agent is presented in Fig. 4. Here we can see a result of a multi-round negotiation. The originally proposed price of the kitchen set (564) was negotiated down to 450,9. Here again: the parameters of a price reduction within a negotiation are a part of global system parameters that can be changed by the students.

SIMULATION OUTPUTS AND THEIR ANALYSIS

Simulation monitor allows to start, pause, resume, and continue the simulations and to open the ERP files. Before the simulation starts, the initial values of the ERP records such as the customers, the vendors, the products etc. can be set up (Fig. 5). The results of the simulation run are recorded in the ERP – REA based system during each simulation step. The values of the most important KPIs can be exported to MS Excel files for further analysis. The complete ERP database file can be saved for future use, too.

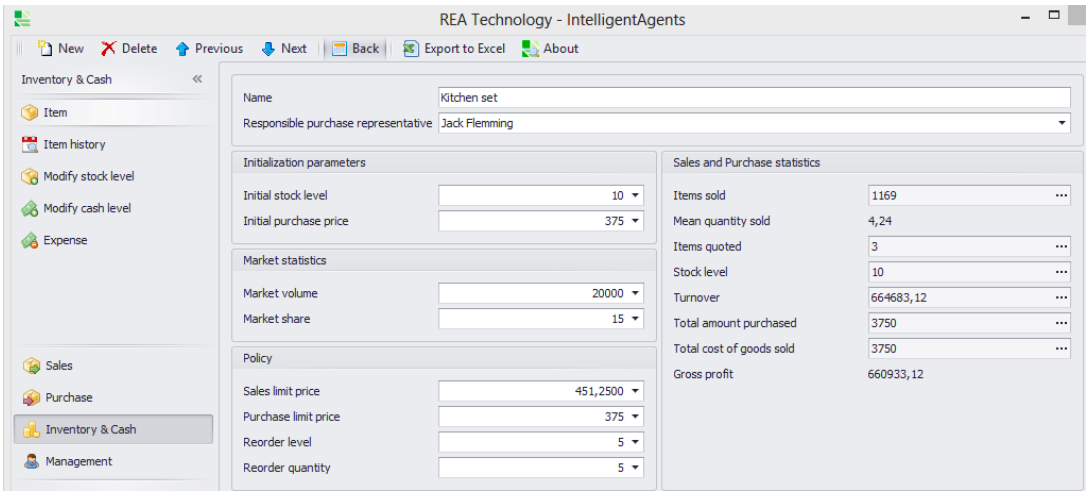


Figure 5: Initial values of the ERP records. Source: own.

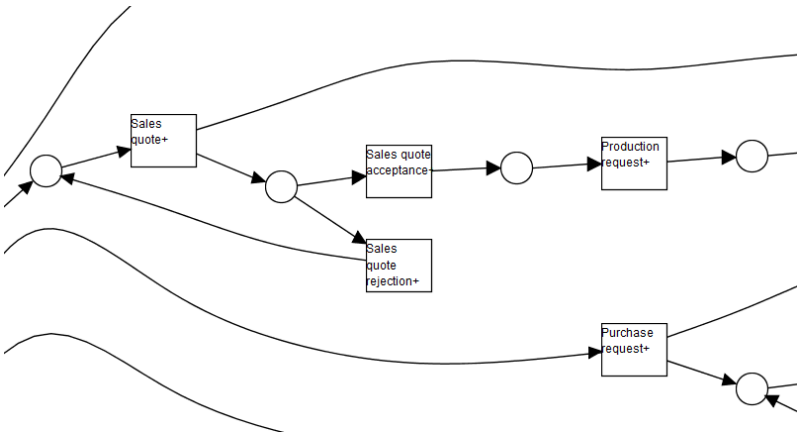


Figure 6: Fragment of negotiating Petri net. Source: own.

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An important part of the results analysis is the validation of the agents' structure. For this analysis, the agents actions are recorded in a special log file in XES format (Van der Aalst, 2011). The XES log file is then analyzed by means of the ProM 6.3 software[11] developed by the Technical University of Eindhoven. Two outputs form the ProM software are used in order to check the structure of the system: the simplified Petri net and the social network of the agents. In Fig. 6 a part of the resulting Petri net concerning the sales negotiation is presented. In Fig. 7 one type of a social network realized during the simulation shows the clustering of customers and sales representatives. From both results we could validate the system structure.

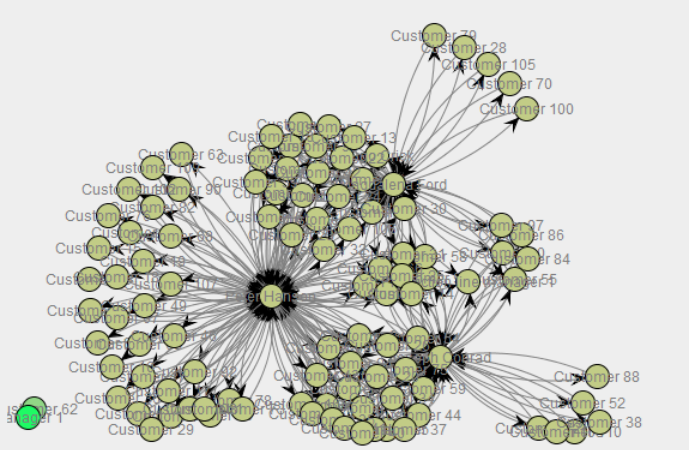


Figure 7: Social network for the negotiation. Source: own.

EDUCATION PROCESS

MAREA application is used in the education process at the Silesian University in Opava, School of Business Administration in Karviná, Czech Republic. It covers a part of the education content of a "Modelling and Simulation of Economic Systems" subject, which is voluntary for students of Managerial informatics in Master's degree. The objective of the application involvement is to provide a more in-depth view into the business processes of a company, and also to give more complex look at the components of the simulation framework.

Students acquire robust tool for the simulation of business processes. They can set up the parameters of a company, run simulation experiments and compare the results. This might help them to understand the managerial decisions concerning KPIs. They can observe the behavior of a virtual company in time with different outside conditions and settings. They get familiar with agent-based models and they can see in praxis the realization of an abstract FIPA negotiation architecture. It is possible to edit the internal structure of agents in source code (own language, based on XML standard). Students can use the simulation results in the form of a log file to further validate the model through process mining methods (statistics, structural models, social networks etc.). This enables us as teachers to follow the general simulation life-cycle in this subject: from the modeling, and implementation up to the verification of the simulation experiment. The feedback from students is positive. They are satisfied with the perspectives of this approach.

[11] www.procesmining.org

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CONCLUSION

We presented basic parts of MAREA education application in this paper. MAREA is a prototype of a simulation based software framework. In the first part of the paper we described a general structure of the simulation model, basic participants and simulation steps. The remaining scope is dedicated to MAREA graphical user interface introduction and the means of structure validation. The MAREA application serves for the decision support of company's management as well as for educational purposes. It enables users to get familiar with the principles of trading using business company virtual model. The setup of the application provides possibilities to edit the company parameters and to run trading simulations. This allows users to analyze trading behavior back-to-back according to the parameters setup. The prototype was tested using real data gathered from the ERP system of high-tech Slovakian company and using randomly generated data as well. The validation shows reasonable results with the necessity to integrate some kind of mechanism dealing with seasonal differences in KPIs. The most important features of MAREA are: configuring options on the lowest level (source code of the agents), availability for distance learning and simulation speed of the framework. Future research will concentrate on the log files analysis to give us feedback about processes in the running simulation experiment.

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