Constantine the Philosopher University in Nitra
Faculty of Natural Sciences

DiVAI 2012

9th International Scientific Conference on Distance Learning in Applied Informatics

Conference proceedings

May 2 - 4, 2012

Štúrovo, Slovakia

European Union
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2012

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Preface

Dear readers,

Issues connected with education, its content and forms are currently under a strict surveillance of the society. Indeed, innovation of the content and forms of education has become nowadays a top priority of higher school and universities. The pioneer of progressive educational methods and forms at the Constantine the Philosopher University is the Department of Computer Science. This Department develops methods of ICT utilization in education, looks for new ways of their exploitation and implementation, and moreover educates in ICT future teachers from other fields as well. It is understandable that most progress has been achieved in innovating own study programs. The flagship here is the study program Applied Informatics. Distance education in this specialization has been successfully carried out by this particular Department for several decades. Relevant results are frequently presented at international conferences, e.g. DIVAI and others – in 2012 already a ninth one of its type.

The need for the conference has arisen along with the growing tendency in terms of information interchange in the field of ICT application in education focusing predominantly on the concept of e-learning. Over time, the conference has built up its reputation and gained on popularity among the e-learning supporters that traditionally meet in Nitra for the ninth time.

The conference proceedings, you have obtained, represent a collection of scientific papers from the international conference DIVAI 2012 – Distance Learning in Applied Informatics.

Moreover, we wish the Department the high quality working staff, lecturers, scientists as well as unceasing interest in the field from the part of students.

I truly believe in successful future development of the Department of Computer Science. As a pioneer in the field of ICT application in education scientific research and various other fields, I am assured the Department will keep updating and ahead in the field. On this occasion, I would like to praise the work of guarantees, the team of organizers and sponsors, lecturers, and last but not least participants of DIVAI 2012 conference, for they all are to be considered vital contribution to the discussed issue as well as smooth conference running and scientific proceeding.

prof. RNDr. Ľubomír Zelenický, CSc.
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Keynote Lectures

Multimedia Application – Effective Support of Education

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Abstract

Multimedia applications have substantially influenced education. They give teachers an excellent chance to demonstrate and visualize the subject matter more clearly and comprehensibly, as well as also enabling them to prepare study material for students which optimizes their study habits. The author of the paper has been prepared with her students various multimedia applications dealing with objects appropriate to subject matter for many years.

Logical thinking is an important foundational skill. It should be enhanced at all levels of studies. Mathematics is one of the leading subjects that develop this skill. Graph theory together with combinatorial optimization, the very interesting and practical part of applied mathematics, is a powerful tool for teachers allowing them to develop logical thinking in students, increase their imagination and make them familiar with solutions to various practical problems.

This paper offers some ideas how to make teaching and learning of the above mentioned branches of mathematics and computer science more understandable and attractive using multimedia applications. A multimedia application created by one of the author's students, the program GrAlg, is introduced at first. This is followed by a case study dealing with the well-known Breadth-First-Search method and its relation to the other problems. The case study is described using a pedagogical background and the program GrAlg. The presented approach used for teaching and learning graph theory and combinatorial optimization can serve as an inspiration for instruction in other subjects as well.

Keywords

Multimedia Application. Education. Logical Thinking. Graph Theory. Combinatorial Optimization.

Introduction

Information technology has changed many things in the world. Suitable multimedia applications can substantially influenced education. They can be used both by the teacher as a supplement to the problem interpretation and by students as an efficient assistance in their individual preparation.

Along with large software products dealing with a wide spectrum of objects developed by a team of professionals there are also various smaller programs dealing with objects appropriate to course subject matter created on a script given by the teacher with regard to students needs. In the paper we devote attention to one of such applications, to the program *GrAlg* (Šitina, 2010).

Student engagement is crucial for successful education. One of the pleasant ways to bring discussed topics closer to students is their illustrations and visualization. Given terms or problems will be recollected well by students if they are presented on real examples. To get deeper into each problem and understand it entirely it is worth to explain subject matter in contexts and from as more points of view as possible. To demonstrate and practice the use of the discussed issues it is often worth including also the appropriate logical tasks into teaching methods. Not just because logical tasks can provide students with an initial idea, and the motivation to apply the theoretical knowledge, but it can also greatly contribute to the development of students' logical thinking and their imagination.

In this paper we initially introduce the five principles that we apply in our teaching of developing logical thinking of students. Then we briefly describe the program *GrAlg* used as an important support for teaching and learning graph theory as well as combinatorial optimization. By means of the program and the pedagogical background we demonstrate our educational approach using a case study dealing with the well-known Breadth-First-Search method and its relation to the other problems.

The purpose of the paper is to present our approach to education using multimedia applications support. This approach that has proved successful in developing students' logical thinking when teaching and learning graph theory and combinatorial optimization can serve as an inspiration for instruction of other subjects as well.

Teaching principles

The aim of the subjects dealing with graph theory and combinatorial optimization is to develop and deepen students' capacity for logical thinking. Well-prepared students should be able to describe various practical situations with the aid of graphs, solve the given problem expressed by the graph, and translate the solution back into the initial situation.

Our approach to the development of logical thinking of students within the above mentioned subjects can be characterized by the following basic principles that we apply in our teaching (Milková, 2009).

- When starting an explanation of new subject matter, a particular problem with a real life example or puzzle is introduced as a motivation and suitable graph-representation of a problem is discussed.
- If possible, each concept and problem is examined from more than one point of view and various approaches to the given problem solution are discussed with respect to the already explained subject matter.
- In addition to words visualization of the particular issue as well as it is possible is done.
- The explained topic is thoroughly practiced and students' own examples describing the topic are discussed.
- Using the constructed knowledge and suitable modification of the problem solution, we proceed to new subject matter.

Multimedia application – program GrAlg

Students find modern technology very handy when looking up things of their own interest. The teachers should take advantage of this fact and should try to prepare for them such multimedia study material, which would optimize their study habits. It means to create applications making students' study more effective, time-efficient and explained topics more comprehensible.

In the subjects dealing with graph theory and combinatorial optimization there is no problem in illustrating the needed concepts using graphs. However, it is very important to prepare suitable illustrative graphs and have the possibility to use colours to emphasize characteristics of the explained concepts.

The ability to create appropriate graphs, to visualize graph concepts and algorithms, and to support preparation of other useful study materials was the main reasons why the *GrAlg* (*G*raph *Alg*orithms) application was created. It was created in the Delphi environment by our student within his thesis (Šitina, 2010).

The program enables the creation of a new graph, editing it, saving graph in the program, in its matrix representation and also saving graph in bmp format. It also makes it possible to add colour to vertices and edges, to change positions of vertices and edges by "drop and draw a vertex (an edge respectively)" and to emphasize with colours basic graph concepts and graph algorithms on graphs created within the program.

The big advantage of the *GrAlg* program is the possibility to run programs visualizing all of the subjects explained algorithms on nondirected graphs (see Figure 1) in a way from which the whole process and used data structures can clearly be seen.

The program allows the user to open more than one window so that two (or more) objects or algorithms can be compared at once (see Figure 2).

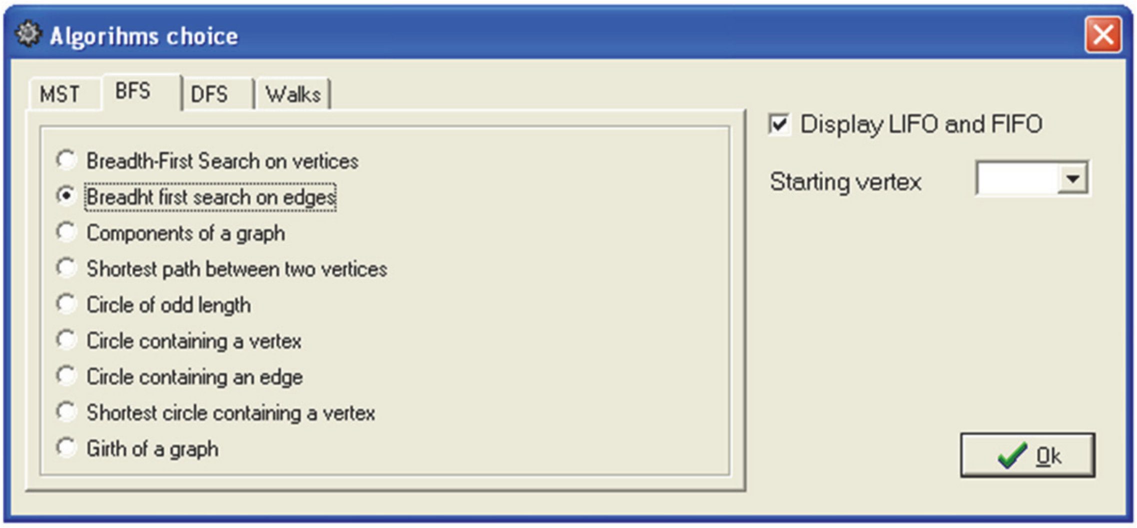

Figure 1: Program *GrAlg* – The list of main algorithms (MST, BFS, DFS, Walks) and detailed list of algorithms concerning the Breadth-First-Search algorithm (BFS).

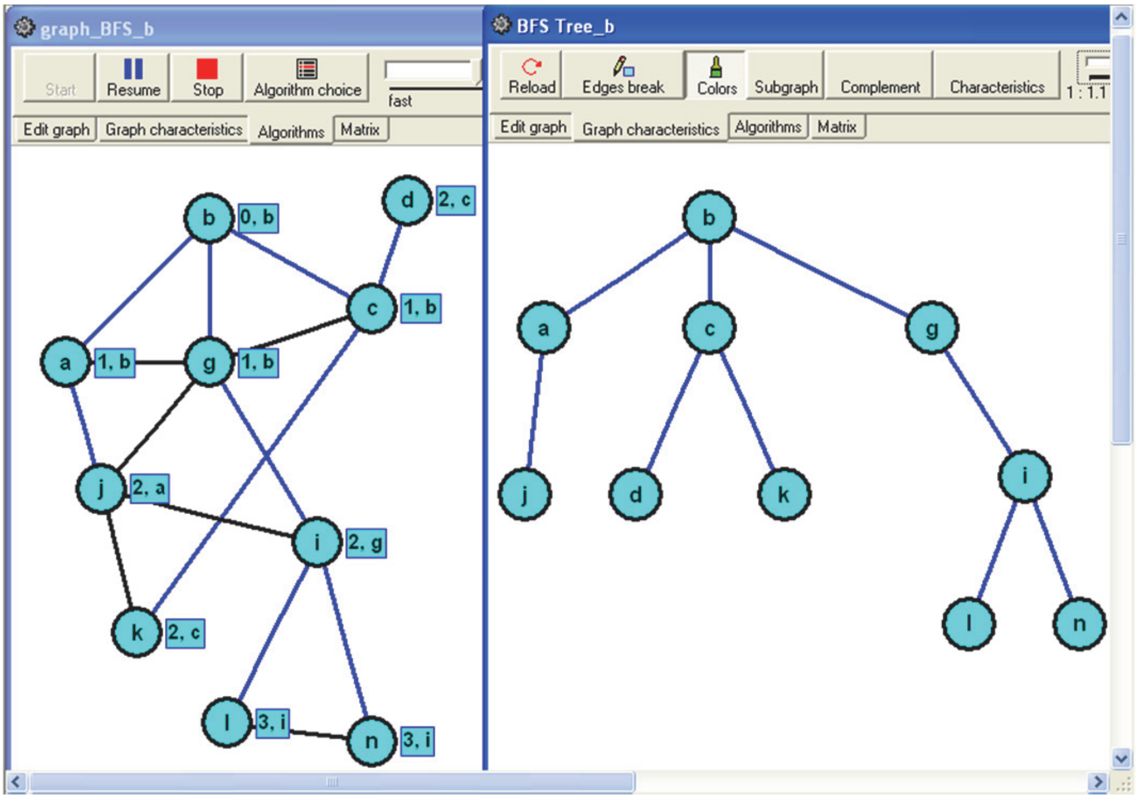

Figure 2: Program *GrAlg* – BFS algorithm run on the given graph starting in the vertex *b* (on the left) and gained BFS Tree (*T*, *b*) with the root in the vertex *b* (on the right)

Case study

The Breadth-First-Search (BFS shortly) algorithm belongs to the most used searching algorithms i.e. algorithms providing a consecutive searching of (working with) vertices and/or edges (see e.g. (Demel, 2002), (Cormen, Leiserson, Rivest and Stein, 2009)). The spanning tree gained by the algorithm forms a rooted tree, so called Breadth-First-Search Tree (BFS Tree shortly), that has special and interesting properties. Using it we can obtain important statements enabling to formulate various other algorithms (Milková, 2010).

In this section we present a possible way to make students familiar with the properties of BFS Tree using the program *GrAlg* and keeping the five above mentioned principles.

1st step: motivation and suitable graph-representation

Example

Let us have a look at the Figure 3. There are two types of cells (fields); white and black. The task is to find a way to move from the point **S** (Start) to the point **P** (Post) using **the smallest number of steps** possible keeping the following rules:

- One step means to move to one cell.
- Go either horizontally or vertically.
- Do not enter nor go through black cells.

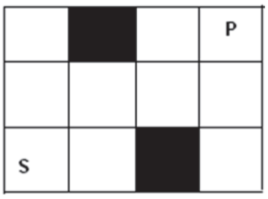

Figure 3: Picture to the given puzzle

The graph representation to the task can be easily done in the following way. Let us complete the Figure 3 by numbers and letters (see Figure 4). Then each cell is represented by the vertex *Pc*, where *P*∈{A, B, C, D} and *c*∈{1, 2, 3} and an edge is between each pair of vertices where the step defined by the above rules is possible (see Figure 5 – created by means of the program *GrAlg*).

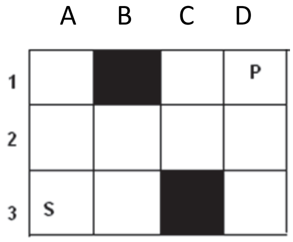

Figure 4: Figure 3 completed by numbers and letters

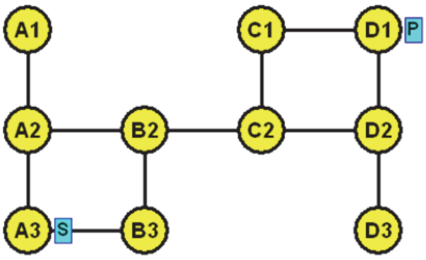

Figure 5: Graph representation to the task given in the example

The solution to the example, using graph theory, is aimed at the usage of **the BFS Tree property dealing with the shortest path** (see the following steps).

2nd step: various approaches to a given problem

Breadth-First-Search of an undirected graph we describe as an edge colouring process:

```
1. Initially all vertices and edges of the given connected undirected
   graph G, with n vertices and m edges, are uncoloured. Let us choose
   any single vertex, insert it into FIFO, colour it blue and search it.
2. while FIFO is not empty do the following commands:
   o choose the first vertex x in FIFO
   o if there is an uncoloured edge {x, y} then
       if the vertex y is uncoloured then
       search and colour blue both the vertex y and the edge {x, y}, and
       insert the vertex y into FIFO
       else search and colour the edge {x, y} red
     else delete the vertex x from FIFO
```

Applying the BFS algorithm starting in a vertex *v*, it is evident that the blue coloured edges form a spanning tree *T* and an appropriate rooted tree (*T*, *v*) with the root *v*, i.e. BFS Tree (*T*, *v*). BFS Tree

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has the following main property: the end-vertices of each non-tree edge of *G* belong either to the same level or to the adjacent levels of BFS Tree.

We can observe end-vertices of non-tree (red) edges either **regarding to the levels** of BFS Tree, or **regarding to the subtrees** (see Figure 6). Using these two different points of view we obtain several useful statements (in detailed see Milková, 2010).

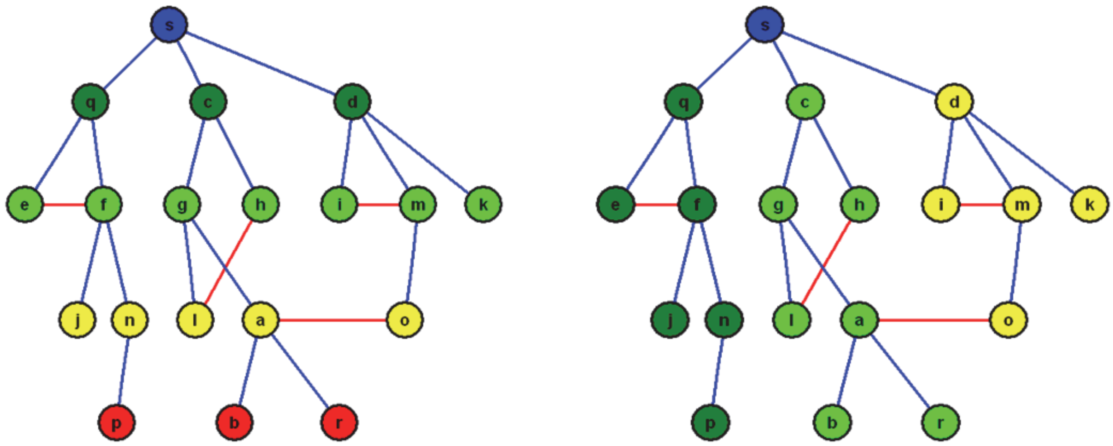

Figure 6: BFS Tree completed with non-tree (red) edges and its observation regarding to the levels (on the left) and to the subtrees (on the right)

The statement concerning the shortest path between two given vertices is important for solution of the example given in the 1st step.

3rd step: visualization

Using the *GrAlg* program visualization of the BFS algorithm starting in an arbitrary vertex *v* can be easily presented at the lecture as well as the appropriate BFS Tree (*T*, *v*) (see Figures 2) and various algorithms (see Figures 1) based on statements concerning BFS Tree. With the help of the program there is no problem to emphasize both above mentioned observations of the BFS Tree (*T*, *v*), demonstrate all statements and to illustrate a solution (see Figure 7) of the example given in the 1st step.

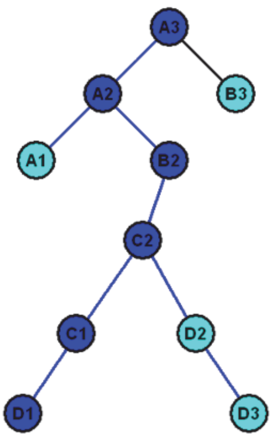

Figure 7: One possible solution of the example, the shortest path from the root A3 = Start to the vertex D1 = Post in the BFS Tree (*T*, A3)

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4th step: practise and discussion

The topic explained and illustrated at the lectures is thoroughly practiced at lessons and students' own examples describing the topic are discussed.

We are very well aware that interesting resources prepared for self-study enable students more consistent engagement with the subject. Students who are familiar with the materials are good partners and lessons can be run more efficiently, like a discussion or consultation.

At our faculty students' **self-preparation is supported in the LMS Moodle**. In the part "Introduction" students find a detailed plan of lectures, the *GrAlg* program, samples of credit and exam tests, and information concerning recommended literature and credit and exam conditions. **Electronic texts** containing the subject matter explained in the lecture **are placed in the appropriate part "Theme"** together with **problem statements of tasks solved in lesson** in addition to **graphs used during the lecture and the lesson**. Students interested in the area explained within a subject can find here additional material, and sources and information outside the immediate framework of the subject.

Using the *GrAlg* program students can revise subject-matter and more deeply understand it. They can use not only graphs prepared by the teacher but also graphs created by themselves and explore the properties of these graphs and run in the program offered algorithms on these graphs. The possibility to open more than one window enables them to follow mutual relations among used concepts and algorithms.

5th step: moving to new subject matter

Completing the BFS Tree, appropriate to the example, by non-tree (red) edges (see Figure 8) we can observe that there are other shortest paths between the root A3 and the vertex D1, i.e. more solutions of the example. We would like to determine all solutions.

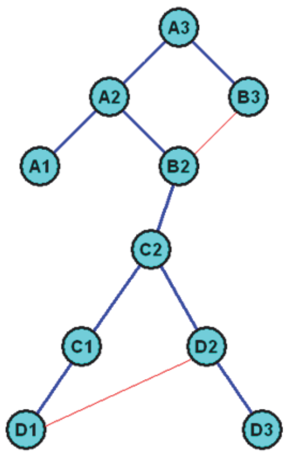

Figure 8: BFS Tree (*T*, A3) completed by non-tree edges

We move to new subject matter – to the definition and the construction of an *x*-*y* Shortest Path Tree $T_{x,y}$ determining all the shortest paths between two given vertices *x* and *y* (in detailed see Milková, 2010).

Results

Using our teaching principles based on investigation a particular problem from more than one point of view if possible, modification a problem and discussion the mutual relationships among solved problems we encourage students to develop their logical thinking, to think about each problem more than usual and to get deeper into the problem and to understand it.

Using puzzles enable us to enhance logical thinking of students in an enjoyable creative way.

Visualization of the particular issue as well as it is possible improves understanding of explained subject matter.

The *GrAlg* program enables the students to acquire, complete, test and deepen their knowledge and increase their imagination.

The *GrAlg* helps teachers explain all needed concepts and the process of particular algorithms. Thus it enables the teacher to complete his/her explanation within lectures in such a way that the topic is more comprehensible; the possibility to use colours allows the teacher to emphasize needed objects and relations; the option to open more than one window enables to explain the problem from more points of view and show mutual relations among used concepts and algorithms. Moreover, the possibility to save each created graph in bmp format allows teachers easy insertion of needed graphs into the study material and thus saves their time when preparing text material and presentations.

Conclusion

There are various professional multimedia applications used as a useful support of education. Using them various mathematical, chemical, physical etc. processes can be visualised in a lucid way (see e.g. Pražák, 2010, Hubálovský, 2010, Balogh, Magdin, Turčáni, Burianová, 2011).

In the paper we emphasised how important and useful support of education can be achieved also by means of a smaller program dealing with objects appropriate to course subject matter created on a script given by the teacher with regard to students needs.

Moreover, students admire quality multimedia applications prepared by their colleagues who, on the other hand, are proud that their works serve as a useful study material.

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Conference Papers

Who Shall Guide Education Process – Teacher or Technology

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Abstract

Evolution in computer and information communication technologies have made also possibilities to develop intelligente technological solution for enhanced learning. Today, most researchers in the field of educational technology seem to be preoccupied with either heuristic, the development of some hove intelligence application, or the philosophy and psychology, concerned with the nature and scope (limitations) of knowledge and representation or varius learning theories such as beheviorism, constructivism and conectionism by computer program. The enthusiasm to develop technological advanced learning tools resulted in technologies with limited application. The need to develop simple computer-based tools to assist instruction and demonstrate its impressiveness to enhance learning is most important, but those tools desperetly need to be designed with didactical and methodological knowledge and only hardly then integrated into a pedagogical framework.

The paper presents the design and use of an interactive computer-aided learning tool for enhanced learning. In this paper we also present the impact of an interactive computer-aided e-learning tool whose primary objective is to assist students in learning.

Keywords

Education. ICT. Didactics. Phylosophy. Intelligente Learning Tools.

Introduction

A serious limitation in the traditional (lecture) approach in education is the fact, that it mostly places the student in a passive role. What influences student's experience is briefly shown at the Figure 1. One of the basic questions facing educators has always been "*Where do we begin in seeking to improve human thinking*?" Fortunately we do not have to begin from scratch in searching for answers to this complicated question. The experts recommend: "One place to begin is in defining the nature of thinking. Before we can make it better, we need to know more of what it is". New discoveries in the field of developmental cognitive science and neuroscience hold a great promise for improving current teaching methods. Yet there remains a significant gap between the scientific discoveries that could improve our education system and the application of this knowledge.

Because the whole education system is too complicated for one paper, we will take into account in this paper only one pillar (see Fig. 1), that is *learning environment*. Today the probably most important element of the learning environment is information and communication technology (ICT). ICT through e-learning, e-lab, networking, knowledge-based systems, and other technologies, will play an increasingly important role in the way that education is taught and delivered to the student, especially to science and technology students. But all this modern technology must have base on special didactics and media didactic. Through these technologies and didactic, the student will be placed in an "active" role, as opposite to a "passive" environment of one-way lecturing. The teacher can then act as a facilitator and author of the learning environment instead of merely a one-way communicator (Novotný, 2011).

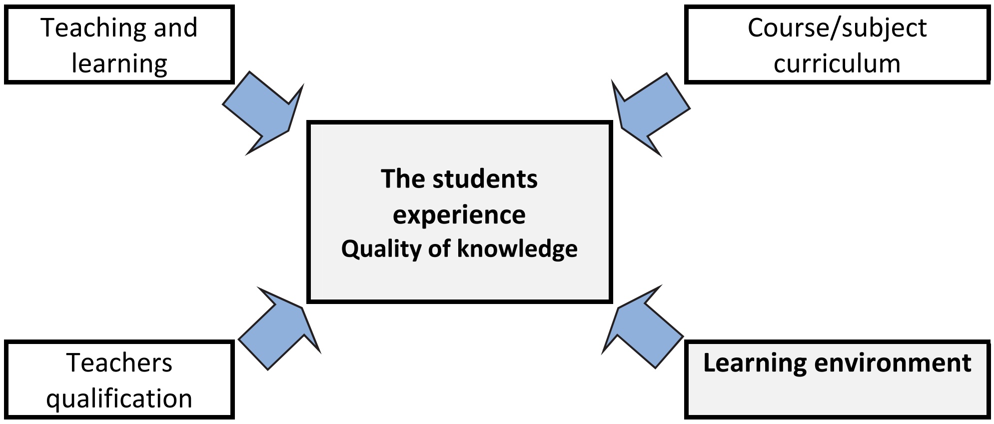

Figure 1: 4 pillars of education system

There is no denying about the appeal of computer and other ICT technologies. Their magnetic effect on students' attention is all too familiar to teachers but parents too, particularly when the alternatives are boring homework and household chores (Massey and Brown, 2005). If we would like to use this entire new gadget, we must know:

- *something about the end user, that is how human intellect works and/or how human percept individual information, and*
- *something about technological possibilities, that is how advance learning environment must be built up.*

And we can put also some additionally basic questions about processing of information:

- How can understanding of the information processing help to be a better teacher?
- What assumptions about learning underlie this process?
- What is metacognition and why is important that teacher understand it?
- What kind of study strategies will help students to learn?
- What teaching strategies can one use to help facilitate meaningful learning?
- Etc.

But let's start from the beginning. A lot of research in education is concerned with the development of intelligence applications such as Computer-Aided Instruction (CAI), Intelligent CAI, Intelligent tutoring system (ETS) and Intelligent Learning Environment (ILA) (Felder, 1993; Allen, 2008) and also with applications that can be justified as being consistent with educational theories. There is also a new trend which deals with comparing the performance and attitudes of students taking online courses versus those taking lecture-based courses (Davis, 2003, Sunal, 2003). Computer-supported collaborative learning (CSCL) is one of the most promising innovations to improve teaching and learning with the help of modern information and communication technology. Most recent developments in CSCL have been called e-Learning 2.0, but the concept of collaborative or group learning whereby instructional methods are designed to encourage or require students to work together on learning tasks has existed much longer. It is widely agreed to distinguish collaborative learning from the traditional “direct transfer” model in which the instructor is assumed to be the distributor of knowledge and skills, which is often given the neologism e-Learning 1.0, even though this direct transfer method most accurately reflects Computer-Based Learning systems (CBL) (Stahl, 2006).

Information processing system

Locus of Control remains an important consideration in successful engagement of e-learners. According to the work of Cassandra B. Whyte, the continuing attention to aspects of motivation and success in regard to E-learning should be kept in context and concert with other educational efforts. Information about motivational tendencies can help educators, psychologists, and technologists develop insights to help students perform better academically (Whyte, 1980).

It seems that advancements in the use of technology for educational purposes have bypassed two mayor elements: the integration of computer based applications in the instructional process and vice versa, and consequently the transforming the role of instructor. While many perceive online computer-aided learning tools a major breakthrough in teaching and learning, many educators and trainers do not support it (Conlon, 1997). Although the growth of online computer-aided learning tools has been significant recently, there still exists a mayor gap in design and evaluation of their educational (teaching and learning perspectives) capabilities and effectiveness in enhancing the learners’ experience (Saade, 2007).

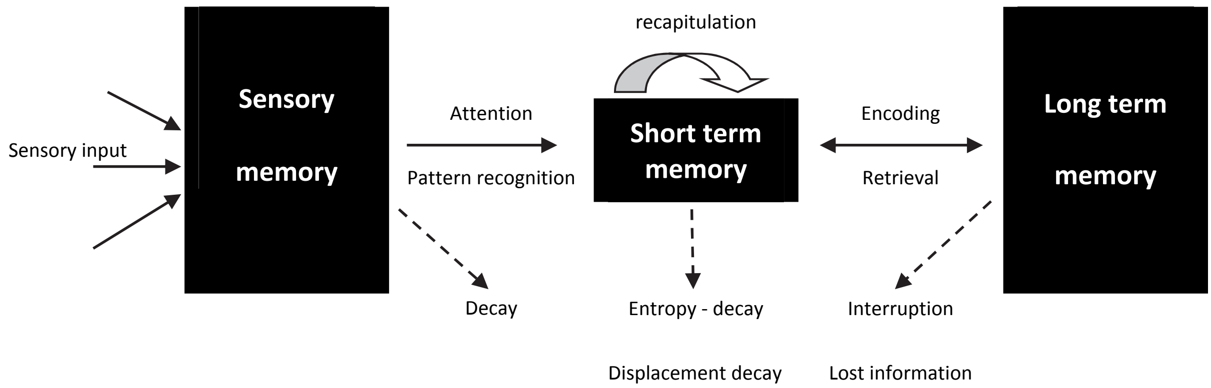

Figure 2: Model of information process

Broadbent (1958) proposed a general model of the human information-processing system as briefly shown in Figure 2. This information processing model presented the basic mechanisms: three main memory storages in which the information is operated on, and the processes of transforming the information from input to output within each storage and from output to input between these storages. The model suggested that the processing is a fixed serial order from one memory storage to the next, and voluntary control of the system was represented by a selective-attention device and by information feedback loops from the high-level processing system to earlier processing stages.

There are many different theories about the human information-processing system, but probably the most widely accepted theory is labelled as the "stage theory". It is based on the work of Atkinson and Shriffin (1986). The stage model assumes that the brain embodies a nervous system that processes the information from the time of the input to the time of storage in long-term memory. The system comprises three main stages that contain different physiological properties: the sensory registers, short-term memory and long-term memory. The sensory registers briefly store representations of external stimuli from the environment until the information can be transferred further. There appears to be different sensory registers for each sense. In any case, the sensory registers can hold information for only a very brief period of time. The information is assumed to be lost from the registers unless it is passed along into short-term memory.

Short-term memory can be thought of as conscious memory because, in addition to holding information, it allows information to be manipulated, interpreted and transformed. The new information in short-term memory, by subjection to further processing, may be transferred to and made part of long-term memory. Long-term memory is a relatively unlimited and permanent repository of information. Long term memory stores for later use of information. Once the information is stored in the long-term memory, it stays.

The information processing model highlights the basic mechanisms in terms of stages and the processes, and the representation and storage of information:

1. Three main stages in which the information is operated on: sensory memory, short-term memory (temporary working memory), and long-term memory.
2. The processes of transforming the information from input to output within each stage and from output to input between these stages, e.g. attention/pattern recognition, encoding and retrieval.
3. Representation and storage of information, e.g. network models, Feature Comparison Models, Propositional Models, Parallel Distributed Processing Models, etc.

Theory into practice: The influence to instructional systems design

Two key assumptions in information processing theories have great influence in the formulation of instructional principles:

- The memory system is an active organized processor of information
    1. Research studies in attention and perception, such as the pattern recognition filter models of attention, and dual coding theory, have great impacts on the instructional message design both in text and visual message in order to maximize the attention and perception of the learners.
    2. Studies in the characteristics of short-term memory, such as limited space and short duration, give rise to the importance of mnemonic devices to reduce the workload of the short-term memory, information organization in chunks or smaller components to increase capacity. Also, the information processing models proposes the use of rehearsal strategies to maintain information, and content organization, such as elaboration theory, to help encode information by relating incoming information to concept and ideas already in memory.
    3. Theoretical explanations on the retention in long-term memory emphasize the effects of different conditions on levels of processing. Meaningful encoding facilitates later retrieval. Graphic representations have been particular effective in facilitating encoding and memory storage of information
- Prior knowledge plays an important role in learning process
    1. The influence is evidenced by the use of advance organizers and any instructional strategies to strengthen activation of the existing memory structure. . Elaboration strategy and Ausbel's meaningful learning employed in instructional design systems

suggests the importance of relating meaning of the new information to each individual learner. Also, the use of the metaphors and analogies provides instructional effectiveness.

2. Emphasize the importance of self-regulatory skills in learning: conscious reasoning and thought

Moreover, with the development of information processing view of learning, the task can be examined from the perspective of human thought process. The cognitive operations that a learner needs to carry out in order to complete a task or to solve a problem become the target of analysis. Information processing task analysis uses flowcharts to represent cognitive operations step by step and indicate the decision making process (Scandura, 1973).

The conceptualization of an active memory system puts a lot of attention on the operation of information. The focus is on what and how this system is related to learning and cognition. In this framework, a lot of different hypotheses are proposed to explain different types of memory systems, the representation/structure of knowledge in memory, and how these representations influence and interact with incoming information. In turn, those hypotheses provide implications on how to control the instructional conditions. The assumption is that the correspondence between the instructional conditions and the internal conditions of this active memory system will maximize the effectiveness of the instruction.

Theoretical results

Today, the term "computer- assisted learning" is used loosely and represents the utilization of any application for delivering content to the student. This may be: electronic material that students would read or interactive learning tools to help learning. Concerns currently being explored by researchers include student's attitudes, course design and delivery, course evaluation, and instructor behaviour and attitudes (Sunal, 2003, Achtemaier, 2003, Aberšek, Kordigel Aberšek, 2010). The effectiveness of computer assisted learning applications and utilization of well-developed research plans are relatively scarce at this time (Sunal, 2003). As we mentioned, any computer-aided application/learning tool, especialy intelligent computer based tutoring system (the tutoring system of the future) must have in general level two parts:

1. The first part is heuristic part. Generally heuristic refers to experience-based techniques for problem solving, learning, and discovery. Heuristic methods are used to speed up the process of finding a satisfactory solution, where an exhaustive search is impractical. Examples of this method include using a "rule of thumb", an educated guess, an intuitive judgment, or common sense. In more precise terms, heuristics are strategies using readily accessible, though loosely applicable, information to control problem solving in human beings and machines (Pearl, 1983). In computer science, metaheuristic designates a computational method that optimizes a problem by iteratively trying to improve a candidate solution with regard to a given measure of quality. Metaheuristics make few or no assumptions about the problem being optimized and can search very large spaces of candidate solutions. However, metaheuristics do not guarantee an optimal solution is ever found. Many metaheuristics implement some form of stochastic optimization.
2. The second part is epistemological part, connected with the philosophy, pedagogy and didactics. Epistemology is the branch of philosophy concerned with the nature and scope (limitations) of knowledge. It addresses the questions: what is knowledge? How is knowledge acquired? How do we know what we know? Much of the debate in this field

has focused on analyzing the nature of knowledge and how it relates to connected notions such as truth, belief, and justification. It also deals with the means of production of knowledge, as well as scepticism about different knowledge claims. The term was introduced by the Scottish philosopher James Frederick Ferrier (1808–1864). In our paper, and in epistemology in general, the kind of knowledge usually discussed is propositional knowledge, also known as "knowledge that". This is distinct from "knowledge how" and "acquaintance-knowledge". For example: in mathematics, it is known that 2 + 2 = 4, but there is also knowing how to add two numbers and knowing a person (e.g., oneself), place (e.g., one's hometown), thing (e.g., cars), or activity (e.g., addition). Some philosophers think there is an important distinction between "knowing that", "knowing how", and "acquaintance-knowledge", with epistemology primarily interested in the first.

At the executive level the intelligent computer-aided learning tools are interactive computer programs which incorporate expertise and provide advice on a wide range of tasks (Aberšek, 2004, Aberšek, Popov, 2005). These systems typically consist of the following three basic components:

- the behaviour of the problem domain,
- context is a workspace for the problem constructed by the inference Mechanism from the information provided by the user and the knowledge – base and
- inference mechanism, which monitors the execution of the program by using the knowledge - base to modify the context.

In addition to the three main modules described above, the system should also be provided with a graceful:

- user interface,
- explanation facility,
- knowledge - acquisition module, as shown in Figure 3.

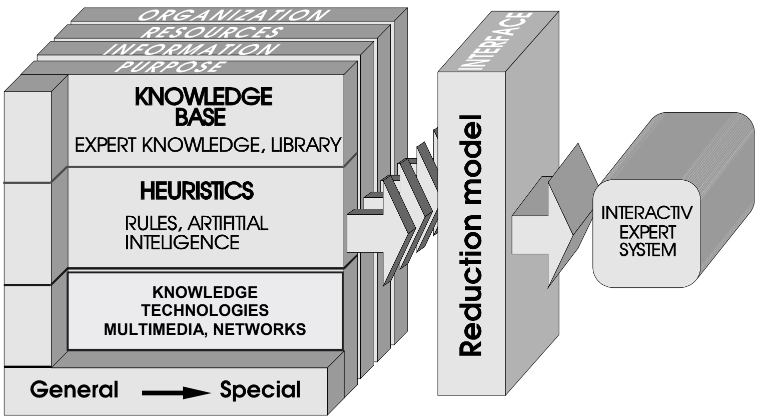

Figure 3: Configuration of the Expert System (Aberšek, 2004)

The mayor research questions that guided our study were:

1. Does the *e-learning tool* have a measurable effect on students learning?
2. What is the impact of the *e-learning tool* usage on students' performance?

In other words, we seek to investigate if there are any usage-performance associations. While using the *e-learning tool*, the score and the time of complete interactive session were measured. This

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embedded the investigation of possible association between students' time to complete a session and corresponding application scores.

Results: The e-learning tool, design and methodology

The study, we shall introduce as a example, examined the impact that the *e-learning tool* may have on learning. The primarily objective of this case was to allow students to explore different perspectives to concepts by manipulating related information. The aim of the exercise was to provide the student with an opportunity to construct his/her own mental model of a specific concept. This objective has some elements of the constructivist approach (Dalgano, 2009) and entails the implementation of learning strategies designed to involve the student in the learning process as well as a relatively high level of interactivity with instantaneous feedback. The *e-learning tool* was developed so that students could practice and assess their knowledge and assess their knowledge of content material and concepts to a specific matter (Jones, 2007).

In using the *e-learning tool*, students rehearse concepts specific to a subject matter by having the application prompting them with multiple choice, true or false and fill-in-the-blanks questions (Figure 3).

A rehearsing process entails a double randomization procedure, one type of question level and the other at the actual question level. After logging into the main page of the *e-learning tool*, the student can select which specific concept he/she wishes to rehearse. The *e-learning tool* now selects from a pool of related questions also using the same randomization function. The student answers the question; the time to answer the question is logged and feedback to the answer (correct or incorrect) is given to the student. Another question is than selected by the *e-learning tool* using the same procedure as described above. The session continues till the time is completed. After that a student gets a detailed performance report and an overall performance score.

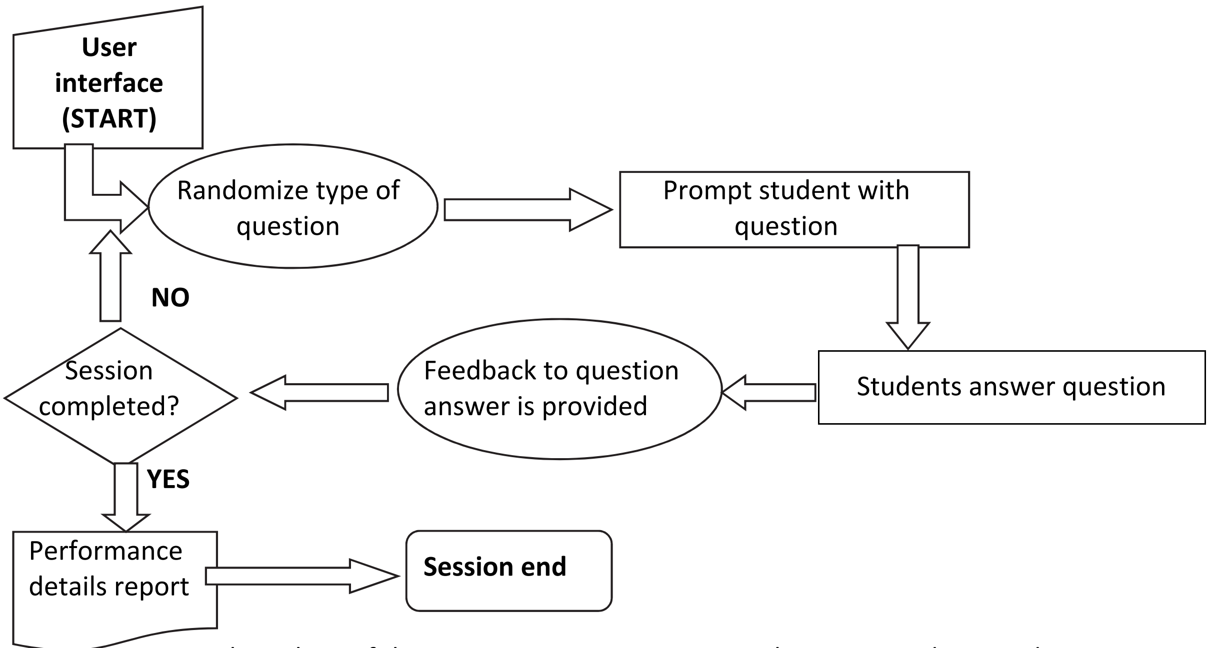

Figure 4: Flow Chart of the QUESTION-ANSWER process between students and system

The study examined the impact that the *e-learning tool* may have on learning. Two groups were used from two different semesters. Students were involved as a part of the Design and technology

Curriculum at the faculty of Natural science and mathematics, University of Maribor. A total of 34 students participated in the study. Once again: the mayor research questions that guided this study were: Does the *e-learning tool* have a measurable effect on students learning? And what is the impact of the *e-learning tool* usage on students' performance? Our research is consistent with the prior results where interactive computer based tutoring system - CBTS was been shown to positively impact students learning (Wegner, 1999, Aberšek, Kordigel, 2010). The results of the study are also consistent with previous research suggesting that students who use some kind of tutoring system for self-learning/evaluation higher in exams that those who use traditional study methods (Aberšek, Kordigel Aberšek, 2011). Table 1 presents the performance statistic of the study.

Table 1: Performance statistic

Sample	Min score in %	Mean (SD)	Max score in %
Group A: With CBTS	46	75 (11.00)	94
Group B: Without CBTS	35	66 (12.00)	82

There is a clear indication that Group A shows better results than Group B. This indicates that the application influenced students learning, this enhanced learning is reflected in the minimal, maximal and consecutiveness in the mean score and indicate difference of 14%.

Conclusion

Information technology, through networking, knowledge-based systems and experience based system, artificial intelligence system and other technologies will play an increasingly important role in the way that knowledge is taught and delivered to the student. Through these technologies, the student will be placed in an "active" role, as opposite to a "passive" environment of one-way lecturing. The teacher can with the help of information technology, through networking, with knowledge-based systems and experience based systems, artificial intelligence systems act as a facilitator instead of merely a one-way communicator.

Computer based learning tools create a compelling experience. For application seeking to teach users through realistic experience, computer based techniques can make the experience much more memorable. In a test bed environment, the context and control afforded by intelligence design techniques, intelligent heuristic allow integration of technologies and evaluation of the overall experience, even with partial implementation. And we must point out, that for good and effective e-learning tools the philosophical and didactical part is equally (maybe even more) important than heuristics (technological, ICT part), since the history proves, that schools had been and can work also without ICT, but ICT without pedagogy and didactics is empty and useless.

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Mobile LifeLong Learners on the Cloud

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Abstract

Mobile professionals can find themselves in desperate situations when they have ambitions and will to improve their skills but have to face problems related to the fact of matching their work schedule with lifelong learning centres timetables. The goal of this paper is to propose a cloud computing solution for mobile learners. For this purpose, some software as services are designed and implemented in order to enable mobile learners to localize learning centres on the move, to match mobile learners' free time with nearest lifelong learning centres scheduled courses, and to make reservation and use of learning resources while being in motion.

Keywords

Lifelong Mobile Learning. Cloud Computing. Software as a Service. Cloud Data Warehouse.

Introduction

Learning is populated by new concepts and technologies which might be used to enhance lifelong learning. Indeed, x-learning such as e-learning (Stockley, 2003), m-learning (Caudill, 2007) and p-learning (Syvänen et al., 2005), represent various approaches that were adopted for distance learning purposes. However the utility of x-learning don't reside only in being far from educational institution but also it lets the learning opened to any person, any age, at any educational level and social class or job (Reding, 2000).

E-learning involves the use of a computer in some way to provide training, educational or learning material (Stockley, 2003). It is a principal solution for distance learning which has emerged considerably with the development of the internet. It is based on providing practical tools via the internet and provides the potential for cooperation and interaction (Bourne and al., 1997).

M-learning is defined as learning with mobile technologies when the learner is not in predetermined location. This system is related to mobile devices that are available and used by all people, such as personnel digital assistant, pocket personal computers or smart phones. It ensures the effectiveness in the professional domain and provides a way to learn wherever and whenever (Caudill, 2007; Schrum, 2002).

P-learning is learning enhanced, by taking into account unsolved constraints, with intelligent environment and context awareness. It is an immersive experience which mediates between the learner's mental (e.g. needs, preferences), physical (e.g. objects, other learners) and virtual (e.g. content accessible with mobile devices, artefacts) contexts (Syvänen et al., 2005). Pervasive learning environment, that has to be offered to nowadays learners, is a collection of mobile users, mobile services, mobile devices, contexts and policies (Syukur and Loke, 2006) through which apprentices can become totally absorbed in the learning practice. In that perspective, we aim to offer to mobile learners a pervasive learning atmosphere able to respond efficiently to their needs through a combination of the above tools with Location Based Services (LBS) concepts and tools.

Cloud computing may offer to both MLs and 2LCs the opportunity of focusing on teaching, learning, and also working rather than on complex configuration and software systems, through fast implementation and utilization. In fact, cloud computing offers many benefits to e-learning solutions by providing the infrastructure, platform and educational services directly through cloud providers and by using virtualization, centralized data storage and facilities for data access monitoring (Pocatilu et al ., 2009). This allowed institutions both to cut down software and hardware expenses by reducing the necessities of licensing and software updating and data centres maintaining.

In (Mircea and Andreescu, 2011), authors propose alternatives to the use of classical information technologies, which improve agility and obtain savings. They strategy includes five stages, with emphasis on the evaluation of data and processes/functions/applications from several major universities based on some key criteria, while creating a correspondence between these aspects and the models/services/applications that exist on the cloud market. Their results support the use of cloud solutions in universities by improving knowledge in this field and providing a practical guide adaptable to the university's structure. The proposed model takes into account the university's architecture and criteria such as mission, availability and importance of applications and also the data's mission, sensitivity, confidentiality, integrity and availability.

In (Rajendran and Veilumuthu, 2011), authors develop a cost-effective model for storing and fetching e-Learning Videos. The study develops an e-Learning model in the cloud environment, which can be easily accessed by everyone without any constraints on geographical location. The video materials are stored in the cloud and through a progressive download approach; the videos in the form of sequence of bytes have been streamed to the learner in real time. The e-Learning Video on Demand is developed similar to the real classroom environment, wherein a learner has to be present on time to get the complete video of the relevant course he has registered for. By providing a smooth and lively streaming of multimedia based e-Learning materials, the learners are benefited with a cost-effective and virtual classroom environment. The application is scalable and cost effective and therefore provides benefit to modern educational institutions in terms of investment and helps in smooth functioning of e-Universities.

In (Al-Zoube, 2009), the author presents a cloud computing based solution for building virtual and personal learning environment which is intended to design and monitor educational content as well as to create a platform for exploring ideas. The author showed that cloud computing technologies can be exploited to build the next generation of platform-independent tools and scalable data storage e-learning systems to provide smart formal and informal learning. This set of technologies has clear potential to distribute applications across a wider set of devices and greatly reduce the overall cost of computing. The proposed approach provides flexible architecture enabling learners to mashup heterogeneous set of services that support different learning activities such as production, distribution, reflection, and discussion. More services that are semantically aware of learners' context have to be developed.

Methods

Learning is the most sacred task for human beings. An important number of persons fail to pursue their studies because of various reasons and keep their ambitions for graduation or post graduation into their hearts. Mobile professionals, a subset of this kind of people, can find themselves in desperate situations when they have ambitions and will to improve their skills but they cannot match their work schedule with their class one. In fact, they are handicapped by their mobility and the inflexibility of Lifelong Learning Centres (2LC).

A Mobile Learner (ML), usually moves from place to place connected by a road network, to take care of his permanent and occasionally customers dispersed geographically. The ML activities may vary in time and can allow him/her to have a free time at any moment. The ML has to react quickly in front of happening events to catch an eventual course or exam. To perform this objective, he has to find a 2LC, a class and a place in an acceptable time, while moving in one of the roads (e.g. in his car or on his/her feet). This can be performed using mobile devices well equipped to query distant databases and get efficient answers while moving. Answers can be ensured through a mediator, implemented thanks to wireless and mobile network architectures, able to provide efficient responses for location dependent queries triggered by MLs.

The goal of this paper is to propose an approach based on a cloud computing system for MLs able to localize, to match MLs free time with scheduled courses, and to make reservation and use of learning resources while being in motion. It supposes the following assumptions: 2LCs are distributed in various locations and grouped and managed in one centralized structure, and MLs can follow their courses in any 2LC.

Cloud computing solutions are based on virtualized resources that can be shared, not only by MLs which do not need any background knowledge about offered services, but also by 2LCs. They refer to both the applications delivered as services over the Internet and the hardware and systems software in the data centres that implement and provide those services. The services are labelled as Software as a Service (SaaS). The data centre hardware and software is called a Cloud which can be made available in a pay-as-you-go manner to the public and sold as utility computing.

Any ML, obviously, could ask the cloud, through its offered SaaS the main following questions:

- Which are the nearest 2LCs close to my current position?
- • Is there some classes corresponding to my planned courses and to my level?
- • Do those classes' schedules match with my free time?
- • Is there available place in these classes?

Results

The cloud solution is performed to ensure providing answers to above questions through a location based services application interface implemented on the ML mobile device and based on the following Software as a Services (SaaS):

- Centre locator SaaS: Following ML query, Centre Locater SaaS determines the Continuous k Nearest Neighbors (CkNNs) 2LCs thanks to Delaunay Triangulation based on road (DT_r) (Khayati and Akaichi, 2008) (see figure 1). DT_r provides a valid response for continuous research of the k-Nearest Neighbors (for example: seek for me the 3 closest 2LCs from my current position).

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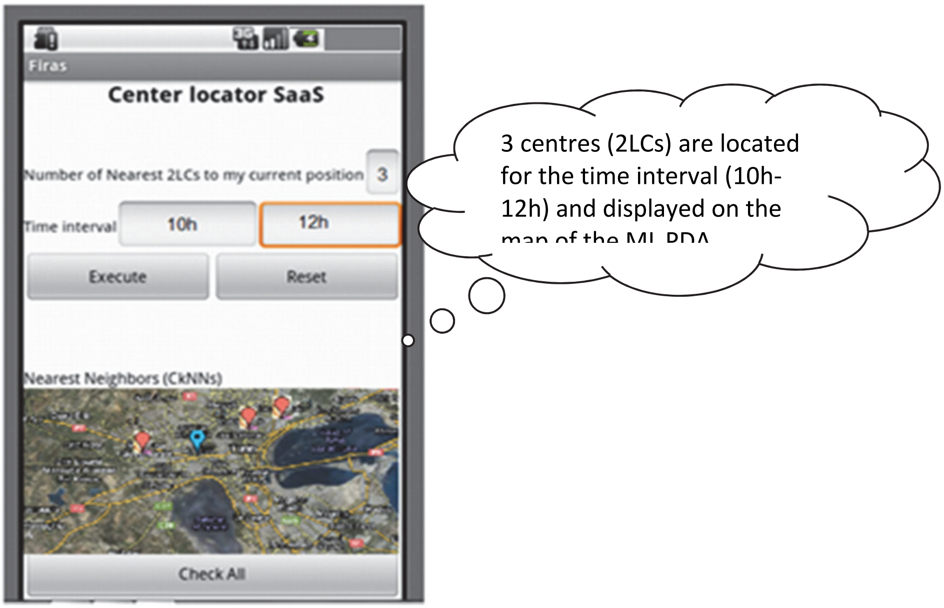

Figure 1. Locating 2LCs

- Classes and Level Matcher SaaS: More than determining the point of interests, the learner desires are to distinguish if these points enclose some classes corresponding to his/her planned courses and to his/her level. This is achieved through the Classes and Level Matcher SaaS able to match planned courses stored in ML mobile device database with located 2LCs databases. It takes into account ML level and course level provided by 2LCs (see figure 2).

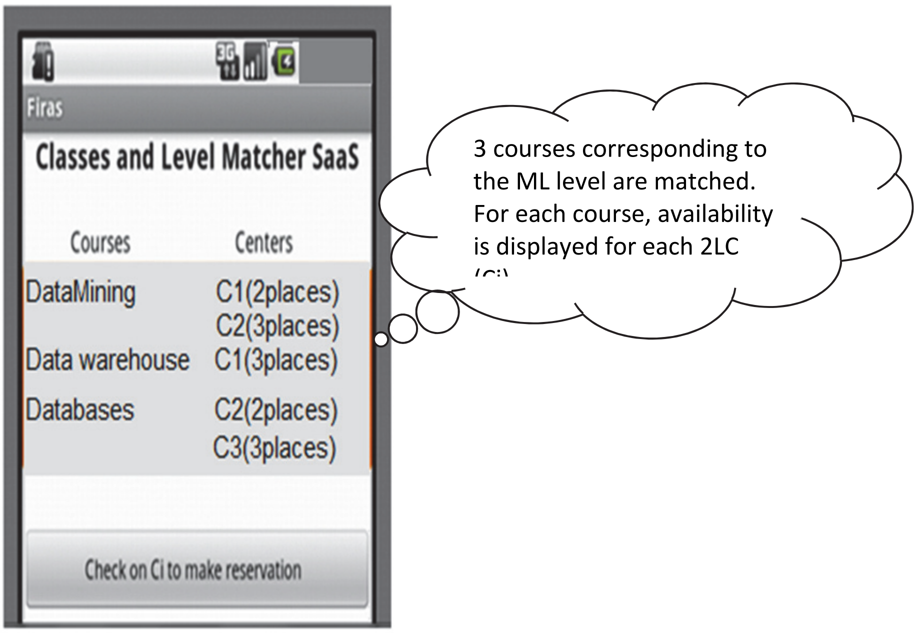

Figure 2. Matching with class and level

- Free Time Matcher SaaS: This SaaS matcher looks for whether the computed courses schedule corresponds to ML projected free time. This is achieved through a matching performed according to free time preferences stored in ML mobile device database with the 2LCs courses schedules.

- Availability Matcher SaaS: The SaaS determines whether there is an available place for ML in the selected 2LC (see figure 3). If it is a positive answer ML decides on its subscription into a class.

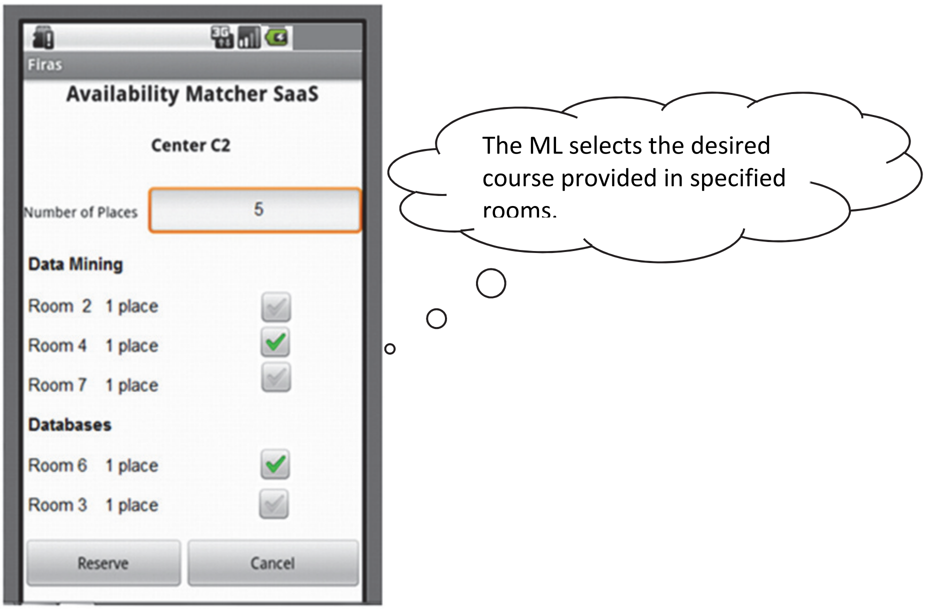

Figure 3. Determining availability and making reservation

- Learning Resources Manager SaaS: This SaaS aims to help MLs to perform other tasks related to the use of some virtual learning resources. MLs have only to provide minimal but sufficient information, to acquire responses to their requests.

Most of the SaaS presented above are interactive. Obviously, this interactivity has to be decreased due to the professionals' mobility related to their work nature. This can be ensured by defining alerts according to ML preferences such as those specifying free times, programmed locations at programmed times, etc (see figure 4). An Alert service, also implemented as a SaaS, may extract MLs preferences information to compute matching performed by one of the above SaaS in automatic way, and alert MLs in an adequate time. Those have only to visualize such messages and to decide, whether or not, they are tolerable to their needs. The Alert SaaS is described by the following algorithm.

Algorithm Alert (ML preferences);

Begin

For each ML **do**

Begin

Step 1: Determine the list of 2LCs l_1 according to ML position;

Step 2: Determine the sub list of 2LCs ($l_2 \subseteq l_1$) according to ML desired course and level.

Step 3: Determine the sub list of 2LCs ($l_3 \subseteq l_2$) according to ML availability.

Step 4: Determine the sub list of 2LCs ($l_4 \subseteq l_3$) according to 2LCs vacancies.

Step 5: If not empty l_4 send it to ML.

End;

End.

The first step is performed thanks to 2LCs Locator SaaS which determines the continuous k nearest neighbours to ML current position. It uses DT_r to filter a first list (l_1) of 2LCs eventually reachable by ML. The list l_1 is provided to Classes and Level Matcher SaaS which has to perform the second step. It consists on the matching of the planned courses stored in ML mobile device database with the located 2LCs databases by taking into account the level reached by the ML and the course level provided by the 2LCs. The result of this second filtering is a list l_2 of 2LCs providing courses belonging to ML curriculum. The list l_2 is an entry for the third step performed by Free Time Matcher SaaS which has to verify if the computed courses schedule corresponds to the ML proposed free time. This is achieved through a matching performed according to free time preferences stored in ML mobile device database with the 2LCs courses schedules table, and giving as a result a list of 2LCs (l_3). This latter serves as an entry to Availability Matcher SaaS to perform the forth step. It consists on determining if there is an available place for the ML in l_3. Availability Matcher agent looks for such availability into the 2LC database and informs the ML with l_4. Results can be visualized by ML on a map, resulting from a Map SaaS, in which we show elements of l_4.

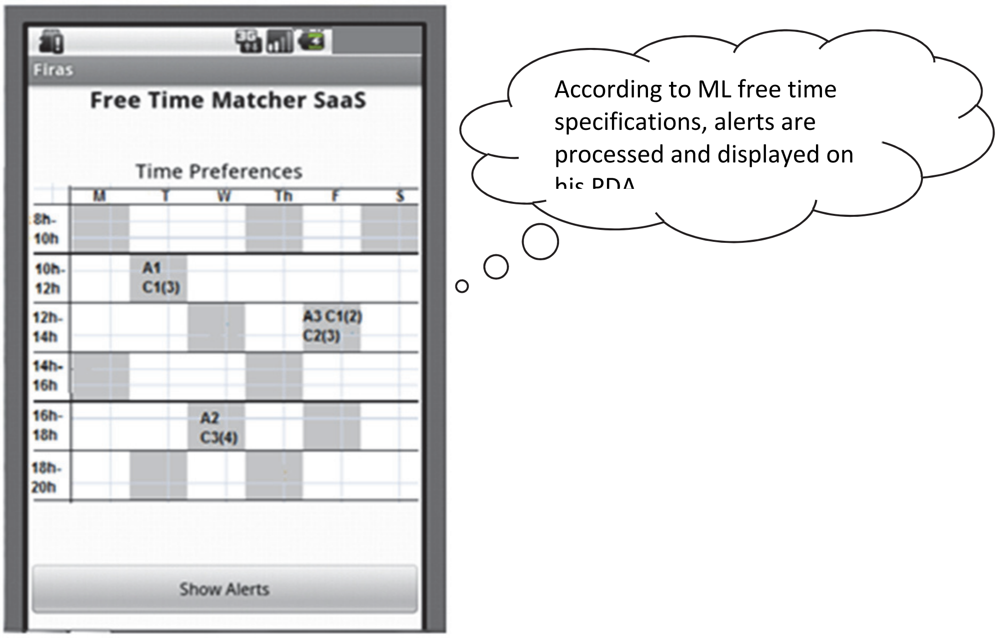

Figure 4. Managing alerts

Discussions

In our proposed system, a huge of data is manipulated. Obviously, the analysis of this data may help to enhance 2LCs activities and MLs success. This is performed by gathering and historizing data about 2LCs and MLs activities related to learning process into one repository called Cloud Data Warehouse (CDW).

A data warehouse is a subject-oriented, integrated, time-variant, and non-volatile collection of data in support of management's decision making process (Inmon, 1992). Our CDW is subject-oriented because it is organized around major subjects, such as ML, 2LC, and courses. It is integrated because it is constructed by integrating multiple heterogeneous sources, such as MLs and 2LCs databases and transaction records related to learning process. It is time-variant because data are stored to provide information from a historical perspective (e.g., the past 3-5 years). It is non-volatile because it is separated physically of data transformed from the application data found in the operational environment. Moreover, it includes spatial and temporal data about movements of mobile learners.

A data cube consents to model and viewed data in multiple dimensions. Those are the perspectives with respect to which we desire to maintain records. For example, we may create a Mobile Learner Activities (MLA) data warehouse in order to keep records of the 2LCs's assignments with respect to the dimensions time, ML, branch, and location. These dimensions allow the 2LCs centralized administration to keep track of things like monthly assignments of MLs, and the branches and locations at which the MLs were assigned. For example, a dimension table for ML may contain the attributes ML identifier and name, initial ML 2LC, etc. A multidimensional data model is typically organized around a central theme, like ML activities. This theme is represented by a fact table which includes numerical measures destined to analyze relationships between dimensions. Examples of facts for a MLA data warehouse include number of assignments, learning time spent, number of courses, etc. The fact table contains also keys to each of the related dimension tables.

Using the above information many types of analysis are conducted on both MLs and 2LCs activities leading to decisions that can be made on enhancing 2LCs infrastructures and MLs work assignments and/or success.

Analysis can be also conducted on alerts by including another fact table called Alerts which shares dimensions time, location, etc. with the other two fact tables ML and 2LCs Activities. Analysts may make trigger queries about rates of MLs subscription following sent alerts. This may lead to enhance MLs administered preferences by performing adjustments on them.

Conclusion

In this work, we proposed an assistance system, based on pervasive cloud solution, for lifelong mobile learners. It constitutes a way out for mobile professionals motivated to improve their skills through a lifelong learning process. The solution is performed by a subset of SaaSs ensuring learning centres localization, learning centres courses matching with mobile professional curriculum and level, learning centres courses schedules matching with mobile professional free time, and mobile professional subscription according to learning centres vacancies. All activities described above generate data which are integrated into a data warehouse and analyzed according decision makers' needs. Future works will focus on enhancing the proposed cloud computing solution by more SaaSs implementing various MLs and 2LCs needs according to educational domains taken into account.

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Modeling of Control in Educational Process by LMS

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Abstract

The final function of the learning management system (LMS) is routing the communication depending on the student´s knowledge and abilities and according to that changing the quantity and ambitiousness of the material offered to the student. Interaction between student and LMS in the process of teaching and learning is a composite process. The aim of the system for the teaching control is to regulate the communication according to the student´s knowledge and ability and thus modify the amount and sophistication of submitted materials for the student. In the concept of control theory, the transition from combinatorial procedure to sequential series and optimized processes is obvious. One of the assets of modelling the teaching processes by means of Petri nets is their formal description, which is complemented by a visual graphic representation. A precise and accurate specification of the process is thus allowed, which enables us to remove ambiguities, uncertainties and dubiousness and contradictions. For the description of teaching processes, such as browsing in the study material in e-lerning education, it is appropriate to use mathematic and graphic methods, where mainly serial machines are successfully used, which, however, have certain limitations. These issues could be solved more effectively using Petri nets for their precise and exact specification.

Keywords

Modeling process. Petri nets. Learning Management System (LMS). E-learning. Web-based education. E-course.

Introduction

Static structure of information on the web, the task of which is to provide information, has long been overcome. More and more web software systems originate which are more complex than ever before. From the point of view of the system´s application, there is a more and more frequent necessity to enrich the information space of heterogeneous sources, managed by the mentioned systems, with elements of adaptation to the user and/or the environment, in which the user operates. The aim is to present the user personalized information, if possible only those that are relevant for the user, and in such a way, which suits the given user most (Bieliková and Návrat, 2006).

With the rapid advance of the Internet, e-learning systems have become more and more popular (Gomez-Albarran, 2005), (Jun-Ming et al., 2006). An e-learning system provides the following functions: (1) delivery of learning content for students via the Internet; (2) record of learning progress and portfolio; (3) management of learning content, assessment and course; and so on (Scorm 4th Edition Version).

E-learning has become an increasingly popular learning approach in universities due to the rapid growth of web-based technologies. 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).

The Internet and related web technologies do offer great solutions for presenting, publishing and sharing learning content and information, as is the case in many other areas. Special software called Learning Management System (LMS) (Figure 1) is generally used in most institutions providing web-based learning (Cavus, 2008). Most universities combine a form of learning using one of a number of commercial or free LMS. They decided to use products such as Claroline, Fle3, ILIAS, MS Class Server, WebCT, Eden, Enterprise Knowledge Platform, LearningSpace, eAmos, eDoceo, Uniforms, uLern, Aspen, Oracle iLearnin, NETOPIL School and Moodle (Cápay and Tomanová, 2010)

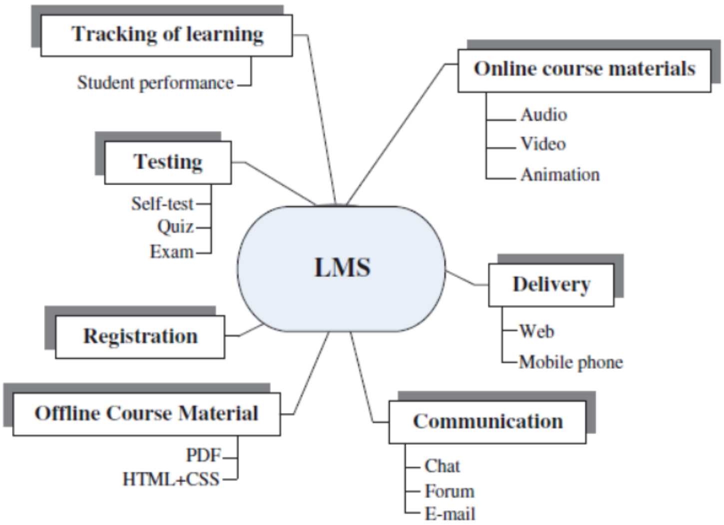

Figure 1: Structure of the Learning Management System (LMS) (Cavus, 2008).

Now that the Internet is recognized as the main platform for education, web-based applications are preferred when it comes to educational activities, channels for communications and systems to access knowledge. LMS are often viewed as the starting point of any web-based learning program (Cavus and Uzunboylu, 2007). Many pedagogues were introducing their models of electronic education in the early 20th century, but they had no sufficient tools to their effective implementation at that time (Skalka and Drlík, 2009). Nowadays electronic learning systems provide the possibility of saving all information about student's activities in one place. Teacher could monitor the student's activities after his login into system. Systems offer submission of the file, testing the control of the communication and cooperation too. LMSs facilitates teacher to keep his methodical portfolio dynamic and offer electronic students´ portfolio in every moment (Cápay and Tomanová, 2010). An LMS provides the platform for the web-based learning environment.

The aim of the system for the teaching control is to regulate the communication according to the student´s knowledge and ability and thus modify the amount and sophistication of submitted materials for the student. In the concept of control theory, the transition from combinatorial procedure to sequential series and optimized processes is obvious (the strategy of continuous assessment of the student instruction reflection, and based on that, adaptation of the following instruction, is comparable with the dual principle of identification and adaptive management). There is an advantageous use of Petri nets for description and consequential control of this kind of teaching form. (Klimeš and Balogh, 2012)

Possibilities of transition with e-course

We differentiate two main types of teaching programmes according to how binding the individual steps sequences are for the student. Those are linear and branch ones.

- Linear teaching programmes dictate a strict and binding sequence of steps for all students in a single line. Contents of education are studied in small amounts of information; however, the best is to study one of the information in each step only. The designed notion is practiced as to the need, until the student masters it. Adding one notion to another, the student gets acquainted with the whole theme and its issues. Opponents of linear programmes state that very small steps interrupt the trains of thought of the student in an undesirable way. As to the practical experience, linear programming is suitable for teaching basics and principles of the problem and also for the formation of the word-stock and new concepts. (Klimeš and Balogh, 2006).
- Branch teaching programmes are susceptible of varied procedures when solving problems. Alternatives of „branches“of the programme finally lead to the successful coping with the problem; however, each student takes the line, while its length corresponds to his personality, knowledge and gift. When teaching facts, a certain main line is visible in the programme, out of which various formed side lines evert and reintegrate. The main line usually allows for proceeding in wider and more demanding steps, which can be mastered only by a gifted student, answering adequately to the inserted control questions. Shorter and easier steps for less gifted individuals and slowly working students take place in secondary lines. There are examples for successful revise of a particular lecture, tasks and instructions referring the student e.g. to solve an experience, use graphic tools or sequence which completes the lecture so that the opinion or fact would be confirmed. Branch programmes are especially suitable for the provision and manipulation with new concepts. Their basic benefit is that they allow the student to choose, upon studying the study material, the individual line, which corresponds to his intellect and previous knowledge. (Klimeš and Balogh, 2006).

E-course modeling with Petri nets

When modelling the educational process, it is necessary to draw from interaction understanding, from mutual social interactions of participants of the educational process. A „general model of educational process“, was thus created which includes wider environs, input factors, the process itself and its products (immediate results and long-term effects) (Balogh and Turčáni, 2009).

The aim is to create a functional communication control model in LMS system by means of the created model in Petri nets. It is necessary to create a universal e-course model in LMS by which the pedagogue´s and student´s activity would represented in the course and in arbitrary subjects, e-courses would be created according to similar models. The model has been created so that it would reflect the pedagogue´s and the student´s requirements. It would be enough modular, intelligible and clear and would not be too complicated.

The 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. For the description of educational processes, such as passing through the study material in e-learning education, it is appropriate to use mathematic and graphic methods where mostly serial machines are profitably used. However, they have certain limitations. The issue can be solved by means of Petri nets, thanks to their precise and exact specification. (Balogh, Turčáni, and Burianová, 2010), (Magdin, Cápay and Mesarošová, 2011)

For the description of the communication of a man with a computer it is suitable to use graphic tools (Markl, 2003), allowing to adequately describe and express the interaction. The teaching interaction between a student and an information system managing the instruction is a complex process, for which Petri nets should be applied.

Edge superimposition is one of the problems with interpretation of the model in Petri nets but in many cases it is necessary. This problem can be solved by marking each of the edges by means of various colours. This colour dissimilarity helps the identification of various process flows and also to understand the functionality of the model. Then it is possible to divide the model into each sector and thus name their components what helps identify each component´s function, i.e. place appellation and transitions.

E-course model production with exam

There are markings (tokens) in two places in the initial model state: Pedagogue (P800) and Student (P0). Tokens symbolises the pedagogue´s and the student´s process while using LMS.

The place and transition numeration is specified. Places, where are the pedagogue´s positions, begin with the number 8 what is the pedagogue´s identification number. The second number identifies the sector (part of the model) where is a place. And there is the last number what is the pedagogue´s place type:

- 0 entrance place – conditions to open a new lesson
- 1 entrance place - conditions for lesson availableness
- 2 entrance place – conditions to peruse the task
- 3 entrance place – conditions for lesson availableness

Student gets into the first sector (introductory part) by registration into the course. This sector contains various information about the course e.g. subject information sheet, recommended literature, course requirement to successfully pass the course, links of web pages referring to the themes, etc. These choices are represented by places P101 to P106. After the token (student) perused the selected information, he gets to the place P109 (Figure 2) from where he will be able to advance to the first lesson, if the pedagogue allows it.

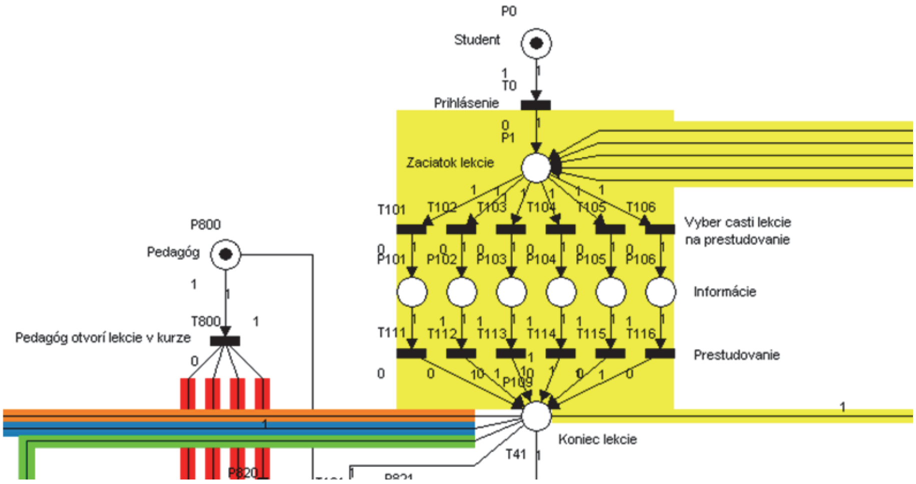

Figure 2: The incipient state of the model

The pedagogue´s task

On the created process model we can see that the information (articles, themes, textbook, and publications) is available for the student only if the pedagogue allows it. In this case the pedagogue is the administrator of the course; he creates and modifies the course, uploads, adds or removes links and materials for study, checks students´ activities, prepares, corrects, replies to tasks and many other functions that the system allows. The created model represents the student´s perspective; therefore, the model does not contain the pedagogue's activity options and the important elements concerned about the student have been left. The pedagogue´s task has thus simplified. He opens new lessons in the course, then assigns some tasks to it and finally, declassifies the exam so that the student would fulfil the requirements.

We can monitor the transition realization on Figure 3 where the first numbers interpret the previous sector on the transitions T121 and T122. The second number interprets the next sector and the third is a type of transition where 1 is the transition for opening a new lesson and 2 is a transition from the previous lesson to the next.

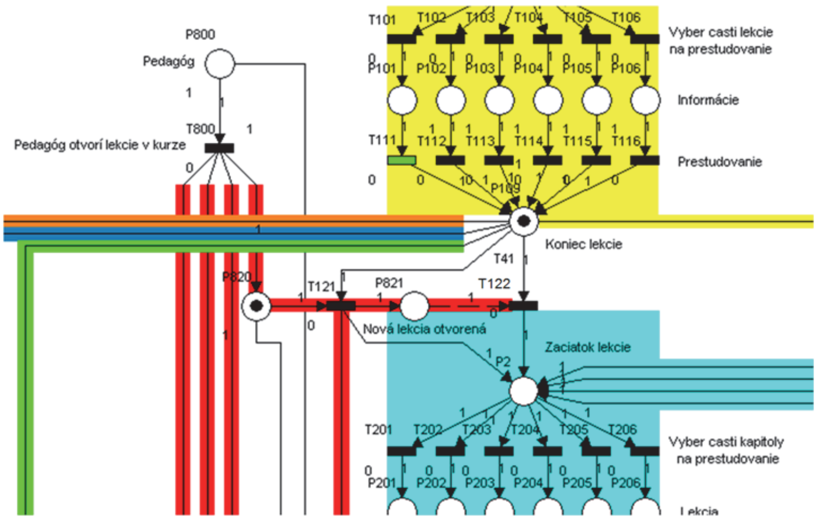

Figure 3: Before transition realization

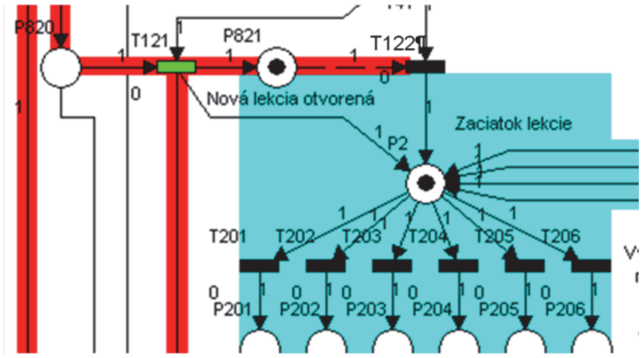

Figure 4: After transition realization

E-course lessons

Courses in LMS are divided into individual lessons according to the course of study of a particular subject. It contains study materials, interactive animation, pictures, tasks, autotests, tests, exercises, etc. Lessons can be divided according to various criterions e.g. theme, content, time, etc. And according to settings, students can set linear or ramified education. It is always the pedagogue who sets these parameters and who determines the style and the rate of the educational process. The number and the content of the lessons are not limited, i.e. PX01 –PX06, where X∈N N = {1, 2, 3...}. The number of lessons does not affect the function of the model.

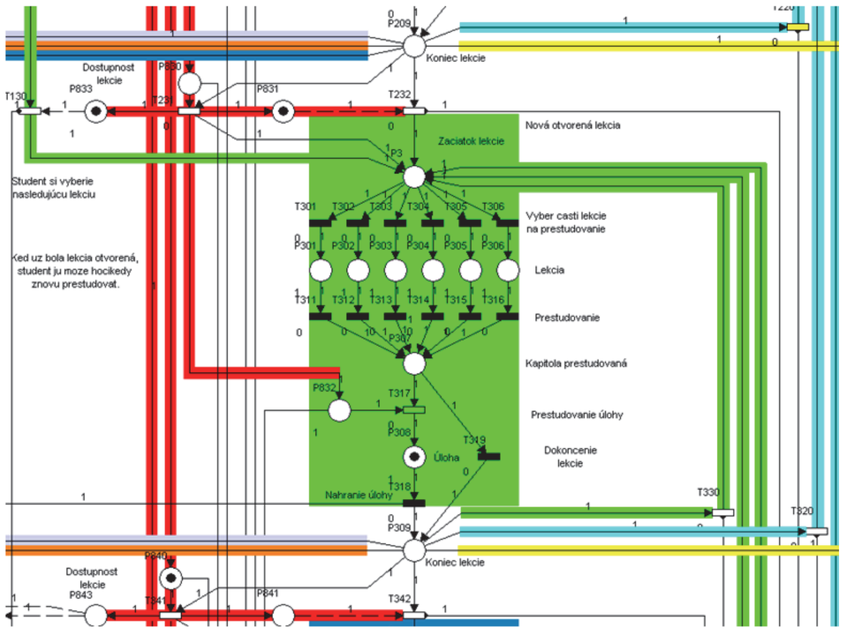

Figure 5: Student´s transition through the lesson

After the student passed the task or perused the lesson, he is able to return to the previous lessons which he had already passed successfully (Figure 6) or is able to shift to another new lesson. He can choose from the previous lessons to which he wants to return and chooses from the transitions T440, T430, T410, (TXX0). The marking logic of these transitions is:

- 1. number identifies the current sector (in this case 4)
- 2. number is the number of sector (lesson) where the student wants to get (3,2,1)
- 3. number (0), is a intersectional transition

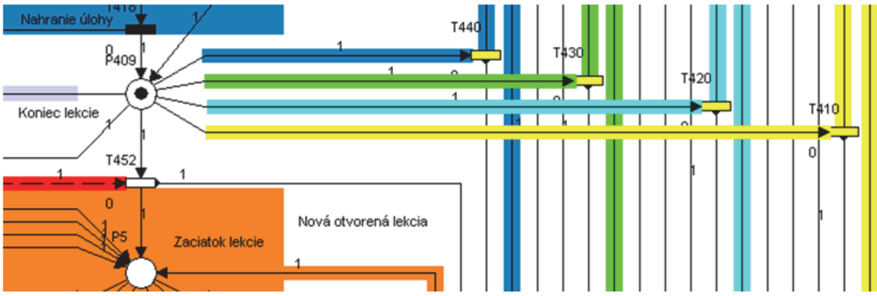

Figure 6: The choice of previous lessons

Inhibitive and test edges were used in the model, then also deterministically types of transitions, places with a given capacity and various IF-THEN rules. Procedural e-course model designed in LMS contains other important parts e.g. scoring, the student´s continuous assessment and the student´s exam results.

Discussion

The importance of advanced information and communication technologies, such to education has increased significantly during the past few years. In order for electronic learning systems making use of these technologies to be successful, effective and of a quality comparable to some of the traditional educational learning systems, the electronic learning systems must be designed and constructed with care, using a scientific approach embracing well designed procedures and techniques (Drlík and Skalka, 2011).

E-learning has become an increasingly popular learning approach in universities due to the rapid growth of web based technologies. E-learning implementation at traditional universities as well as creating of any kind of virtual universities is a long-lasting and complicated process. It is necessary to see the e-learning implementation as a continuous and iterative process. The points of the entry into this process will vary depending on the institutional context and personal skills of the teacher. It is becoming increasingly clear that there are many reservations, worries, objections and questions about e-learning from the pedagogical, professional, and sociological point of view that must be taken seriously (Barajas and Gannaway, 2000).

Conclusion

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. In the theory of management there is an obvious transition from combination procedures to sequence chains and optimized processes (the strategy of continuous assessment of the student instruction reflection, and based on that, adaptation of the following instruction, is comparable with the dual principle of identification and adaptive management). For the description of the communication of a man with a computer it is suitable to use graphic tools (Markl, 2003), allowing for suitably describing and expressing the interaction. The teaching interaction between a student and an information system managing the instruction is a complex process, for which Petri nets should be applied. Another attitude to the description of true and real teaching procedures is an application of fuzzy modelling (Novák, 2000). Most frequently, the personalization of e-learning courses is realized on the bases of extracted knowledge of usage data by means of the web log mining techniques (Munk, Kapusta and Švec, 2010), (Munk, Vrábelová and

Kapusta, 2011) (Munk, Kapusta and Švec, 2010); however, we focus on the personalization using Petri nets.

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Education of Primary and Secondary School Teachers in Informatics Supported by Digital Technologies

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Abstract

Informatics is a young subject taught at primary and secondary schools in Slovakia. Based on the new school reform, it has been taught compulsory since 2008. Lifelong education of the teachers of informatics subjects at primary and secondary schools is therefore a must. The teachers have to respond flexibly to the changes in the field of information and communication technologies and to use modern methods in the educational process. Learning to learn and ability to use modern information and communication technologies effectively are becoming the most important competences nowadays. The implementation of the school reform pointed out the lack of qualified teachers suitable to teach Informatics and Informatics Education. That was the reason why national project aimed at further education for primary and secondary school teachers in informatics financed from European structural funds was prepared. A strategic objective of the project was to design, prepare and realize modern further education supported by digital technologies. Direct education was broaden by e-learning support via LMS Moodle. Communication, assignment submission and/or testing were thus mostly conducted online. Some time after the successful completion of the project we conducted a questionnaire investigation the main purpose of which was to explore the opinions of the teachers participating in the project. The questionnaire was aimed not only at the area of acquired knowledge and abilities. We were particularly interested in the usefulness of the methods as well as study materials presented during the education – mainly whether the teachers use them in their teaching practice.

Keywords

Computer Science Education. Life Long Learning. National Project.

Introduction

The need to increase the qualification is closely connected with the term lifelong learning (Baran, 2011). LLL comprises all phases of learning, from pre-school to post-retirement, and covers the whole spectrum of formal, non-formal and informal learning. It means that learning as a process occurs at all times in all places. It should be a process of continuous learning directed towards not only providing the individual needs, but should also be relevant to the community (Laal, 2011).

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Several key competences were formulated to enable the creation of the system that would reflect the needs of modern society. Ability to use modern information and communication technology (ICT) effectively is one of them. However, it is not only the students who should be able to work with ICT. If the teachers want to teach new things, they first need to know them and be able to use them in real life as well as for educational purposes (Mesárošová and Cápay, 2011).

In comparison with the teachers of other subjects, the lifelong education of informatics teachers is remarkably different mainly due to the quickly developing requirements on their subject. The teachers of informatics subjects prepare their students for reality that will be noticeably different in the time when they finish their studies. Teachers must give students the opportunity to learn how to learn and help them to succeed in the process. Informatics is a young subject taught at primary and secondary schools in Slovakia. In 2008 a new school reform was introduced into practice. It included also informatics teaching strengthening into primary and secondary education and in this way, it replies to a process of society informatization and digital technologies dissemination into all parts of life. (Lovászová, 2011).

Many of informatics teachers do not have formal university education in the field “Informatics Teaching”. The problem of the lack of qualified teachers can be systematically resolved by a formally accredited study. For these reasons national project of further education for primary and secondary school teachers in informatics financed from European structural funds was prepared and executed in 2008 - 2011. After the end of the project, we conducted an investigation on the satisfaction with the project – the results of the investigation are described in the last chapter of the paper.

Possibilities of the development of ICT abilities and knowledge of primary and secondary school teachers

The term lifelong learning (LLL) can be seen as general as well as vocational education and preparation within the student’s life (Meerah, 2011; European Commission Directorate – General for Education and Culture, 2002), while the result is the development of abilities, knowledge and competences from the personal or professional point of view. (Murdoch-Eaton, 2012). Fostering LLL is a topic of high relevance for current educational policy. School lays the cornerstone for the key components of LLL, specifically persistent motivation to learn and self-regulated learning behaviour. LLL is a central socio-political concern and has been a focus of European educational policies since 2000 (Lüftenegger et al., 2012). Nowadays, due to the decision of European Parliament in the field of LLL development the programme named “Lifelong Learning Programme” is being executed. Its aim for the period of 2007-2013 is to develop particular existing educational systems and systems of professional preparation within the European Union, so that they will become the world quality standard.

Continuous education

Today’s world is characterized by continuous education (Volodina, 2011). Continuous education is closely connected to lifelong education. Its name implies the education that is continuing, ongoing, therefore postgradual. It represents the education assigned to the teachers who work as pedagogues at schools. Therefore it is focused on modernisation and innovation of everyday educational process in primary, secondary or tertiary schools environment. An example of continuous education within lifelong education aimed at development of knowledge and abilities in the area of implementation and active usage of ICT in education was project DVUI (Ďalšie vzdelávanie učiteľov základných škôl a stredných škôl v predmete informatika – Further education of the teachers of primary and secondary schools in the subject of Informatics) realised in 2008-2011. The project began as a respond to direct assignment and operational program learning announcement (no. OPV/K/RKZ/NP/2008-2) of the Ministry of Education SR.

Similar projects have been executed since 2007 throughout the whole European Union. For instance, in Czech Republic the Operational Programme Education for Competitiveness was established in 2007, being a part of long-term thematic operational programmes category. It is aimed mainly at enhancement and modernisation of the systems of initial, tertiary and further education, their interconnection into complex system of lifelong education and at improvement of the conditions in research and development. The list of all operational programmes, that were accepted by European Commission at the beginning of the programme period (namely 2007-2013), is available at the http://ec.europa.eu/regional_policy/country/prordn/index_sk.cfm website. Particular programmes are aimed at the area of regional politics, but they enable cooperation and development among the member countries of the European Union as well.

Qualified informatics teachers at primary and secondary schools

Informatics is a young subject taught at primary and secondary schools in Slovakia. In 2008 a new school reform was introduced into practice. Based on objectives of school reform, content of informatics subjects in primary and secondary education is divided into five themes:

1. Information around us,
2. Communication by means of ICT,
3. Procedures, problem solving, algorithmic thinking,
4. Principles of ICT functioning,
5. Information society.

As we have already mentioned above, there is a lack of qualified teachers of informatics subjects, while they do not have formal university education in the field “Informatics Teaching”. For these reasons, the national project “Further education for primary and secondary school teachers in Informatics” financed from European structural funds was prepared. An investigator of the project was National Institute for Education. The execution of the project started in October 2008. A strategic objective of the project was to design, prepare and realize modern further education for informatics teachers at primary and secondary schools supported by digital technologies. The project was realised during 36 months. Its specific objectives were (DVUI, 2009):

- to prepare and realize accredited study programs for three target groups of informatics teachers in primary and secondary education,
- to equip education participants with digital technologies needed for their effective education which they can consequently use in a teaching process.

The education was conducted at five Slovak universities which prepare future informatics teachers: Comenius University in Bratislava, Pavol Jozef Šafárik University in Košice, Constantine the Philosopher University in Nitra, Matej Bel University in Banská Bystrica and University of Žilina. In cooperation of these universities, under the supervision of the main expert supervisor of the project prof. Ivan Kalaš from Comenius University in Bratislava, a concept of three study programs for three target groups of teachers was created (DVUI, 2009):

- the first target group (1TG): specialized study for teachers in primary education,

- the second target group (2TG): qualification study for teachers in lower and higher secondary education without qualification for informatics teaching,
- the third target group (3TG): specialized study for qualified informatics teachers in lower and higher secondary education.

Purpose of all three study programs was to provide the participants with modern, actual and attractive education which pursues four content lines (Lovászová, 2011; DVUI, 2009):

- digital literacy of a teacher – the objective of education in this line was to obtain and develop knowledge and skills for productive, creative and safe use of digital technologies in ensuring professional and personal needs of a teacher,
- modern school - the objective of education in this line is to get participants familiar with modern cognitive theories and with new views on school as a space for reflection, research, communication and cooperative learning, with new forms of cognitive process organization, modern forms for pupils' motivation and evaluation, alternative educational systems, and to present a vision of a modern school that uses digital technologies for the key competences development of pupils,
- informatics – is a core of a training for education participants. This line content was thematically and professionally drawn up to be suitable for each target group needs,
- didactics of informatics – the objective of education in this line is to get participants familiar with objectives, content and methodology of informatics teaching.

Each of these lines in all three study programs consisted of modules as the basic study units (study unit represents 6 or 8 lessons depending on target group).

Proper education was preceded by preparation of study programs, study materials, e-learning education environment and by training of lecturers.

The professionals from five universities and the teachers from practice took part in this preparation. The result of their cooperation is a series of about 100 textbooks and some original teaching software. Printed study materials for participants of education were created too and were supported also by e-learning courses which contain materials and software necessary for studying and enable participants to communicate electronically with lecturers and also the other participants.

The teachers in all target groups elaborated their final paperworks under supervision of the experienced lecturers. They finished up the education by its presentation and discussion about the subject of study. Their final paperworks were mostly focused on preparing original methodology materials for teachers and learning materials for pupils or creating of didactic software applications and e-learning courses.

A strategic objective of the project was to provide education for 1500 informatics teachers from all parts of Slovakia. The education was conducted by five universities from June 2009 to June 2011. The specialization study within the project was finished up by 350 teachers in primary education (the 1st target group) and 300 qualified teachers in secondary education (the 3rd target group) in June 2010. The same number of teachers completed further education in the second year of the project duration. New qualification for informatics teaching was obtained by 200 teachers in a two-year qualification study (the 2nd target group) (Lovászová, 2011).

At Constantine the Philosopher University in Nitra education was provided by Department of Computer Science for teachers from Nitra and Trnava regions and was finished up by 160 teachers in the 1st target group, 42 teachers in the 2nd target group and 120 teachers in the 3rd target group. Teaching was provided by 17 lecturers.

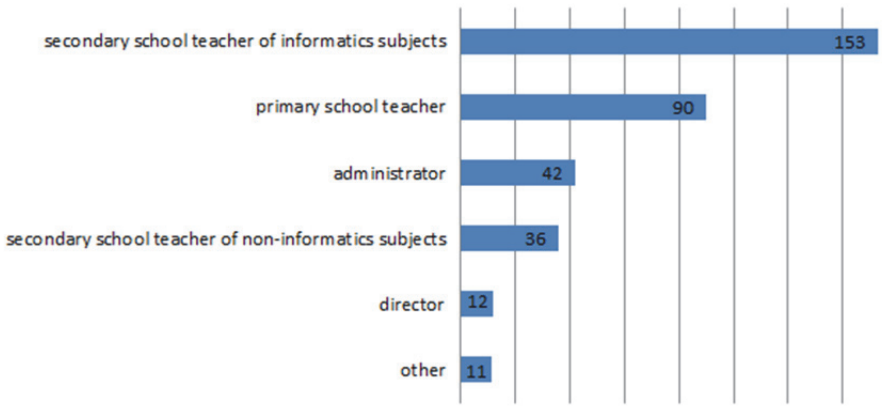
The investigation of the satisfaction with the DVUI education

The investigation was conducted some time after the end of the project (1.5 a year after the first run, 0.5 year for the second) among teachers from Nitra and Trnava regions. The teachers therefore had enough time to evaluate the relevance of the project from the point of view of their pedagogical practice. The objective of the investigation was to find out how the pedagogists evaluated our methods of teaching within DVUI project and to point out the problem items in the assessment of the teaching methods. Moreover, we wished to find out whether the teachers of Informatics and Informatics Education use acquired knowledge and abilities, as well as study materials in their own teaching. The questionnaire was also designed to show the existence of greater differences in evaluation of quality and educational method of individual participants of DVUI education, and whether the participants actively implement the knowledge and skills acquired during the education in their current work in educational institutions. We were thus interested mostly in the area of implementation and use of ICT, whether on primary or secondary schools, or active use of acquired innovative approaches and methods in education.

The investigation was conducted by means of electronic questionnaire in the course of January and February 2012. We mostly used closed type of questions with five-point scale of agreement or disagreement. The respondents were able to give their opinion in open questions.

General data of the respondents

211 participants took part in the evaluation altogether, 48 male and 163 female. 66% of the respondents were from primary schools and 14% from eight-year gymnaziums. The rest of the respondents were from business academies or specialised schools. Only 14 teachers completed continual education based on their employer's instruction. The rest stated that their participating was based on their own initiative. Most of the respondents, on top of teaching informatics subjects, also teach other subjects or are in charge of computer administration (Figure 1). 12 respondents stated they are head masters of educational institution. All of the respondents consider their relationship towards long-term education very good or good.



Source: own research

Figure 1: Work position of respondents.

We get interesting results when we compare the length of teaching practice and the length of teaching of informatics subjects practice. As many as 36% of the respondents have teaching practice longer than twenty years (Table 1). Some of the respondents were university graduates at the time of the project execution. Almost 60% of the respondents, however, have teaching of informatics subject practice shorter than 5 years (Table 1).

Table 1: Frequencies of respondents' teaching practice

Teaching practice		Teaching of informatics subjects practice	
interval (years)	frequencies	interval (years)	frequencies
1 - 5	8	1 – 5	122
6 - 10	32	6 – 10	41
11 - 15	54	11 - 15	29
16 - 20	41	16 - 20	10
21 - 25	33	21 - 25	7
26 - 30	30	26 - 30	2
31 - 35	11		
36 - 40	2		

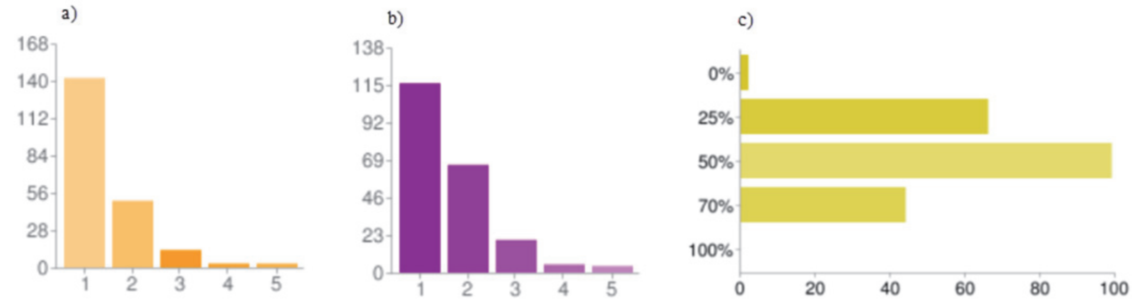
Source: own research

Ergo, the teachers with long-time pedagogical practice started to teach another subject. We can only conclude that before the execution of the project, these were the teachers who did not complete formal preparation; however, the educational reform did not speak about teachers' qualification. The reform was primarily aimed at the content of education. The numbers only confirm the fact that informatics is truly a new subject. We were also surprised by the fact that among the respondents there were teachers who have been teaching informatics for more than 20 years, when the people did not even consider this kind of global impact of modern technologies.

Results

The questionnaire method allowed the respondents to express their agreement or disagreement with a particular statement (1 – I completely agree, 5 – I completely disagree). The results are presented in groups of graphs logically related to each other.

The answers show that during the continuous education, most of the teachers acquired information suitable for their current needs (Figure 2a). Many of the project participants were creators of a school educational program, directors of subject committees, administrators of school websites, school's webmasters or administrators of technicalities. This is the reason for them to find the content of some of the modules familiar. There was no teacher who would find all of the presented information completely new (Figure 2c). Despite this fact, most of the teachers had the opportunity to be inspired by the demonstrations in practical exercises and discussions (Figure 2b), which they could consequently utilize in further teaching practice. According to 72% of the respondents, the education was sufficiently interactive, which means they had the chance to try the work with individual environments in practice, participate in discussions etc.

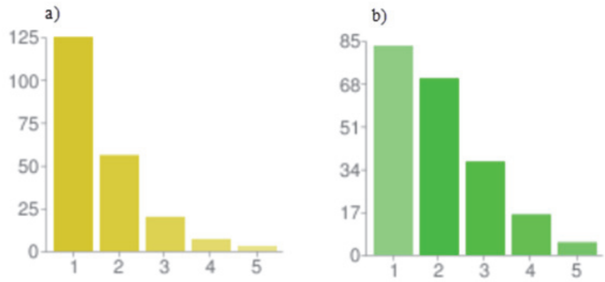


Source: own research

a) Information I acquired during the education are suitable for my current needs.
b) Practical parts and discussions conducted by the lecturers provided me with sufficient amount of demonstrations and inspirations utilizable in my further teaching practice.
c) What percentage of the education's content was completely new information to you?

Figure 2: Frequencies of respodets' scaled answer.

After some time, it is appropriate to think also about the benefit of the provided materials and technology, acquired by each of the participants, to the teachers. The acquisition of digital technology (laptop and data projector) for the purposes of enhancing the educational process was considered very important. The technology stays at schools, letting the school save their own financial resources, while the teacher gets a new universal teaching aid. 87 specialized publications were developed as a part of the project (18 - 1TG, 47 – 2TG, 22 – 3TG); they were specially developed for each of the modules, taking account of the needs of the particular target group. These materials, together with additional materials in the framework of e-learning support, were the basis for the education. It is therefore interesting that not all of the participants used the materials during the education (Figure 3a). After finishing the project, the utilization of the materials deteriorated even more (Figure 3b).



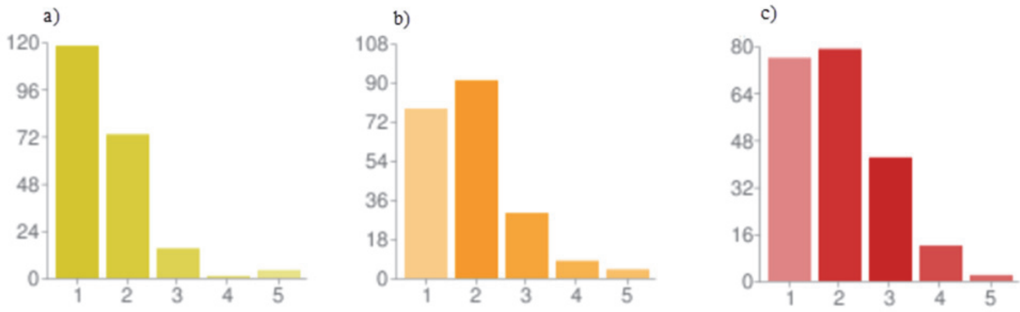
Source: own research

a) During the education, I used the provided study materials.
b) I use the provided study materials also in the present time.

Figure 3: Frequencies of respondents' scaled answer.

The method of the education was adapted to current situations, modules and also target groups. In some situations, the groups were joint (a discussion was conducted), in others, activation methods were used or, in addition to the main lecturer, assistant lecturers were available. This was the reason for 74% of the respondents to state they had a chance to exchange experiences with lecturers and also other participants during the education.

The lectures and exercises in the framework of the education enabled the respondents to acquire or broaden their skills, or to develop their intellectual and cognitive skills while using and implementing ICT to the educational process (Figure 4a). Getting familiar with individual environments and ways of work during customization of media elements (pictures, animations, video, sound) was not perceived sufficiently (Figure 4b). Didactics of programming had the worst results in the evaluation (Figure 4c).



Source: own research

Figure 4: Frequencies of respondets' scaled answer. Description in the paragraph above.

Modules were divided into four areas (described above). Their structure was not considered definitely good by the participants (only 46% of the respondents). Our ambition was to preserve the logical progression of education, from the general knowledge to the specific, which, from the point of view of the respondents, could have led to inappropriate timing of module in the education. Problem solving and programming was, together with Digital literacy, considered to be the most valuable topic (33 %).

Conclusion

The National project of further education for primary and secondary school teachers of informatics can be considered a successful pilot project. Within the project, a unique set of study materials was created, and is a high quality study literature for practising informatics teachers as well as for future informatics teachers (Lovászová, 2011). In case of future conducting of such a project, 70% of the investigation's respondents would surely like to participate again. Participation in the project was a contribution not only for the participants, but also for their lecturers, who had the opportunity to confront their teaching methods and materials with other lecturers and the teachers, and cooperate with their colleagues during preparation of education modules and study materials**.**

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Utilization of Web Portals at Selected Universities: Comparative Study

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Abstract

The research team of Faculty of Informatics and Management, University Hradec Králové has been involved in the issue of utilization of web sources in tertiary education environment. The paper brings an extract from an extensive long-term investigation on utilization of web portals in university environment. In here presented findings come from the latest phase, from surveys which were conducted in five European universities with students with comparable field of studies and with comparable level of computer literacy. The survey explored students´ acceptance and breadth of web offer utilization in a wide sense of the its meaning; covering various kinds of web portals from standard generally utilized search engines to specific professionally designed portals, e.g. educational portals or collaboratively developed social software application Wikipedia. The aim is to find out how much time university students with similar specialization spend in selected Internet portals aside from professional or nonprofessional reasons and compare and discuss the gained findings.

Keywords

Communications Applications. Internet. Portal.

Introduction

The Internet as a general phenomenon influencing our professional and non-professional lives with its endless width of applications which are in perpetual process of change have attracted attention of their common users as well as researches trying to explore the Internet potential from various points of views, to determine its strengths and pitfalls, to show its beneficial contribution and possible limitations. (Šimonová, 2010)

Searching for information, watching news, ways of communication in virtual communities, boom of social nets, professional and interest forums, marketing on the Internet, Internet banking, shopping and last not least studying on the Internet is a common matter nowadays. Studying on the Internet can be more or less some kind of directed systematic learning in specific learning management systems, or it can be just natural free learning, all that fully corresponds to a natural human need to learn and explore new areas and so consequently calls for an elaborate research.

In this contribution is primarily explored students´ acceptance and breadth of web offer utilization in a wide sense of the its meaning; covering various kinds of web portals from standard generally utilized search engines to specific professionally designed portals, e.g. educational portals or collaboratively developed social software application Wikipedia.

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Methodological frame

The methodological frame except giving definition to the key word of the study covers the following sections: background of the study, explanation of the study topic, stating the aims of the comparison study and description of its survey sample and a research tool.

Key word definition

There is a wide offer of definitions of the key word "Portals" due to the fact that each of them, as a rule, reflects specialization of their author and supporting the area of study, see more (Isaacs, 1999), (Jafari, 2003), (Li Xiao, 2005), (Plachý, 2007), (Munk, 2010) or (Malcolm, 2011).

But the core of the definition stays the same; portal as a gateway to other links and services or an introductory page for a specific area or topic:

- "An Internet site offering a directory of links to other sites (the free dictionary online)"
- Portals are designed to be gateways to the Internet. They may have a link to a search engine, a subject directory, and provide other services such as news, weather, entertainment information, stock market information, shopping, and other services. Many portal sites provide an option to customize the site according to the user's personal interest. Portals are sponsored by the major search engine and browser providers, and may include alliances with other major players on the Internet. (http://www.sldirectory.com/searchf/portals.html)
- 'In simple terms, a portal is a web "supersite" with a collection of links to popular web services on the Internet, a kind of "doorway into the Internet. The site provides a variety of services including directories, online shopping, discussion groups, Web searching, channels (small windows within a page that are dynamically updated and determined by the user) and links to other sites.' (University Utah, 2008).

When it comes to portal categories, the situation is similar. There is no universal portal categorization Collins (Collins, 2003), Malcolm (Malcolm, 2011), etc. except for the original, let´s say traditional division that has not changed up to now: the Horizontal and Vertical portals or General portals like Yahoo and Specialized, eg. CNN.

Study Background

The initial stage of an extensive long-term investigation on utilization of web sources in tertiary education environment started four years ago when the first survey on time spent in assorted kinds of portals from Search portals, via General, News, Educational, Language and Other portals in sense of both professional and leisure interest was run at the Faculty of Informatics and Management, University of Hradec Králové. At the initial stage of the research there were over two hundred portals analysed. On the basic of pilot findings a set of selected portals was created. The key criterion was width of utilization in population of web services users. Together with portal visits the width and frequency of utilized services was examined. At that time the case study was based on comparison of findings gained from accessible sample consisting of teachers and students of FIM (Faculty of Informatics and Management). Various kinds of portals were selected; respondents were to answer which of these portals they visited and how much time they spent in them. The other followed issue was width and frequency of used web applications. The aim of the study was to find out what time burden utilization of web portals and their services represent, see more (Černá, 2008), (Černá, 2009).

Study topic, goals and sub-goals of the study

In this study the sample of participants is made of university students from five European countries with similar field of studies and with comparable level of computer literacy. Likewise in the previous survey the core of the investigation lies in portal visits.

The aim is to find out how much time university students with similar specialization spend in selected Internet portals aside from professional or nonprofessional reasons and compare and discuss the gained findings.

Special focus is devoted to Educational and Language portals with the aim to map situation in utilization of virtual environment in education and learn about websites facilitating their language studies. Last explored portal is a collaboratively developed social software application Wikipedia which is considered to be a current phenomenon of shared wisdom; favorite with students and generally cursed by academics Jaschic (Jaschic, 2007).

The selection of researched portals resulted in two sets of surveyed portals: a basic set and its shortlist. The main research tool enabling gathering data in this study is a questionnaire which contains the whole original set of portals encompassing Search Portals (comprising subsections Google, Yahoo and open section Other Portals - search engines), General Portals, News Portals, Educational Portals, Language Portals, Wikipedia and another open section Other Portals where we expected that specialization or hobbies of respondents might have got reflected to a certain extent. (Černá, 2008)

A shortlist of selected portals was done to highlight educational aspect of virtual environment: Google, Educational portals, Language Portals and Wikipedia.

Research instrument

A non-standardized questionnaire, ´Web Portals and their Services` serving as a research tool was created. This questionnaire was verified in a pre research. Questionnaire reliability ranged from 0.61 to 0.72. The questionnaire contains scaled items and open questions.

On the basis of the interviews which had preceded the final version of the questionnaire a few modifications had to be made. Especially professional terminology had caused misunderstanding within respondents. They found it difficult to choose the proper answer when they did not understand clearly the meaning of expressions like `horizontal or vertical portals´ they needed and asked for further explanation so that they could complete the questionnaire. Simplified portal categorization with typical examples of particular portals was set together with defined time periods. For example, Google and Yahoo represented Search Portals, people who use also some other search portal were given option to mention it in the part - Other search portals.

When the printed questionnaire was distributed to students by the researcher the respondents were informed that participation in this study was anonymous and that no personal identity information was collected in the survey. It took about 10 to 15 minutes to complete the survey.

The researcher collected all the questionnaires so the return rate was 100%. Then at foreign universities a short presentation was given of findings gained from the survey with our students which served as the door to further conducted discussion with respondents on other software applications like Facebook, experience with on-line dictionaries, preferred ways of on-line communication, playing games, pros and contras of studying in virtual environment, etc.

Research sample

Research sample consisted of 195 respondents; 92 men and 103 women. All respondents were university students (Czech, Spanish, Greek, Latvian and French) belonging to the age category 20-25 years old.(see Figure 1)

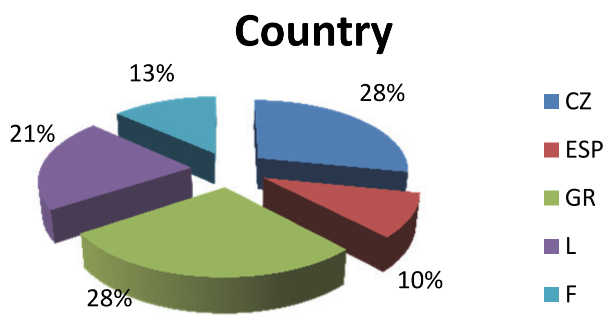

Figure 1: Research sample

Figure 1 illustrates the ratio of respondents from particular countries. Data from foreign universities were collected during Erasmus Teacher Mobility Programmes when lectures on “Internet study resources” were given by the researches. Students involved into the research were from the following universities: The Technological Institute of Pireus (36 respondents), Technological Educational Institute of Larissa and Faculty (18 students) Riga International School of Economics and Business Administration (41 studens), the Universidad Politécnica de Madrid (19 students), Université d'Orléans, Faculte des Sciences (26 students) and Czech Republic was represented by 54 students from the Faculty of Informatics, University of Hradec Králové. The gross proportion of men and women M/F participating in this project were following: Greek 1:2, Latvian 1:1, Spanish 3:1, French –only women, Czech 3:2. In the previous research on portals visit we followed a genre issue as well, the survey showed that factors like: age, work position or sex hadn’t played any influencing role in case of explored accessible sample consisting of students and teachers from the Faculty of Informatics and management, University of Hradec Králové, see more (Černá, 2008). The gender issue is mentioned marginally, it doesn´t belong to main concerns of this paper.

Research analysis and findings

Return rate of questionnaires was 100% due to the fact that the researchers distributed and collected them personally. Data were initially inserted into the spread-sheets and then graphs on frequency of portal visits were made. Graphs illustrating the individual findings are supplemented by commentary. These graphs show the answer to the stated primary question on time burden on the amount of time which students commonly spent weekly in selected portals regardless of reasons; whether they visit the websites intentionally on study or business purposes or just, for example, because of pure interest or boredom. Time spent weekly in particular portals is divided into five time categories: 5-30 minutes, Up to one hour, 1 - 5 hours, More than 5 hours, Never. During data processing one more category had to be added – 'No answer', because respondents sometimes omitted to mark an answer, when they didn´t select any of the proposed options. We might have assumed that not marking any of the categories corresponded to the category “Never” but we did not want the data to get biased.

Search portals

The first explored portal category were Search portals as most established robust portals of everyday use with sophisticated search engines. 'Google' was chosen as the most frequently used search engine at present and 'Yahoo' as its natural competitor, the third followed variable was an open category 'Other portals'.

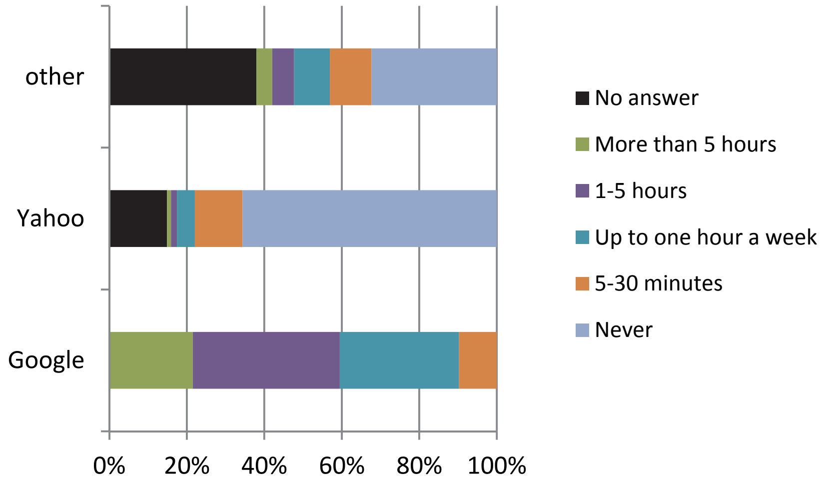

Figure 2 : Search portals – general view

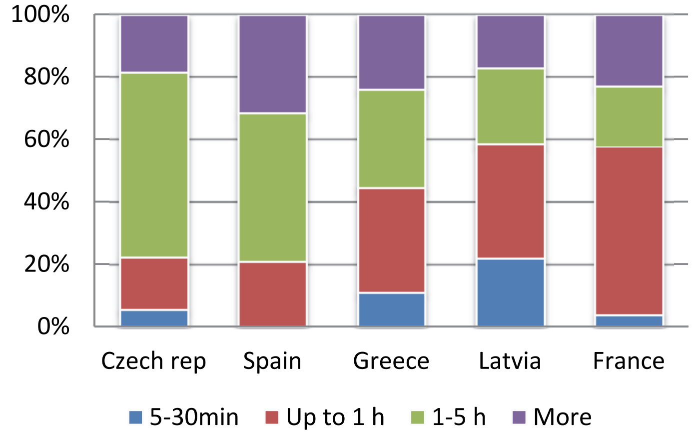

Figure 3 : Time spent in Google

The first graph on Search portals Figure 2 gives findings from the whole sample, regardless of respondents´ university.

It is evident that 'Google' plays the main role as the most significant search engine, for plenty of respondents it serves as a home page, all respondents use it irrespectively of which country they come from; nobody omitted to answer the question and nobody marked time category Never.

On the other hand Yahoo 'dominates the bar 'Never'.

Following graphs illustrate the situation in detail, with particular universities.

The graph Figure 3 shows utilization of Google at individual universities. Nearly 60% of Czech respondents spend in this server stunning 1-5 hours weekly and 18% even more.

More than half of French students use this portal about one hour weekly. But there is a quite high frequency of Yahoo visits as will be shown later on. Moreover every fifth student browses Google more than five hours weekly.

Half of Spanish students use Google 1-5 hours weekly and astonishing one third even more. As for Latvian and Greek students the results achieve aligned values.

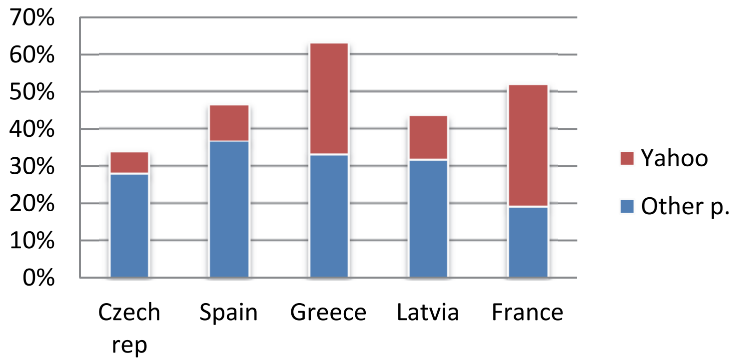

Figure 4 : Utilization of Yahoo and Other general search portals except Google

Only 20% of respondents use Yahoo and 30% use Other search portals as can be seen in Figure 1 and 4. Students from Greece and France use it most frequently, on the other hand there were surprisingly only three Czech students visiting these websites weekly moreover all of them marked the shortest time category.

French students use Yahoo when they get prepared for French classes but when they get prepared for English classes they use Google so a clear influence of national culture and study focus can be identified in this case.

Utilization of Other portals by representatives from individual universities is quite balanced.

Educational portals

Among Educational portals were also included learning management systems like WebCT or Moodle or other similar systems. In some cases these portals can be represented by specific virtual university environment. Educational portals which were included into the research were portals known to respondents. Findings show the irrefutable potential of Educational portals and their plausibility by students. WebCT is used only by students from the Czech university; Moodle was mentioned by several students from France and Spain.

Findings relating to educational portals call for further elaboration; in the next stage of the research on Utilization of web sources it will be worth analyzing motivation and the reasons of high frequency of educational portal visits, whether students attend them on the basis of teacher´s instructions, whether it is their standard way of systematic studying or kind of additional studies and to what extent they fit their learning styles. (Šimonová, 2011)

Overall, the frequency of educational portals visit is high, see Figure 5. Only 14% of students from the whole sample don´t use them so the number of students who do not visit Educational portal websites is negligible. All Spanish regularly use them.

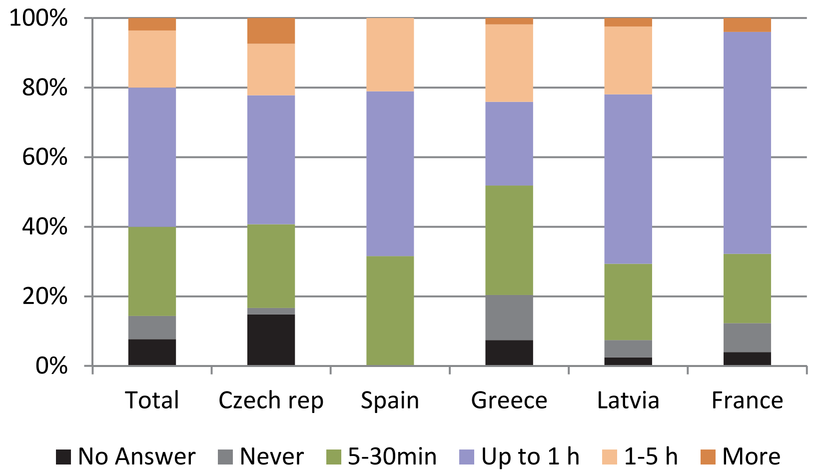

Figure 5: Educational portals

Numbers in various time ranges vary. As for Czech students the frequency of occurrence in particular time categories completely corresponds to the total view - to the average values of the whole sample:

- There is a high rate of short visits; one quarter of Czech, 30% of Greek and Spanish students, and about 20% of Latvian and French students devote to educational portals 5-30 minutes weekly.
- Every fifth Spanish, Greek and Latvian student spends there two to five hours.
- Except Greece, the most often ticked category is 'Up to one hour' weekly. It seems that requirements on students from the selected universities are either very similar or students are willing to devote similarly long time to study preparations.

Language portals

Language Portals might be taken as a subcategory of Educational portals. There is wide range of language portals, for example EGO4U, BBC Learning English, OneStopEnglish. They were given extra space in the questionnaire because of the language aspect, as we wanted to find out more not only on time span of portal visits but also on utilized language websites covering on-line dictionaries, as well.

As for Educational portals it is quite positive that frequency of their visit is so high, only 14% of students do not use them but when it comes to Language portals the situation is surprisingly much worse 43% do not use them to support or develop their language studies. 40% Czech and 37% Spanish 60% Greek, 32% Latvian and 47% French students directly wrote that they do not visit language portals or completely ignored answering this question showing this way no interest in this topic.

If there are portal visits they predominantly belong to short time categories, e.g 'Up to 30 minutes' category was marked by one quarter of Czech students and 38% of French students, as for the category 'Up to one hour', it was ticked by 20% Czech, 26% Spanish, 29% Latvian students. The only significant exception is Latvian students where 20% of them marked time category 'More than 5 hours'.

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Wikipedia

Last inhere described portal findings relate to Wikipedia generally warmly accepted source of information by students and rather sceptically accepted by academics. The survey revealed following deep discrepancies between individual universities. See Figure 6.

43% don´t use Wikipedia. This high percentage is significantly influenced by Latvians and Greeks; astonishing 80% of Greek and 83% of Latvian students don´t visit this portal.

All Spanish and French and Czech students (except three) use Wikipedia.

The most frequent category is 'Up to one hour'. A quarter of Czech students and even 32% of Spanish students spend in this kind of portal 2 to 5 hours weekly.

Wikipedia is favourite with Czech, Spanish and French students but they use it only as a source of information, out of the whole sample there were only 5 students who edited the application.

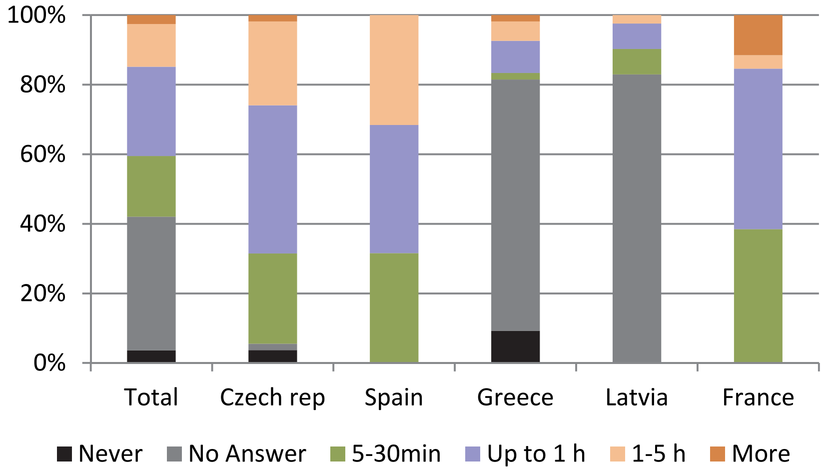

Figure 6 : Wikipedia

Conclusion

The sample of inhere described investigation consist of students who are typical representatives of net generation who have lived all their lives surrounded by information technologies – that is why utilization of Internet and its services is completely natural to them.

The findings bring the answer to the primary stated question on time burden on the amount of time which students commonly spent weekly in selected portals regardless of reasons; whether they visit the websites intentionally on study or business purposes or just, for example, because of pure interest or boredom.

In spite of the fact that they spend hours in them as illustrated in the graphs they perceive that as natural – none out of all 195 respondents expressed any discomfort with the issue; they work in the environment they are familiar with and sources they find relevant, the question is whether the sources are really relevant and to what extent they are efficient. Findings prove students´ interest in educational portals.

Two promising topics for further discussion have arisen:

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- What lies behind a wide scale of strong interest to complete disinterest of students from various countries in selected portals?
- Findings relating to Educational portals call for further elaboration; in the next stage of the research on Utilization of web sources it will be worth analyzing motivation and the reasons of high frequency of portal visits. This topic strongly links to success of web sites and might be developed in sense of usability study of web-sites.

We believe that the research results might provide readers with an up-to-date beneficial insight into the web portals. Inhere described survey represents a kind of evaluation of the success of Web portals and can serve as a starting point for the discussion on web-site usability, web portal satisfaction (Collins, 2003) and portal design including implementation of Semantic web technologies dealing with overcoming boundaries in web applications like data portability, semantic wiki or knowledge networking. Beside this technological issue we believe that this contribution will be also beneficial from the educational perspective showing the width of on-line potential which might be inspiring as well as ultimately limiting (Breslin, 2009).

Acknowledgement

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E-learning and Teaching - Methodological or Technological Problem

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Abstract

How to solve the educational problems of young generations of students (with the old kind of teacher)? In this article we will hand out the concrete activities, that will indicate solutions above for mentioned problem. Important is that we use methods which enable students to actively participate in educational process while acquiring skills necessary to function in tomorrow's world, especially tomorrow technological society. As we mentioned previous we will restrict our attention in this paper only on two of four pillars of educational system, namely only on the learning/teaching process and on the educational environment.

To produce high quality e-learning materials is not enough subject knowledge, but we need at least two areas of knowledge: ICT and the didactic field. The didactic field, which is crucial for making e-learning material, doesn't get enough attention. In the past there were variety of different didactic approaches developed, which would be useful even in a modern e-learning and teaching based lessons. One of these is also programmed instruction. The article will show how we can adapt existing theory with today's technological possibilities.

Keywords

E-learning materials. Programmed instruction. Didactic principles. ICT.

Introduction

E-learning and related e-learning materials are nowadays becoming increasingly used and desirable form of learning and teaching in the world and in Slovenia. In schools, teachers use and produce different e-learning materials, but they almost never deepen in the didactical features of such e-learning materials. Didactical features are the ones that make e-learning material in a way that they meet the main purpose, which is actively enhancing the quality of education and knowledge; e-material becomes e-learning material. In this article we will talk mainly about the latter. (Achtemeier, Morris and Finnegan, 2003)

The broadest definition of the e-material is the material that is sent to the user on an electronic medium. If we relied on the assumption that the modern electronic learning material is enabling active learning, that results from the individual's knowledge, it include formative and final verification by automatic feedback and thereby improve the quality of learning results and knowledge of learners, we need at least three profiles of experts and expertise for making such material (Ausubel, Novak and Hanesian, 1978):

- Experts in the field of didactics, who are responsible for the designing of e-(learning / teaching) materials. In order to make the material suitable for use in the learning environment, we must always seek answers to questions:
    - how people perceive information and how information may be provided;
    - how people learn;
    - what methods and didactic principles can be applied;
- Experts in content that have a special professional knowledge and can answer questions:
    - which contents are relevant, to which knowledge in a given field;
    - how is this knowledge connected to the whole;
    - what is the basic knowledge and what is an upgrade;
- Experts in computer science or ICT to produce e-learning material to the standards and guidelines and to answer questions:
    - how computer programs are built and how, on this basis the electronic learning materials can be built;
    - what are the technological capabilities of use in education;
    - which standards of electronic learning materials will fit to it;

When making e-learning materials it is also necessary to provide a methodological, technological and content suitability. The biggest problem of today's e-learning materials is the neglect of the methodological and consequently also the content area. Often there are the interactivity and multimedia and the final verification, the only didactic elements contained in e-learning material. (Aberšek and Poppov, 2004)

Didactical solutions to e-materials-based learning and teaching can be found in a number of existing methods of learning, one of them is also programmed instruction which was in the early seventies, emerged due to the rapid development of industry, science and technology and the need for a self-learning (Strmčnik 1978). The authors have carefully developed a didactic concept but did not have the technology with which it could be used effectively. By using their results and with today's technology we can produce effective e-learning material, which enables the active learning and enhance the quality of acquired knowledge. Over time some studies have suggested that programmed instruction is superior to conventional teaching (Chatterjee and Basu, 1987; Daniel and Murdoch, 1968; Fernald and Jordan, 1991; Kulik, Cohen, and Ebeling, 1980) while some others studies have indicated just the opposite (Kulik, Schwalb and Kulik, 1982; Bhushan and Sharma, 1975). Differences between studies are in design discrepancies. Several meta-analyses of a programmed instruction (Hartley, 1978; Kulik et al., 1980, 1982; McDonald, Yanchar, and Osguthorpe, 2005) have indicated that more recent studies have produced better results becouse more recent programming possibilites were used.

Technology enhanced learning

Technology enhanced learning (or TEL) refers to the support of any learning activity through technology. TEL is often used synonymously with E-Learning even though there are significant differences. The main difference between the two expressions is that TEL focuses on the technological support of any pedagogical approach that utilizes technology. However this is rarely presented as including print technology or the developments around libraries, books and journals in the centuries before computers.A learning activity can be described in terms of the:

- learning resources: creation, distribution, access, compilation, consumption of digital content; tools and services;
- actions: communication, collaboration, interaction with software tools;
- context: time, duration, surrounding people and location;
- roles: A learning activity is carried out by various actors in changing roles (e.g. student, teacher, facilitator, learning coach, human resource or education manager);
- learning objective: to support every human in achieving her or his learning goals, respecting individual as well as organizational learning preferences;

Learning activities can follow different pedagogical approaches and didactic concepts. The main focus in TEL is on the interplay between these activities and respective technologies. This can range from enabling access to and authoring of a learning resource to elaborate software systems managing (e.g. learning management system, learning content management systems, learning repositories, adaptive learning hypermedia systems, etc.) and managing (human resource management systems; tools for self-directed learning, etc.) the learning process of learners with technical means.

About the definition

The existing definitions for technology enhanced learning spread very broad and change continuously due to the dynamic nature of this evolving research field. Hence, the definition of TEL must be as broad and general as possible in order to capture all aspects. Technology enhanced learning (TEL) has the goal of providing socio-technical innovations (also improving efficiency and cost effectiveness) for learning practices, regarding individuals and organizations, independent of time, place and pace. The field of TEL therefore describes the support of any learning activity through technology.

Didactic concept

Nowadays it is probably the main methodological problem of e-materials their inability to adapt to the user's needs and previous knowledge. The majority of e-learning materials which are produced today have the same scenario, content and objectives for all users regardless of their level of knowledge and diversity. What this material is missing and it is therefore imperative it is the individualization of e-materials. (Ausubel, Novak and Hanesian, 1978).

The answers of this methodological problem and how to apply the individualization in electronic learning materials can be found in the idea of programmed instruction.

Definition of programmed instruction

The tendency to effective teaching and self-learning devices can be traced from Socrates to the modern times, or as in 1963 Skinner wrote: *"If by some miraculous invention we could edit the books so that the second page would be clear only to those which would master the first page, then it would be a big part of what is needed now to direct the activity of the teacher, students can learn themself. "* (Skinner, 1963, p. 335).

The main characteristic of programmed instruction is that it enables self-training, because the function of transmission and consolidation of knowledge assume the computers (machine learning), either by special education programs or the teaching materials. They consist of the special psychological, didactic and technical programming standards which allow (Strmčnik, 1978):

- careful analysis of the logical structure and basic concepts;
- concentration of learning content around the main logical axis;
- programming of learning paths;
- work in the individual tempo and individualized programs (personal tempo),
- gradual progression (step by step approach);
- integration of unknown with the familiar and immediate self-control;
- transfer of knowledge and skills directly to practice;

In the past the programmed instruction evolved in two directions:

- Behavioristic direction (learning as a function of human adaptation to the principle of stimulus and reaction) (Anderson, 2007);
- Cybernetic direction (the process of programming and management of teaching and learning as a pedagogical application of cybernetics to the field);

Since a pure behaviorism and cybernetics tend to different extremes it is best to avoid both, and define programmed instruction as only one of the methods of teaching and learning. Therefore programmed instruction is a learning method which allows through methodologically and technologically pre-defined and relevant teaching resources and tools, relative independent and individualized learning.

On this basis, the programmed instruction is only a part on teacher-based lesson, which does not exclude it but connect it. Programmed instruction should not be understood as a replacement for the teacher, teacher is still an indispensable part of the learning process, but as a learning method that relieves the teacher and allows division of work. We can agree with Skinner, when he says: " *Learning machines are an excellent means to save teachers time and facilitate its work. If a teacher leaves the machine those learning features that can be mechanized, then is free of his irreplaceable human tasks in the learning process.* " (Skinner, 1958, p.63). In the flood of information and the growing packed schedules of students and teachers should be programmed instruction and its good basic features and principles applied in all levels of education.

Programmed instruction and individualization

The theoretical bases and the construction principles of the programmed lessons are subordinated to the consideration of the individual differences among students. The set goal was to achieve a complete individualization with the help of the programmed lessons (Newel, 1990).

The programmed lesson offers, besides the theory of learning steps, also four principles, guides for individualization:

- Individualization of personal tempo;
- Individualization of learning content;
- Individualization of learning methodology;
- Individualization of learning assistance;

The theory of short learning steps of programmed lessons results from reality because the comprehensiveness of the students is very different and therefore it seeks for possibilities also for poorer students to understand the learning content. Therefore different approaches can be used:

- linear program or
- branched program.

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The linear programs that allow students to progress no matter the mistakes he or she makes or it sends the student back to the starting point, they don't contribute to better understanding and motivation. Far better are the branched programs where the student can't progress before he or she does not answer the question correctly. The mistake is than discovered by him-herself individually with comparison of his-her answer with the correct one or what is even better with the help of additional information or suggestions. This way we enable the student to study the mistake thoroughly and so the non-stimulative mistake is changes into satisfaction that he-she recognized the mistake and corrected alone. (Gerlič, 2011).

The personal tempo or we can also call it the learning tempo is by each individual different. It depends on the pre-knowledge of an individual, his-her motivation, learning habits, understanding of the content and what is most important from his-her capabilities of thinking in dependence of the process complexity (Blažič and others, 2003).

The technique of the branch programming enables much more varied individualization of the learning content. It offers to the students more additional side ways with additional information that enable them to overcome a specific barriers on the main learning path or to broaden the knowledge of this path.

The individualization of the learning methods, forms and techniques has been until today known as notable principle in the present electronic learning materials. At the beginning of programming the lessons there were no possibilities to add the interactive and multimedia elements. Today we cannot imagine the electronic teaching material without pictures, sound, animation and movies. But we have to stress that by the linear programming of electronic learning materials the use of these elements is note as expressive as by the branch programming. The essence of the individualization of the learning methods is in the act when we offer the students the alternative learning sources and tools and not offering them a little bit of everything (Myers, 1995).

The last dimension of the individualised programmed lesson is the individualisation of the immediate learning assistance. This individualization has proved to be the most difficult at the beginning of the programming of lessons and is as such today. It remains an eternal question how to assure the students a learning assistance when he-she is in trouble. It is true that with a good programming, appropriate instructions, suggestions, impulses, encouragements and additional clarifications, we can avoid most of the problems, however some individuals or groups can encounter the unexpected difficulties.

The experts view of that time were about this different. Some believed that the machines will in the short time be able to offer direct assistance to every student at any time. This kind of assistance is presently not possible. The progress of artificial intelligence and also the availability of this technology in the educational process is at the very beginning. Therefore we can join the others who claim that the direction to the individualisation of the learning assistance is hidden in the good programming of the e-materials. With testing and proving we can avoid most of the problems that can be accoutred by the students, whereas most of the bigger unsolved problems can than be solved only by the teacher. The programmed program can enable the student that he-she can repeat over and over again and try to solve the problem but he-she cannot independently discover his-her weak points. The concrete or personal assistance of the teacher is still his-her greatest advantage.

Guidelines for the modern e-learning material

Taking into account the present situation and the desire to manufacture modern electronic learning materials, which would allow an effective and independent learning, we should strictly follow the described methodological characteristics of programmed instruction. This would avoid the situation where the majority of electronic learning materials is only mapping the textbooks with added interactivity and multimedia elements.

In modern electronic learning materials, we must take care that there is appropriate hierarchy established (Figure 1). Learning whole is composed of several learning units and these are composed from different building blocks.

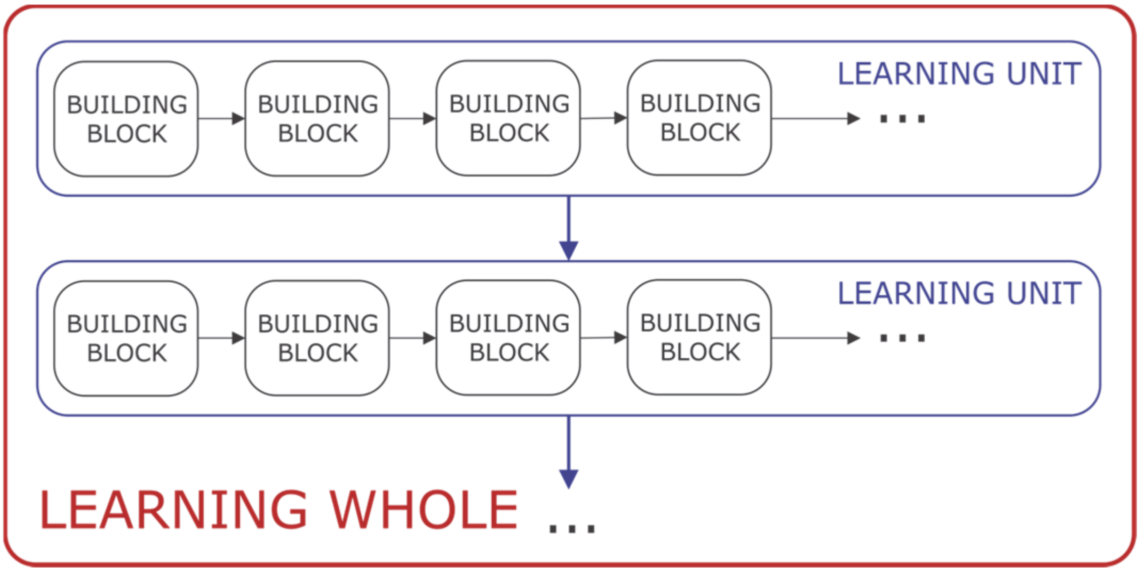

Figure 1: Learning whole

The building block (Figure 2) is a basic and essential element that affects the quality of e-learning material.

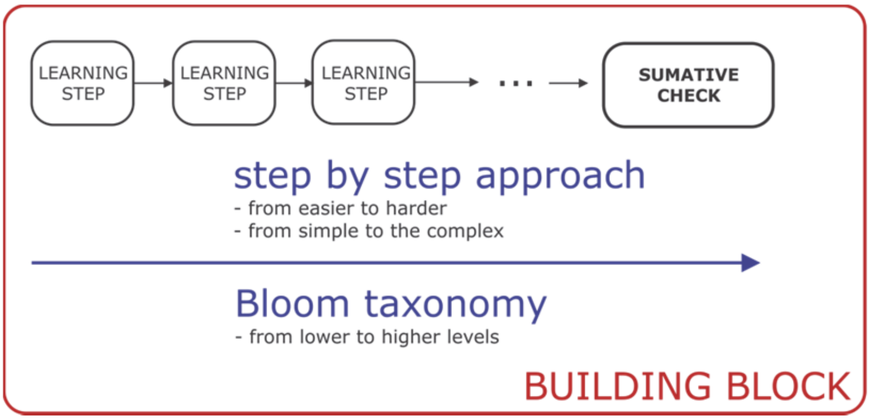

Figure 2: Building block

It must have an appropriate branched learning steps (Figure 3) that:

- should not be fragmented but connected to previous and the following learning steps;
- must be adapted to individual needs, level of knowledge and abilities of students;
- should include regular checks with feedback that guide the students from beginning to end of each learning step;

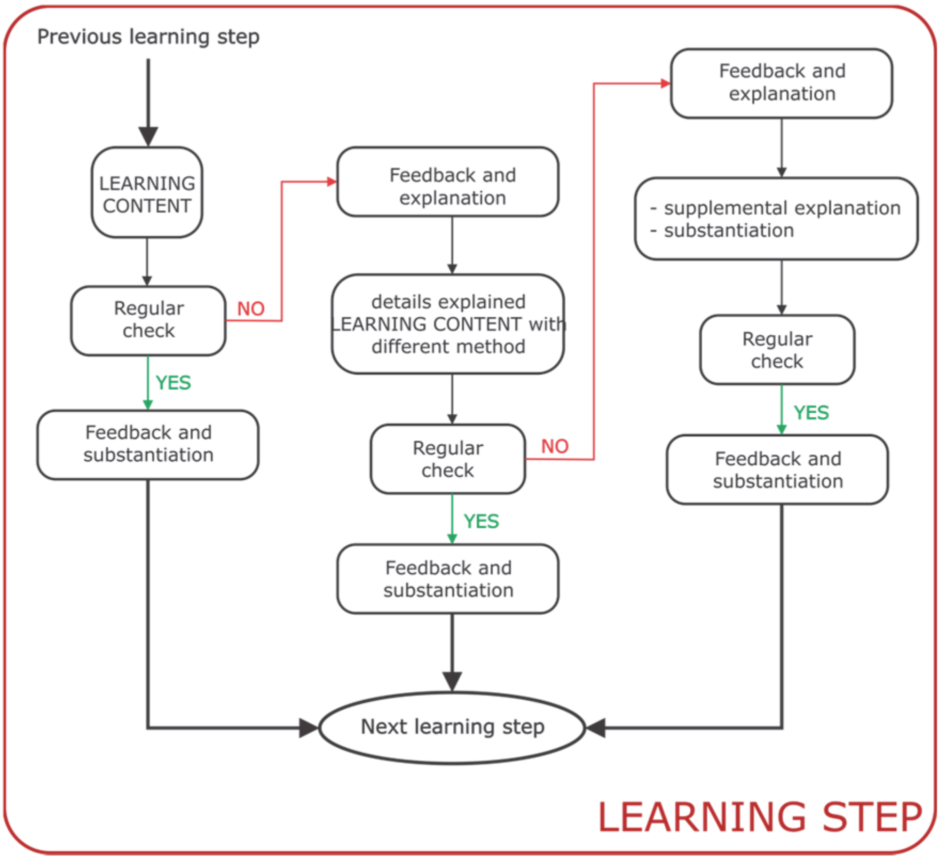

Figure 3: Learning step

This is the only way that a student can understand and comprehend the chain of building blocks in the final whole.

With construction of such building blocks and, consequently, learning units, we could ensure that the learning unit will contain several building blocks with several different operational objectives. Taking into account the target hierarchy, the learning unit can also have its own intermediate learning objective. The learning unit should be complemented just with appropriate diagnostic check, which would include sets of tasks from summative checks of building blocks. Set of multiple learning units can be combined into learning whole, which becomes right and rounded representation of electronic learning content.

Conclusion

Information Communication Technology (ICT) has already an integral part of the school system in Slovenia. E-learning and e-learning materials are concepts, without which the education nowadays is no longer imaginable. Therefore it is so important that the e-learning materials are skillfully manufactured to serve to supplement teaching and are intended for active teaching by emphasizing the possibility of self-study and independent student activity, but not to have an end in itself, as often happens.

Mapping a content from schoolbooks with added multimedia and interactive elements should not satisfy us. Such production of electronic learning materials is otherwise the fast, easy and inexpensive, but it can not be said that this is training material and such material certainly does not belong to school. Electronic material is a learning material only when allows an individual to come to the desired objective on the path which corresponds to it, allows a gradual progression, and their own personal tempo, equally such material should not allow an individual with no knowledge or insufficient knowledge to progresses. Manufacturing of electronic learning materials requires different skills and profiles of experts, requires individualization and differentiation of individual participants and ongoing checks, that does not serve for evaluation but for guiding an individual within relevant path. As shown in the article, this quality is achieved by using the theory of programmed instruction.

Department of technical education, Faculty of natural sciences and mathematics, University of Maribor is preparing an extensive research designed to measure the effectiveness of programmed instruction and analyze its advantages over traditional teaching. For the research e-learning material will be used, which will have a branched structure that allows individual, independent and effective learning.

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Design, Simulations and Manufacturing Strategy in the Teaching of Engineering Subjects

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Abstract

Post introduces a potential for utilization of tools for design, simulation, design of production technology and data management in technical education. Tools are used in the context of the curriculum of engineering disciplines of secondary schools and colleges. Use of applications to support teaching of thematic units of basic subjects with a subsequent transition to a comprehensive use of the project education is expected. Target of the use of the listed application of these technologies according to the presented concept is to increase knowledge and skills of students of engineering disciplines for independent solutions of sophisticated design and technological tasks. The concept of teaching takes into account requirements of industrial experience on the professional competence of graduates. Optimization of the teaching methods is based on a research conducted at secondary schools and colleges of engineering and of information-engineering focus. In connection with the project teaching, supported by information technologies, growth of motivation of students to study engineering problems and their subsequent application in professional experience in the field of study is monitored. Experiences with computer-aided education and the possibility of advantageous use of potential of other, in engineering practice used, software tools are listed in the paper. In particular, the issues of application of tools for data management in the role of learning management system are presented, which is particularly beneficial in the final stage of preparation of technicians, where largely individual work and teamwork on complex projects of virtual prototypes is expected. The strategy of data management system enables checked work on educational projects also outside the school environment. Interim results of research are mentioned in the text with links to possible solutions and optimizing of the didactic system of teaching of engineering subjects is given.

Keywords

3D digital model. Design. Product Lifecycle Management. Simulations. Virtual prototype.

Introduction

Procedures applied in the current industrial engineering practice put new demands on knowledge and skills of graduates of technical schools, connected with a significant proportion of the use of tools for design, simulation, production technology and data management solutions for the design and technological tasks. Computer-aided engineering activities open up new approaches to creation and analysis of designs and also for creation of processes of manufacturing and assembly. A large number of data sets, the complexity of procedures and the need of sharing of information in various points on the planet with adequate check and security of shared information required the deployment of data management systems and processes. Features of tools deployed in industrial practice and also in the school sector are known and have already been mentioned in many publications, intended for training of technical personnel in industry, but particularly in preparing of students at all levels of technical schools (Fořt and Kletečka, 2007). Verification and optimization of teaching methods takes place within the long-term research conducted in the teaching of engineering-oriented subjects at the secondary school and college. Survey is focused on the increase of knowledge of students by teaching of basic academic subjects with the use of visualization and simulation possibilities of computer applications. Implementation of teaching procedures and results of undertaken experiments are presented in the text. The focus of research activities is the depth analysis of projects in progress and completed projects of students' virtual prototypes. The data sets represent an important carrier of information and, in addition to communication medium by the process of design and technical preparation of a specific products, it allows an insight into the thought processes of a student. By default knowledge and skills, their expansion and especially consolidation of cross-curricular links can be expected. Since it is a specific industrial sector and the priority is to prepare graduates for success in the field, the content and form of teaching must be based on the requirements of industrial practice. A part of a comprehensive research is based on this sector in addition to the analysis procedures carried out in sophisticated design and technological departments of industrial companies, the investigation is aimed at the adaptability of students and graduates in practice. The result of these activities should be an optimized didactic system of teaching of engineering subjects, supported by tools for design, simulation and data management. Educational procedures of relevant thematic areas of other subjects taught at all levels of schools can be derived of this concept.

Tools for design, simulation and technologies in context of teaching of technical articles

Applications of this category are commonly used in the school environment. A complete installation is very expensive, but a part of a business strategy of the majority of software vendors in this category of software is to ensure the accessibility of its use in the education sector with regard to the material possibilities of schools. There are academic licenses, fully functional and for a symbolic price. They can be often installed on home computers of students and educators (Kapusta and Munk and Turčáni, 2010) This important fact gives students space for individual development and learning outside the classroom. It allows to teachers continuous work on input, optimization and evaluation of pupils' work. Costs of academic licensing may be included in grant programs, or they may be involved in industrial enterprises for the region's schools. The financial aspect is not a barrier for the use of this category of software in teaching. Schematic representation of information flows among the main products of the described tools is in Figure 1.

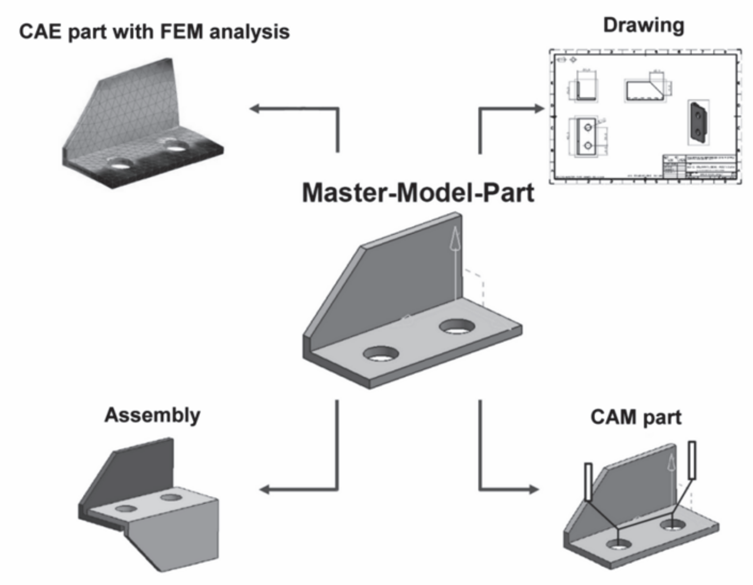

Figure 1: Master Model Concept with context Design, Simulation and Technology tools.

Design

CAD - Computer Aided Design are tools for computer support of creating of 3D or 2D digital models and 2D drawings. Currently, the standard is production of volumetric or surfaced 3D model by parametric methods (Matějus and Šedivý, 2011). The parametric model has dimensions and relationships between related objects determined by values of parameters that can be constant or variable and whose value is the result of a defined formula. The starting point for creating of 3D solid body are usually 2D curves, which are extruded into space in a straight line, revolved around an axis, or drawn along a guide. In spite of the fact that the priority is the creation of a 3D volume model, we can still find examples of use of a 2D curve model. 2D curve model can be used for example to generate a NC code to control of a machine by the creation of the technology for machining of a simple body, or as a reference for the calculation and the finite element simulation. Besides creating a basis for further constructional activities based on calculations and simulations with 3D models and their set, it is used to create visualizations, the proposal in the context of the assembly and last but not least to perform basic measurements and physical analysis, directly in this module.

Knowledge and skills of work with 2D and then with 3D CAD applications are together with theoretical knowledge of basic and cross-sector engineering subjects basis for subsequent computer-aided design activities, and subsequent work on complex educational projects. Acquisition of basic skills is necessary already in the first years of the study, together with the knowledge and skills of using a computer, operating system and applications for creating text, spreadsheets and presentations (Dostál, 2009).

Simulation

CAE - Computer Aided Engineering are tools for implementing of simulations and engineering calculations on 3D digital models and assemblies created in the CAD module. Computational algorithm works based on Finite Element Method - FEM. In connection with the design of structural design out strength calculations to determine the stress and strain in the loaded part of the structure is usually carried out. A network of elements is defined on a 3D digital model or assembly. Geometric and structural boundary conditions are specified according to functionality of construction. After completion of the calculation, the quantitative results for selected construction sites, or qualitative visualization of the monitored parameter on the surface and inside the volume element are to evaluate. Based on the obtained results the construction can be considered as properly designed, undersized or oversized, which is the basis for further editing and optimization of the model. Introduction to a CAE module in teaching is possible through case studies and examples of the topics taught in technical mechanics and physics, initially without further theoretical knowledge of finite element method. It enables a gradual transition from analytical solutions to computer-supported technical calculations. Gradually full use of the work on educational projects is expected.

Creation and verification of production technology

CAM - Computer Aided Manufacturing enables to create and verify machining technology for a numerically controlled machine. In addition to a tool-path that is determined by shape features of a design, the type and size of the used tool can be defined and cutting conditions can be determined. Production technology is optimized on 3D data of digital models.

Product Lifecycle Management

PLM - Product Lifecycle Management System is an application for data management, definition of information flows, including the management of processes associated with creating of the design and technical preparation of production. A specific example is the use of PLM tools in the role of the LMS - Learning Management System. PLM system can be used for organizing of all documentation competent to projects. They enable a quick access not only to CAD data, but also to text and other graphic files that are associated with the project solved. CAD data and documents can be viewed by designated users of PLM system however they have defined property rights, and editing rights.

The students can during work in teams work at different places, from the home. Information can be transmitted within the system and all activity can be monitored by a teacher - a project consultant. Instructions or intermediate and final evaluations can be added to the set of project data, which can be applied for the classification of individual students then. Another possibility of the system is the distribution of educational materials. The data may be available, for example in the form of a comprehensive training course, or in nonlinear form as sub-sample tasks. Interim results of research carried out in connection with the teaching of CAD technology show a lack of relevant learning materials and teaching supports. It is also confirmed by the survey among students in the course of teaching and project work. CAD model solution, text, or image presentations and movies with annotated methods can be distributed through a PLM tool. The advantage of deploying of a PLM tool in addition to standard LMS is to familiarize students with the application used in industrial practice and gaining of practical experience with the philosophy and procedures applied by work in the field after graduation.

Engineering and pedagogical teaching concept of engineering subjects

Creating and testing of new progressive ways of teaching of technical courses may be based on engineering and pedagogical approach to teaching, as detailed above all in (Melezinek, 1994).

„As engineering pedagogy are considered all activities aimed at improving of teaching of technical subjects regarding objectives, content and forms of teaching".

Sources of engineering pedagogy and links between them are shown in Figure 2. Objectives in this area are predominantly determined by the demands of industrial practice. Content is given by yet acquired knowledge of field and should react on the on-going development and implementation of new technologies. The development is evident also in the field of educational technology and teaching methods. Support for teaching of technical subjects through the instruments used in industrial practice and developing of new practices is an example of the close relationship of theory and practice in didactics of technical subjects. The paper presents one of methods of use of modern didactical technologies in practical teaching.

The deployment of information technologies in teaching of non-informatics subjects reflects the current trend of dispositions and interest of generation of potential engineers. This is connected with the achievement of learning objectives as listed in the taxonomy (Blom, 1956) and for teaching of engineering subjects closer specified by (Melezinek, 1994) not only in the cognitive area. Natural perception of computer applications environment leads to the gradual formation of the affective area and work with objects in a 3D virtual environment also to obtaining of skills in the psychomotor area. The structural design in a virtual environment, supported by performing simulation and design of technology solutions in the framework of educational project leads to the organization of knowledge structures and consolidation of curricular, and in some cases, interdisciplinary relations of a studied issue.

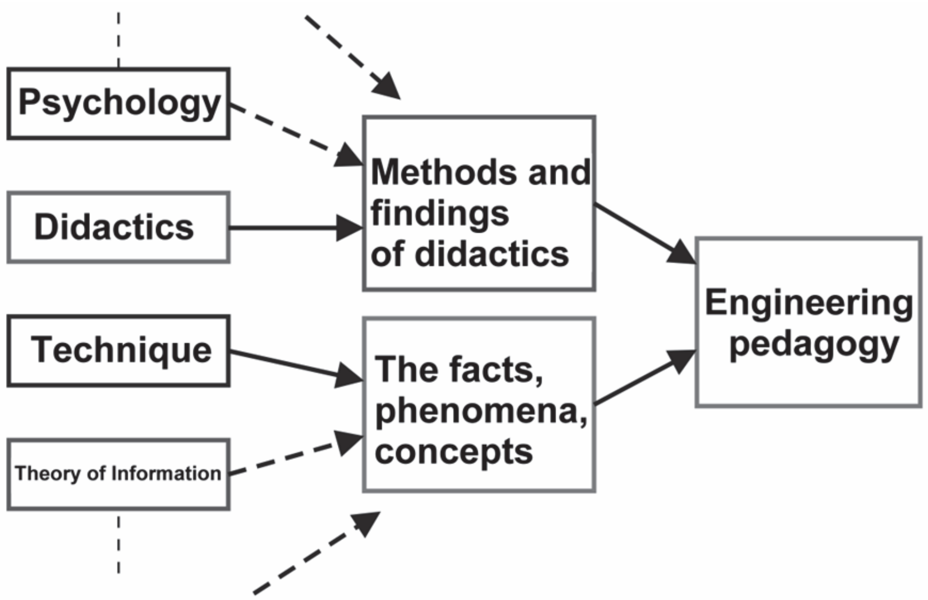

Figure 2: Sources of engineering pedagogy (Melezinek, 1994).

Concept of teaching supported by a computer

Teaching of sub-topics of basic subjects

Didactic potential of design and simulation tools can be applied already in the initial stages of studies to support the teaching of basic subjects. Engineering and technological subjects can be modeled in CAD applications and their subsequent performances can be carried out by a demonstration directly from the virtual environment. This method allows you to introduce for example geometry of cutting and forming tools, or molds for casting. Visualization of distribution in space, variability of a design, or a use of standardized parts can be done by engineering constructions. Samples of specific examples can be later used for complex performances of the broader issue for strengthening of relations between the sub-issues and within the subject also cross-curricular links (Balogh and Turčáni and Burianová, 2010). Tools for design and simulation can be also used with advantage in the education of theoretical subjects which knowledge is important for solving of complex problems for an example may be some parts of physics and technical mechanics.

Project education, supported by tools of information technologies

Efficient teaching methods with a goal to strengthen cross-curricular relations of specialist subjects are the teaching on complex projects. Knowledge of subjects such as technology of a field, engineering, engineering technology, technical mechanics, creation of technical documentation, information and communication technologies and other industry-oriented courses taught at lower secondary schools is used in the education. Transition to the teaching on project supported by CAx / PLM technologies is gradual and in the higher grades complex project work have predominantly role. In particular, teaching at college is since the beginning focused on project teaching to consolidate ties of gained knowledge and skills of the studied field.

The projects are solved in subjects of CAD, CAE and ICT in engineering. The number of lessons corresponds to one semester or term and the range is designed specifically for individuals or groups of two to three investigators. Some of the semester projects are developed to the level of successfully defended thesis. The recommended timetable for implementation of the educational project, indicating the most important activities, is shown in Figure 3.

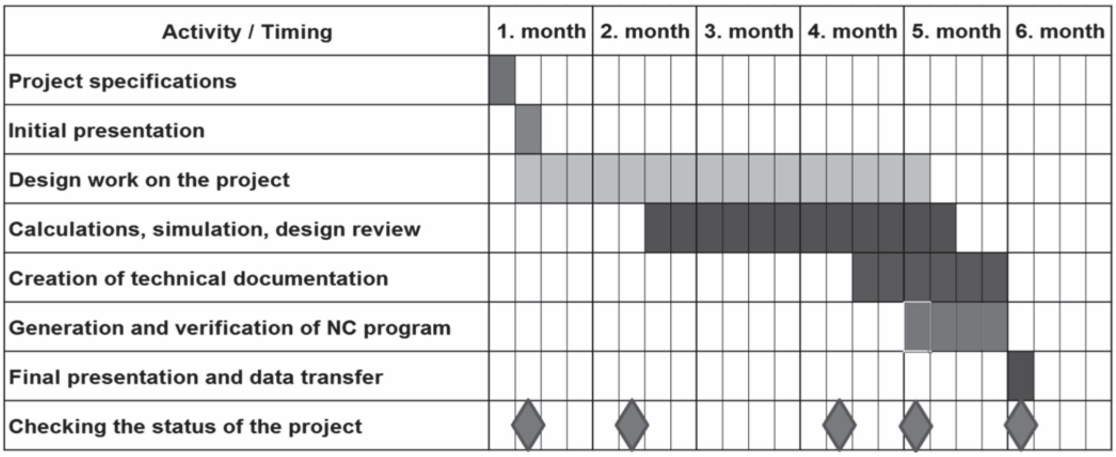

Figure 3: Timetable for ideal process of implementation of a pupils' project with key points.

Visualization of 3D data of the completed project of a virtual prototype of a model for pressure casting of aluminium alloy is shown in Figure No. 4. General principles of engineering design, rules for creation of tools and technology issues of inlet and solidification of the casting material in the actual process of casting were applied for the development of the project. A project of this type was processed by a student in a period of three months.

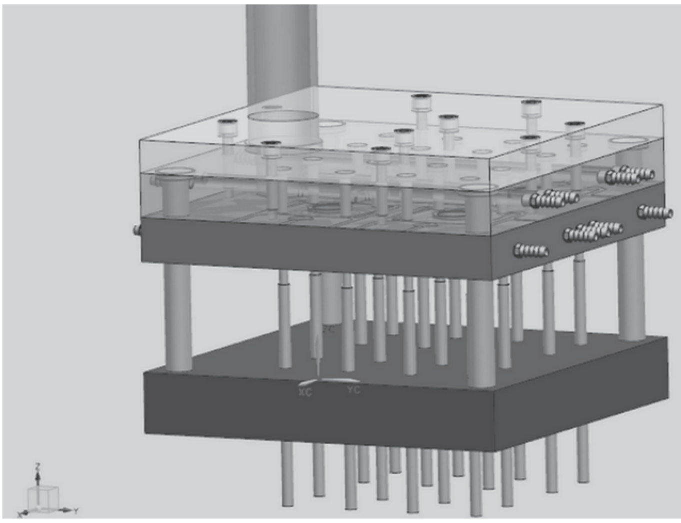

Figure 4: 3D virtual prototype of a model for pressure casting of aluminium alloy.

Reasearch of the use of tools in the education

Progress of project work can be assessed both in the classroom observation, and by analysis of ongoing status of projects that listeners process outside school lessons. Final outcomes of completed projects can be also analyzed. The structure of CAx data enables to assess the level of technical thinking of a student, his spatial imagination and creativity. From this point of view, the most suitable are CAx applications that allow you to achieve the same result in different ways. Due to the material possibilities of schools and to different licensing strategies for different providers of these systems, this requirement is difficult to reach (Hubálovský and Jelínek and Šedivý, 2012)

Despite this fact CAx data created in any application are a carrier of sufficient amount of information to produce partial conclusions and for subsequent optimization of the concept of teaching, including teaching supports in the form of text and animated electronic materials. Animated materials are created directly through animation and visualisation tools of a used CAx application. They contain procedures of 2D and 3D design and setting up of corresponding simulations. Increase of knowledge and skills is verified by an experiment on two parallel groups in education. Sub-thematic unit is in the experimental group demonstrated with a use of a CAx tool. A classical method without the use of CAx applications is used in the check group. In both groups there are the same initial knowledge and skills, as measured by a pre-test. A post-test is entered and evaluated in both groups at the end of the learning process and this post-test is also repeated in a period of 1 month after completion of the interpretation of the topic. The results of the first post-tests of three final experiments are shown in Figure No. 5. In all cases it was a demonstration of the cutting tool geometry using a CAD model. Several so specified experiments were carried out throughout the research. Selection of pupils to groups was made according to organizational options and criteria, which do not affect the examined parameters. Independence of choice was assessed on the basis of pre-test results. Numbers of pupils in each group were 15 to 30. An experiment was performed repeatedly with an emphasis on ensuring of the same conditions, consisting of the initial knowledge of students, course work, testing and evaluation.

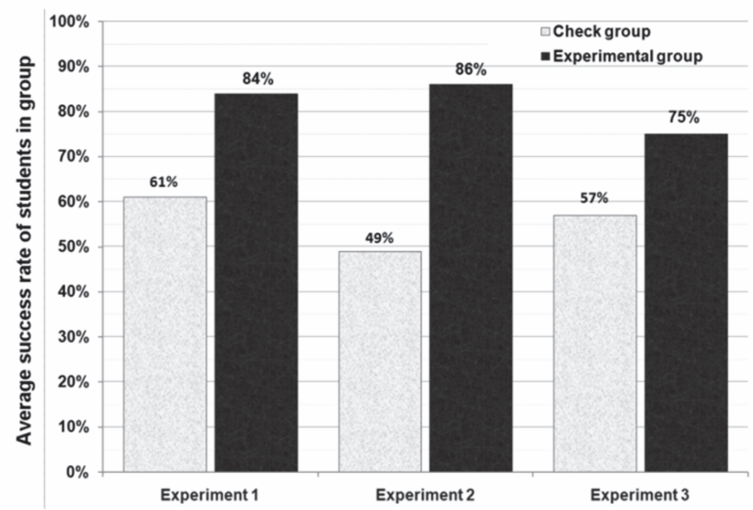

Figure 5: Verification of deployment of a CAD tool in education - students' success in posttest.

Research of attitudes of students and graduates to CAx technologies and to the teaching supported by these instruments is carried out using a questionnaire and an interview. A web questionnaire for obtaining the necessary number of respondents also from remote locations was created for this purpose (Chromý and Drtina, 2010). Selected results of positive responses, which have a significant influence on the creation and optimization of conception of computer-aided education is presented in the graph of Figure No. 6.

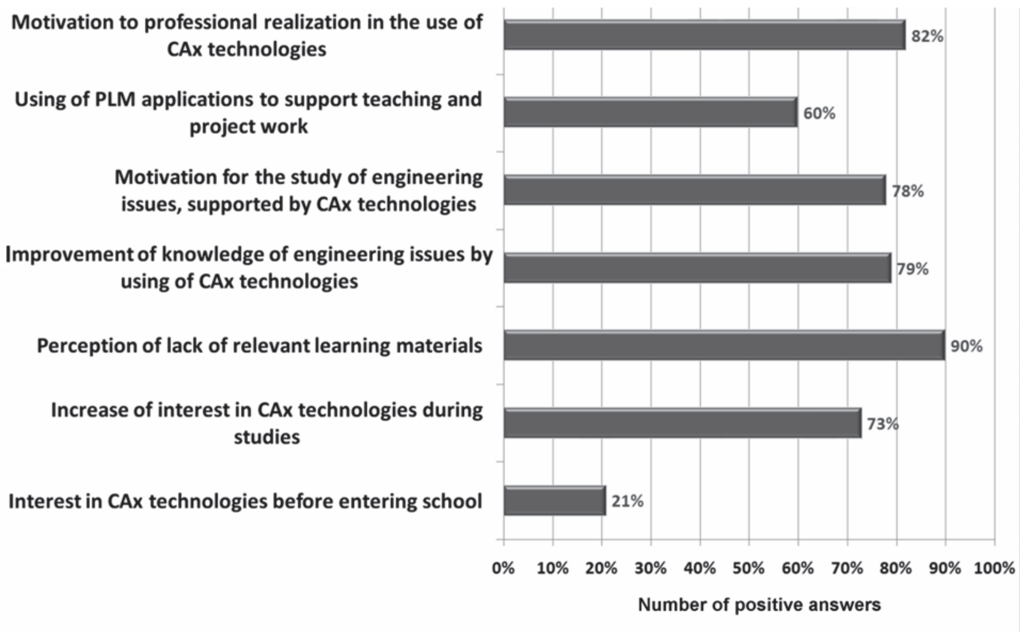

Figure 6: Results of the survey of attitudes of students and graduates of technical schools to CAx technologies.

PLM aplication in the role of the educational LMS

The following example demonstrates a configuration of a PLM system to meet the educational role of the LMS. The data structure and information flows are based on the experience and research investigations in education (Milková and Hubálovský, 2010). Use of a PLM system in comparison with known universal LMS systems brings the opportunity to familiarize with the approach applied in industrial practice. Process Map of one possible solution is shown in Figure No. 7.

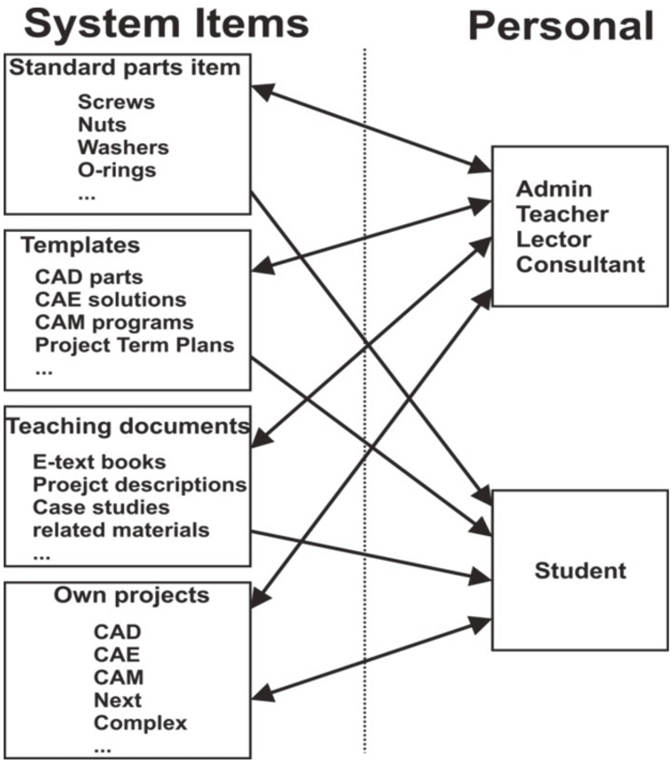

Figure 7: Diagram of data structure of PLM system in the role of the LMS.

Conclusion

Researches show the benefits of deploying of tools for design, simulation, technologies and data management in the teaching of technical, engineering-oriented subjects (Hubálovský, 2011). The concept of teaching, where the described applications are deployed with escalating intensity, is determined by the theoretical bases of education, experience, industrial requirements and by specific characteristics features of the used teaching tools. Research at this stage managed to show a significant influence on the growth of skills of students and graduates in technical fields and also their motivation to study technical issues and to professional orientation in the field. Increased knowledge can also be expected, however, the growth rate is not significant in comparison with the skills. Teaching can be realized through CAx applications, commonly available in industry and also in educational sector. Availability of academic licenses is not an obstacle for the deployment in teaching of not only engineering subjects. Deployment of CAx tools integrated with PLM application creates a comprehensive information system, allowing complete support for presence and distance learning.

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Customer Oriented E-learning Courses

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Abstract

The paper is focused on customer oriented courses. As e-learning we consider use of information and computer technologies to create learning experiences (by Horton, 2006). This complex definition covers a lot of forms and types of e-learning. Customer oriented courses are one of the emerging trends in the field of e-learning (see survey ASTD, 2011). The e-learning opens new opportunities for non-formal learning and creates support for informal learning. There is a possibility of using viral marketing to motivate students/customers in both ways: for the external and internal motivation. The appropriate motivation is of course the key point of a well prepared and well designed course. In this paper we briefly present some examples and open the discussion how to use principles of viral marketing to motivate students and to support customer oriented e-learning courses. In this context we must also consider the use of tools for social learning (wikis, blogs, social networking sites…).

Keywords

E-learning. Customer courses. Marketing. Viral marketing. Motivation. Non-formal and informal learning.

Introduction

We recognise customer oriented e-learning courses as one of the current trends in e-learning development. This fact has two faces. The first one is the face of marketing and communication with clients and customers (we considered this part as component of internet marketing). The second one is the learning and teaching process that is connected with ICT (instructional design of e-learning focused on informal learning is very important here).

Trend of the use of customer oriented courses is documented by research undertaken by ASTD (2011). 40% (2010) and 34% (2011) of respondents (deputies of companies) interviewed realise customer service training. Relationships with customers and their satisfaction have become an important factor for any successful business. Conversely, we can say that customer dissatisfaction comes from a less adequate knowledge of the product or service features and results in increased customer care costs, difficult sales and lost revenues (Data Center Solutions, 2012). It appears that providing training to customers on products or services is a growing area.

There are lots of definitions of e-learning but we use the so called complex one. (Horton, 2006, p. 1) "The e-learning is the use of information and computer technologies to create learning experience". This definition is as an "umbrella" term that covered all old and new forms or types of e-learning. And of course for customer oriented learning we need to work with many forms and methods of e-learning that occur in practice. E.g. Conklin and Robbins-McNeish (2007) present next

„methods of delivery for e-learning“. For comments on customer use of social networking sites see (Eger and Petrtyl, 2011).

- Web based/Computer based learning – both types have already been in use for customer support few years yet.
- Wiki, blog – new types. Especially a blog is very well applicable to the previously known FAQ. The FAQs were static; wikis and blogs enable interaction and sharing of experience.
- Webinar – new type of e-learning. New technologies have enabled the development of this type. Its use in CRM (in the Czech Republic) is not yet common.
- Webcast (Podcast) – webcasts have quickly gained popularity thanks to YouTube etc.
- Electronic bulletin board – there are many types of this tool to be seen in practice.
- Electronic library as a knowledge base – structured information on products and services are now often offered in this form.
- Online help and context sensitive help – new tools for this area will again offer the necessary interaction and information sharing in customer clubs or in open communities on social networks, etc.

Proposed solutions

First, there are traditional materials delivered via ICT (manuals and classic tutorials redesigned to manuals and tutorials published on CD, DVD and the Internet).

Second proposed solution is use of the so-called rich multimedia and new ways of communication to make customer service more user friendly and achievable in real-time.

Third (most up-to-date) innovation is focused on benefits offered to us through new tools enabled by collaborative environment. Its purpose is to increase motivation for customer loyalty and the participation on communication to identify priorities of customers and of course to improve marketing activities.

The latest innovations not only reflect the fact that 80% of households with young children (ČSÚ, 2012) have access to the Internet, but also that younger and middle generations are increasingly using new communication tools like wikis, blogs and Facebook, YouTube etc.

Access to the Internet has increased, households are well equipped with (ICT), and some customer segments are even implicitly supposed to have some IT skills (Eger in Veteška a kol. 2009) = there are created prerequisites for customized courses enabled by ICT. Our pilot research (Eger, Petrtyl, 2011) also showed how young people communicate in the Czech Republic on Facebook. There are opportunities to communicate with young people, but also threats if companies do not understand the specifics of open communication in a social network.

What can we suggest as partial conclusions?

- Customers are connected (they are able to use the Internet and our support anytime and anywhere).
- It is possible to use rich media and new tools for communication with customers.
- The main problem is the question of motivation and development of a long-term relationship between company and its customer.
- The advantage of e-learning support is also possibility to personalise information and an easy update.

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- We can obtain customers if we offer (needed) added value.

Then we bring to the discussion:

- It is possible to consider the effects of the use of viral marketing (viral message as a motivation to study and to post the link to friends etc.)
- Learning (and customer informal learning) should be flexible and available on mobile (Are we able to delivery the learning content via a smartphone or via a media tablet?)
- Which kind of teaching and learning approach we should choose to make courses useful but also interesting and relevant to a target group?
- How to change social learning through a traditional e-learning and tools as LMS (learning management system)? Social learning often takes place outside the organisation, but some organisations use social learning as a part of knowledge management inside organisation.

Viral marketing

"Viral marketing is a marketing strategy that is geared towards making an awareness about the company products and services that is being catered to a specified range of people. It primarily employs the word-of-mouth method to propagate the presence of the company and the existence of products and goods." (Allen, 2008, p. 35), or "a marketing technique that seeks to exploit existing social networks to produce exponential increases in brand awareness" (Hollensen, 2007, p. 563). A guru of marketing using social media, Eric Qualman, sees not only significant advantages and a potential of the so called "Socialnomics", but also warns that every company aiming to use the tools of online word-of-mouth, must "understand and be willing to unleash control over their brand" (Qualman, 2011, p. 179). In other words, word-of-mouth (or even Qualman's term "world-of-mouth") may be very convenient and powerful, but can also work in an opposite way: just imagine possible implications in case of experience with a bad product.

To be of viral character, the marketing must respect basic characteristics (Klofanda, Hacker, 2008):

- The message must contain/inform about certain value (sharing trigger).
- There must be a good starting point and appropriate points of sharing (web servers, discussion forums, blogs, e-mailing, instant messaging etc.).
- People who share the message (first wave, optimally containing an opinion leader; and people, who will share the message in a viral manner).

Although the latter authors see only commercial messages as „truly" viral ones, the stated requisites are valid also in case of "simple", and "spontaneous" sharing of unique content. That means the message can become of viral character even though it was originally not meant to. Or, in other words, customers themselves may create a message shared spontaneously and noticing something special. Notably, as in many other cases, many authors use many definitions. The most important point in case of viral marketing is the sharing itself and its impacts (both, intended and unintended) which they result in.

In case of education, the value of product itself is gained knowledge. As we will see, the form of a e-learning may differ case to case, and messages can involve fun (see e.g. Czech National Bank), or can be strictly practically oriented (see Gartner). Thus, it is clear that every concept must reflect target audience and values the members of target groups may expect.

Two model target group representatives may be (1) a random visitor of Czech National Banks website (looking for a general information on money), and (2) an IT professional who is looking for detailed explanation of certain current problem. Each of them will probably prefer different ways of attraction, but they both are looking for information mediated through the tools of e-learning.

Examples of customer oriented e-learning courses

Formal learning (CEDEFOP: Learning that occurs in an organised and structured environment (e.g. in an education or training institution or on the job) and is explicitly designated as learning (in terms of objectives, time or resources). Formal learning is intentional from the learner’s point of view. It typically leads to validation and certification.

Certified courses are for example common in ICT or in management or marketing. Certification is often associated with face to face examination. This is not an area in which we are focused on our contribution.

We can classify the typical free access customer oriented courses as non-formal teaching and learning and support for informal learning.

Non-formal learning: Learning which is embedded in planned activities not explicitly designated as learning (in terms of learning objectives, learning time or learning support), but which contain an important learning element. Non-formal learning is intentional from the learner’s point of view. It typically does not lead to certification (CEDFOP Glossary, 2004).

Support for informal learning (CEDEFOP: Learning resulting from daily activities related to work, family or leisure). It is not organised or structured in terms of objectives, time or learning support. Informal learning is in most cases unintentional from the learner’s perspective.

Here are two examples from the field of finance and financial literacy.

The first course (Figure 1) was created by The Czech Consumer Association and is focused on frauds in the e-banking. The course shows how to prevent potential risks in customer transactions on the Internet. Course design and navigation are simple. This is an example of an older web based course.

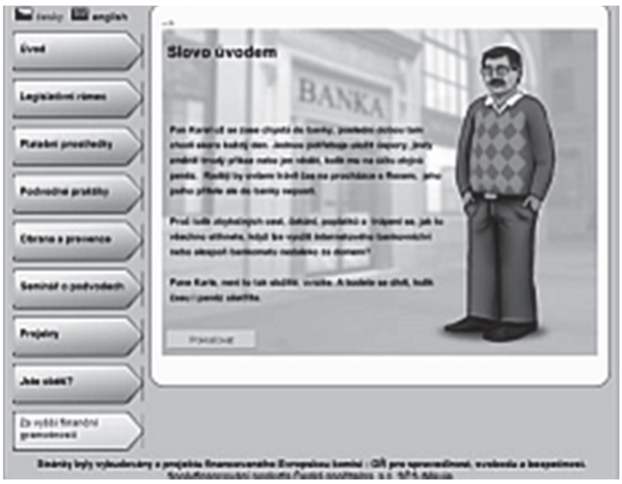

Figure 1: Podvody v e-bankovnictví (Sdružení českých spotřebitelů, 2009)

The second course was created by The Czech National Bank. The animated film "Of Money and Men" presents the circulation of currency, the payment system etc. Currently it is available on the internet, see YouTube.

Figure 2: Of money and men (CNBcz, 2011)

Customer oriented courses are typical for companies in the field of ICT. Some of them are paid (e.g. SAP), but some are available for free (open courses for MS Office). These support materials offer user friendly design and clear structure of the relevant content.

The third example of the e-learning (a webinar) comes from a consultancy company Gartner. The webinars are provided on-demand, and can be viewed in real-time or after the time of live broadcasting (lesson). The real-time webinars are interactive hence attendants can pose questions (when subscribed as attendants). Materials can be downloaded in PDF (presentation), or viewed online (commentary/audio), or both. All in all, the quality of content is high, and it implicitly promotes Gartner's paid services. There are limits when wanting to share webinars on social networking sites: Gartner offers the only one default way of sharing, via e-mail. But, this kind of e-learning is not meant for masses of people, as it is dedicated to IT professionals. Nevertheless, support of easy sharing (e.g. on the professional network LinkedIn, Twitter, etc.) could be useful.

Figure 3: Gartner webinar (Gartner, 2012)

Courses created by customers

Consider, for some products, possibility of finding many manuals, tutorials or courses. If searching e.g. for a manual or course “How to use Skype?” you receive links to PDF manuals, to web based learning courses or to YouTube video tutorials. In this case a lot of them are created and published by customers themselves, not by the company that operates and develops Skype software. Of course, the quality of these materials is may differ, source by source. See an example of a professional course:

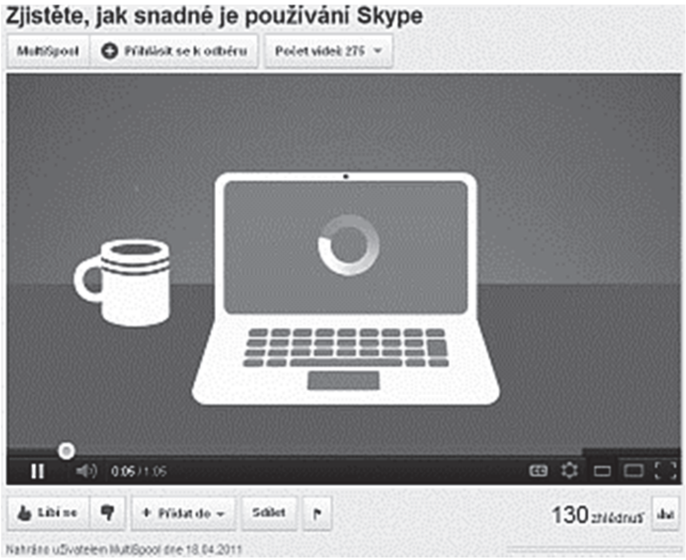

Figure 4: Skype course on YouTube (Multispool, 2011)

Compare the picture with the example of a simple manual (web based support) that was created by society APPN for their members.

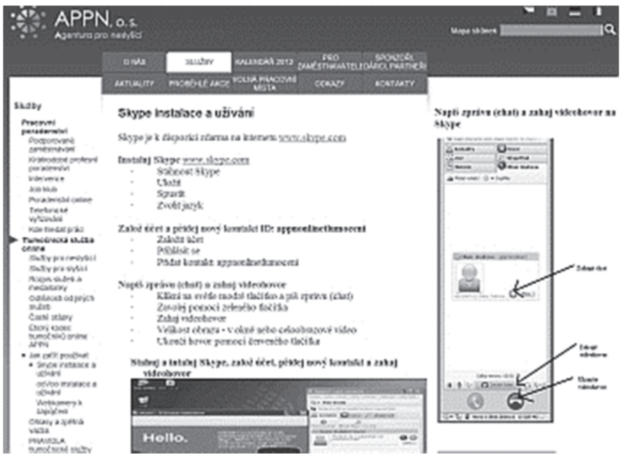

Figure 5: Online course for a specific target group (APPN, 2012)

The last example represents informal learning and blog or wikis as a support tool for social learning (interaction and information sharing in a customer club).

Figure 6: Blog – topic: How to use Skype? (Odpovědi.cz)

Our idea of using viral marketing approaches in e-learning courses corresponds also to one part of Khan's E-learning Framework (2004). Khan recognises next eight dimensions: pedagogical, technological, interface design, evaluation, management, resource support, ethical and institutional.

For evaluation of the course as a product, Khan emphasises marketing: "Effective marketing will help institutions to attract and recruit students for their courses and programs. An important marketing strategy for any offerer is to provide the accurate information about its e-learning offerings known to as many potential learners as possible".

We believe that marketing (and viral marketing approach) is important especially for non-formal and informal customer oriented courses. Their purpose is to communicate the response on customers' needs, to announce a value and motivate customers to use these courses or to study.

In this way we see it as an important part of the external and internal motivation.

Conclusion

When we return to our examples, what is the motivation to study these courses?

Example no. 1: Banking

- How to prevent malpractices on internet banking?
- How to spend time and money?
- And perhaps how to become a more skilled IT user?

This is certainly motivating by having the information on internet banking and to know how to save time and money...

Example no. 2: Of Money and Men

This course has a more general educational value. Its design is also interesting but the course has not strong impact on personal motivation (from authors' point of view).

Example no. 3: Gartner

Gartner's webinars are well-known educational tools aimed on IT professionals who are looking for the most up-to-date information on information technologies. The webinars are interactive, available for free and their added value lies in well-founded explanation, commentary and professional approach.

Example no. 4: Skype

Our example presents three possible ways. First – the course is created by company and delivered for free via You Tube. Second course uses some free external resource and offers web based supplements. The third one is not a typical e-learning course, but weblog – a part of informal social learning.

Although there are differences among the presented courses, the overall perspective of Skype e-learning is somehow similar. The second course is focused on activities for members of special group. The third one starts with internal motivation of an individual, but it is possible (through word of mouth) to send new useful information to friends and to share results of the learning process.

All in all, the e-learning has a strong potential to be used as an appropriate educational tool. Possible fields for use are almost everywhere (see ASTD survey: trends 2011, how the organisations use e-learning). As seen, various subjects can use it to educate the target groups in various domains, be it Czech National Bank or just a specific group of people with similar interests/objectives.

Like in every domain, also in case of e-learning the main target is to deliver value. Simple sharing, educational potential, and easy access to courses (even the advanced ones may be for free) are not the only triggers of interest. The possible use of tools of viral marketing is an important issue for consideration.

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A New Programmed Learning Module in LMS Moodle

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Abstract

The contribution deals with the principles of programmed learning, specifically with implementing a new module to LMS Moodle. This study activity allows the construction of a new question type. If a student doesn't answer correctly, the main question is substituted by a set of easier sub-questions. The order of these sub-questions is set by means of question maps suggested by the teacher. All processes related to displaying, answering and evaluating the questions are managed by the Moodle question-answering system. The new module extends the offer of question types in LMS Moodle. The paper briefly introduces the principles of programmed learning and it describes the method of branching learning that is used in the module implementation. Next the methods and the used tools for the module implementation are presented. The question map as a core of the module is explained, its function is described and the cooperation with the question bank is presented. The use of the module is explained on a simple example. Finally the results of the new module as tested by users are discussed.

Keywords

Education. Programmed learning. LMS Moodle. Question-answering systems. Graphical user interfaces.

Introduction

A lot of e-learning courses are constructed on the basis of a common template. The study texts are presented and then the teacher examines the students' knowledge and their understanding of problems by means of self-tests or tests. These two areas (study texts reading and testing) are generally divided from each other. A self-test as a teaching tool is an effective way of practising, but the use of programmed learning and integrating the practice straight to the learning process is a further approach to the problem of effective learning. The study problems are divided into a number of small parts sequenced in a logical order. Each part is controlled by a question and the correct or incorrect answer to this question navigates the student to the next selected part according to the correctness of the answer. This approach supports the student's activity and makes the texts more comprehensible. If a student answers correctly she/he continues to the next problem. On the other hand, if the student answers wrongly, she/he can study the problem in a row of smaller and simpler sub-problems.

In the paper we present the implementation of an approach that is best illustrated by one of the study activities in LMS Moodle. The result of our effort is the new module of LMS Moodle that uses the questions taken from QB to create a set of new questions and it is exclusively based on the Moodle mechanism of answering and evaluating the questions. The module allows constructing a new question type which can be related to simpler sub-questions from QB and the course teacher can determine the way of proceeding through the sub-questions.

Programmed learning principles

Programmed Learning (PL) as a learning methodology was introduced for the first time by B. F. Skinner in 1958. According to Skinner, the purpose of programmed learning is to "manage human learning under controlled conditions" (Pritchard, 2009). Programmed learning has three elements:

1. it delivers information in small bites,
2. it is self-paced by the learner,
3. it provides immediate feedback, both positive and negative, to the learner

The methodology involves self-administered and self-paced learning, in which the student is presented with information in small steps often referred to as "frames". Each frame contains a small segment of the information to be learned, and a question which the student must answer. After each frame the student uncovers, or is directed to, additional information based on an incorrect answer, or positive feedback for a correct answer. (Pritchard, 2009).

The Skinner's ideas of linear programmed learning are developed by N.A. Crowder (1960) in a branching version of the Program Instruction approach. If the user makes a correct response, the program asserts the reasons why she or he was correct and moves on to a new material or a new task. If the user makes an incorrect response, the program informs the user about the error and then navigates the user back to the previous frame for another try or moves the user to a simpler task as a part of the main task solution.

Crowder's approach was used in implementation of the programmed principles to LMS. Some contemporary works follow these principles in the development of an adaptive environment in LMS depending on the content (Kapusta, Munk and Turčáni, 2010). These principles were also applied in the current study activity "Lesson" in Moodle. The student reads study materials and at the end of each small part she/he is questioned according to the content of the study text. The question is in the multiple choice format and each choice navigates the student to the next part of the study text. The activity Lesson doesn't allow the application of different question types. That's why we focused on developing a new activity for the construction of questions. It is a new type of questions that consists of a set of sub-questions. These sub-questions are simpler and clearer than the main question and they explain the solution of the main problem in smaller steps. If the student doesn't solve the main problem, she/he is moved to the first sub-question and if she/he solves this sub-problem, the solution process can continue by solving the main question or by solving the next sub-question.

Methods and used tools

In the first step of the implementation of the programmed learning module we looked for a suitable LMS that supports PL or supports the implementation of PL into the system. According to these findings we have selected LMS Moodle with respect to the following:

- Wide community of LMS users and developers worldwide

- Widespread use in many educational institutions
- Rich and useful documentation

Last but not least, LMS Moodle is used at University of West Bohemia and the implementation can be done in cooperation with the local lecturers and on the basis of their demands. We selected LMS Moodle version 2.0.2 and now the system is being prepared under the new version 2.1.

The developed module allows the implementation of the branching program according to N.A. Crowder. Each branched sub-question can be connected to the next question via two references. One of them is used in case of a correct answer to the question; the other one follows in case of a wrong answer. The student is guided to a suitable question in compliance with the prepared scheme (question map). The basic principle is shown in Figure 1.

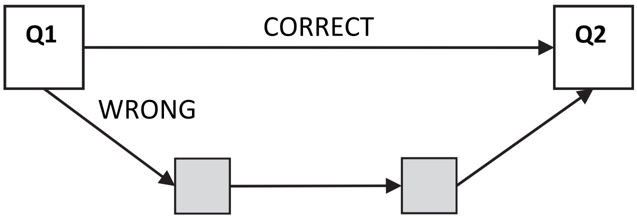

Figure 1: An example of question branching (Source: own)

Figure 2 shows a graphical object that represents a sub-question as a basic building element in the construction of the main problem (question). The question creator can position the question as the first one in the chain of the sub-questions; she/he can then set the following question according to whether the answers were right or wrong and furnish them with possible control elements.

During the implementation of the module we followed the below principles:

- User friendly environment for students and course teacher
- Easy localization to other languages
- Maximum employment of the current program code of Moodle
- Possibility of controlling the students´ results and progress

The success of the basic programmed learning principles depends on the course teacher. It is necessary to prepare study texts and it is important to divide the problems into smaller and easier parts carefully. Thanks to the course structure it is possible to attach a short lesson or study text with an appropriate question or with a set of such questions.

We used LMS Moodle documentation (MoodleDocs, 2011) widely describing the implementation of the new module step by step. The support for a Moodle developer offers a pattern of the new module and it allows its modification.

PHP was used as the main programming language (PHP DTP, 2011). The new module was implemented on MySQL database. In the module the universal database adapter in Moodle code has been integrated and the module can cooperate with any database supported by Moodle. The important part of the new PL module is the question map (QM) that allows constructing and displaying the scheme of questions. This graphical user interface was developed by means of the JavaScript component jsPlumb (jsPlumb, 2011).

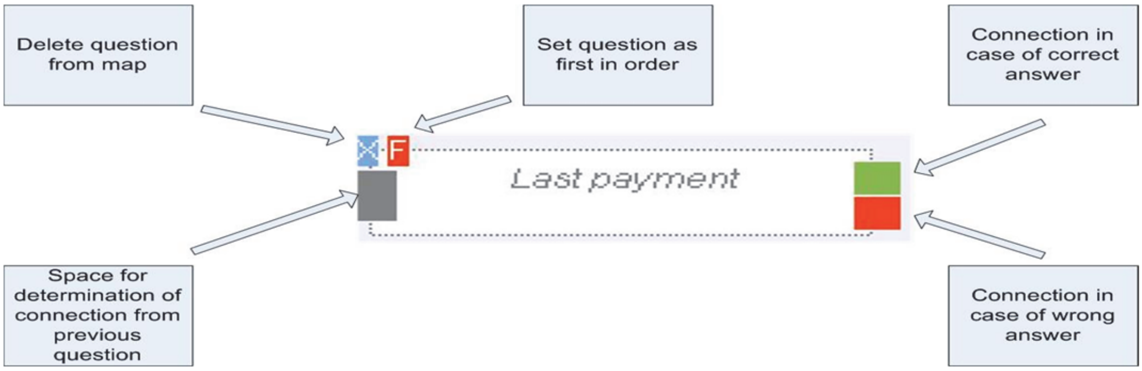

Figure 2: An example of question positioning (Source: own)

The component jsPlumb enables to insert the questions from the question bank to the QM and the setting determining how questions are interconnected. The teacher manages all these operations by means of mouse only. As a part of jsPlumb the jQuery JavaScript component is employed. We selected version jQuery 1.4.4 and version jsPlumb 1.2.5.

After saving QM the process has to detect the position of the question elements on QM and to detect the connections among them. These data are saved in JSON format (JavaScript Object Notation) from YUI2 library (JSON, 2011); they are then transferred to the server and then they are saved to the database. Moodle consists of a basic part of YUI2 library and the JSON part installed as an attachment of the library.

PL module proposal and implementation

The process of the new PL question creation starts by selecting a new student activity – a PL question. The creator fills in the name of the question and maximum grading as in the case of other questions. Then the environment of PL question construction opens.

The basic element of the environment is QM. This scheme consists of smaller and easier problems that explain the main problems (questions) and their solution. The QM allows inserting different questions and setting connections among them. During the implementation we used the current system of questions in Moodle and their evaluation. It means that the questions of all the offered types can be inserted to QM from the question bank, and, at the same time, all questions, i.e. both the main question and the relevant sub-questions are part of QB in any category. The graphical user interface of QM is shown in Figure 3. We used an example from financial mathematics – the calculation of the last irregular payment of annuity. This problem consists of several steps – sub-problems. First of all the student has to determine the number of periods, then she/he has to know how to calculate the future value of annuity and then she/he has to determine one of the two methods for the last irregular payment calculation. All of the described sub-problems can be practised by means of single questions that are prepared in the question bank. This QB is displayed together with the QM for the teacher (question creator) in the same form as it is during the quiz creation (see Figure 4).

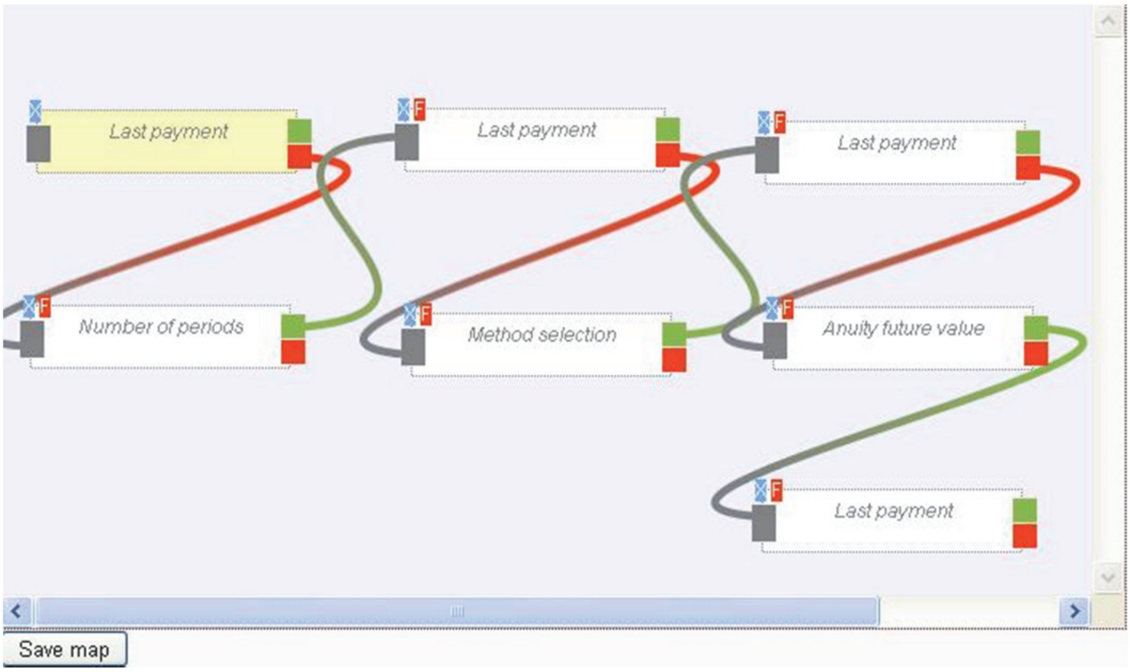

Figure 3: An example of a question map (Source: own)

The questions are moved from QB in the same manner as in the quiz creation. A new graphical object (see Figure 2) representing the question is created in the window of QM. Then the creator can move this object to any place on the QM and then she/he can connect the question to other objects by means of mouse dragging. Finally the QM and the whole PL question are saved.

Evaluation of PL module

We tested the use of the new module in cooperation with 8 users. They had to create a new PL question in the implemented module and to connect the sub-questions to one another. The PL question consisted minimally of 3 sub-questions. Finally the users tested and evaluated the new PL question from the student´s point of view. No users had known LMS Moodle as administrators before and that's why the basic procedures in the administration of the system were explained to them, but the administration of the new module was not mentioned. The results showed the following conclusions:

- Despite the fact that the users had no previous experience with the administration of the system, 75% of them used the new PL module without any problems.
- Only one user met a serious technical problem, because she/he operated Moodle in an older web browser version.
- Most users (75 %) felt that using the new module would be interesting and useful for students.
- The users suggested only one innovation of the module, and that was improving the orientation in QM in case of a larger number of sub-questions.

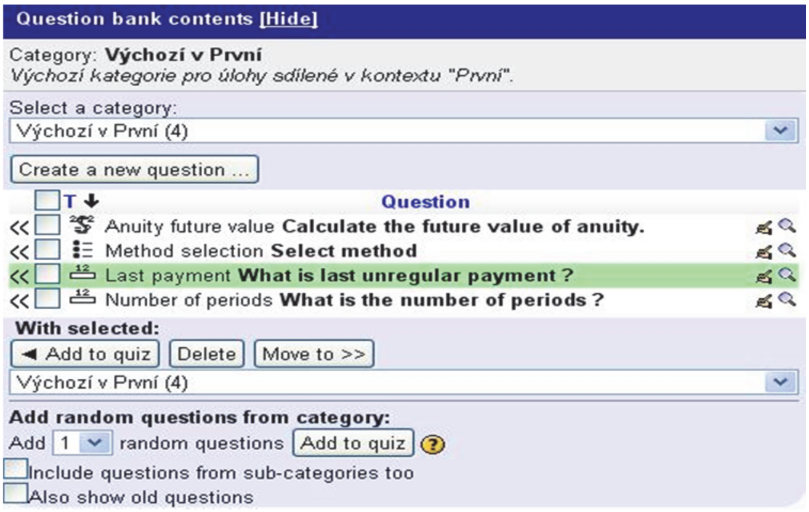

Figure 4: An example of questions in the question bank (Source: own)

Conclusion

The presented new module integrates the principles of programmed learning into the courses in LMS Moodle. The proposed mechanism of the question map allows the teacher to determine the way of solving difficult problems. Students can solve the question in smaller and easier steps. With respect to the determined scheme of the sub-questions the student can return back to the main problem after succeeding in the solution of any sub-problem.

Based on testing the module by users and on our experience the following improvements can be done:

- A detailed report about the progress of students in the course of solving the PL question,
- Clear management of sub-questions with respect to their number. The implementation of question maps as a separate window with an adjustable size is desirable.
- The implementation of a PL question in the form of a new question type under the Moodle question-answering system.

The next step in developing the new question type is the implementation of a recursive mechanism and improvements in the structure within the question map.

Despite the above mentioned imperfections the developed module proved a useful tool for enhancing the students´ learning efficiency. At last the quality of learning depends solely on the way how the teacher proposes the structure of all the sub-questions.

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Using Marketing Models to Review Academic Staff Acceptance of Digital Technology to Enhance Learning in Higher Education

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Abstract

Traditional management approaches suggest that resistance is an enemy of change. However there is an increasingly attractive counter view which suggests that, resistance is something to be explored and understood, in order that communication and understanding about the proposed change is better implemented. This is the approach taken in this paper, which seeks to explore resistance among academic staff to the adoption of technology affordances in Higher Education teaching and learning.

The initial hypothesis based on survey research suggests that there will always be faculty who try to avoid information and communication technologies (ICTs) – beyond basic PowerPoint™ and email - and thus will be unable to take advantage of learner engagement through the pedagogical affordances both of virtual learning environments (VLEs) and of Web 2.0. Institutions increasingly require staff to adopt basic engagement with VLEs, but that is as far it goes with many teachers. Rather than just have to put up with this situation, or make people participate despite their personal views, we should seek to understand better what causes such resistance, what underlying personal pedagogies are driving this perspective, and how best to accommodate strongly held personal pedagogic diversity amongst teaching staff. The application of a recent marketing model to the adoption of digital technology helps us to understand both the negative force of resistance and the potential positives we might find useful.

The research discussed in this paper analyses initial qualitative unstructured interviews with staff, selected for their reluctance to explore the possible learning and teaching affordances of ICTs. Results from this initial study have been discussed in relation to current thinking on change management discussions of resistance (Waddell and Sohal, 1998, Ford et al., 2008), and the application of a business marketing model which focusses on customer centrality has then been applied to guide our thinking and offer some tentative recommendations on how this phenomenon may be further studied and how institutions wishing to develop staff adoption of ICTs in learning and teaching may proceed.

Keywords

Technology Enhanced Learning. Resistance To Change. Pedagogies.

Introduction

Brighton Business School has been using and evaluating learning technologies, initially through an intranet and then through virtual learning environments (VLEs), for over a decade (Flowers et al., 1998). For much of this time, academic staff enthusiasm for developing learning and teaching has been the main driver for adoption (Greener et al., 2007), however, as for many other Higher Education Institutions (HEIs), this has led to a disparate pattern of adoption. From the outset, the introduction of these technologies in learning and teaching has led to both more and less informed debate, with academics often vehement on both sides. The use of technologies in learning challenges the nature of the academic's role (Greener, 2008) and offers us vehicles by which to drive forward teaching beliefs and pedagogic practice, but can also crash into the barriers of time-poor teachers' deeply held values and sense of self-efficacy.

Resistance

As Flowers, Newton and Paine pointed out back in 1998, there is much about the notion of culture change involved in the adoption of learning technologies. These writers used Rogers' work (1962) on the diffusion of innovation and Moore's "chasm" between early adopters and mainstream users of technology change (1991) to explore staff responses to their new intranet for learning and teaching. Traditional management approaches suggest that resistance is exhibited by mainstream and "laggards" in relation to the change, and this seems self-evident when we look at the total academic population of an HEI in relation to technology-enhanced learning. Conferences on e-learning offer many examples of exciting innovations which have not quite made it to the mainstream. The enthusiasts are prepared to put in more time, more effort and more love to achieve the innovation they believe in, than those for whom the innovation is presented as a given.

We tend to describe this reaction against the enthusiasts as "resistance". Although usually considered a negative concept, Waddell and Sohal (1998) among others discuss the positive utility of resistance. Seeing resistance as a potentially positive response to change starts to counter the idea that all change is good and all resistance is bad. We know from the dangers of groupthink (Janis, 1983) that an idea which is subject to little opposition may be a flawed idea and lead to bad decisions, or as Maurer suggests:

"*Resistance is what keeps us from attaching ourselves to every boneheaded idea that comes along*" (Maurer 1996, cited in Waddell and Sohal, 1998: 545)

But as Ford, Ford and D'Amelio explain (2008), even positive thinking about the utility of resistance can lead to a reification of the idea of resistance. Innovators come to expect resistance and this becomes a self-fulfilling prophecy, whereas all that may be there under the label of "resistance" is a thoughtful scepticism, which is bred from endless media hyperbole about "the latest" thing to hit our screens. These authors offer the concept of "inoculation theory" which assumes resistance is something to be countered and ends up hardening the presumed resistance.

"*Inoculation theory suggests that change agents who do not develop and provide compelling justifications that overcome the potential or prevailing counterarguments, or who fail to demonstrate the validity of those justifications, end up inoculating recipients and increasing their immunity to change*." (Ford et al., 2008 : 366)

Such a theory has an immediate resonance with those of us who return from e-learning research conferences full of great ideas for application to teaching and learning, only to find a distinct lack of enthusiasm amongst our colleagues, indeed strong opposition from some. It is then easy to make assumptions that X will never consider technology and Y will not be prepared to change their ways of teaching, points of view which clearly set up their own ripples of resistance. Ford et al's contribution to this debate (albeit in the field of change management rather than learning technology) is to make us sit up and take notice that our assumptions about non-enthusiasts for technology could actually be causing some of the resistance we encounter. They make the positive case for resistance, an increasingly attractive counter view, which suggests that resistance is something to be explored and understood, in order that communication and understanding about the proposed change is better implemented.

Academic staff adoption of technology and marketing models

Bovey and Hede (2001) put forward the idea in their paper on defence mechanisms in organisational change that too often change is driven in organisations from the top with a major emphasis on the technical features of the change and with little attention to the individuals involved. This notion is reflected in Morris and Rippin's account of educational institutions' adoption of technology for learning (2002) in which they analyse institutional adoption strategies as enthusiast/explorer, emulator, efficiency seekers and entrepreneurs, none of which strategies focuses on individual teachers' responses to the imposition of learning technologies from the top. So should we take a more user-centric view? In a very recent publication (2012) in the business marketing field, Sheth and Sisodia offer a new take on traditional marketing approaches from an organisation perspective (generally known as the 4 Ps of price, place, product and promotion) and design a new marketing model from the user or customer perspective. Just as the early adopter model from Rogers and later Moore (1991) related the theory of adoption to marketing products and services which has been frequently used in the discussion of technology adoption, so Sheth and Sisodia offer a marketing model which we can apply to staff adoption of technologies for learning. Their model looks at the innovation's acceptability (the extent to which the innovation meets user expectations), affordability (ability and willingness to pay – in our case from an institutional perspective, although educators will also pay in terms of professional time), accessibility (the availability and convenience of the innovation) and awareness (both of brand and product knowledge).

Institutions increasingly require staff to adopt basic engagement with VLEs, but that is as far it goes with many teachers. Rather than just have to put up with this situation, or make people participate despite their personal views, we should seek to understand better what causes such responses, what underlying personal pedagogies are driving this perspective, and how best to accommodate strongly held personal pedagogic diversity amongst teaching staff. As part of a larger project to explore and map academic staff stances in relation to e-learning and e-teaching, the exploratory research discussed in this paper first analyses survey responses from staff involved in e-learning and then initial qualitative unstructured interviews with staff, selected for their reluctance to explore the possible learning and teaching affordances of ICTs.

Findings

Research conducted in 2009 through two small surveys of academic staff involved in some way with technology enhanced learning, many of them engaging with this for the first time, produced evidence that trying to understand staff responses to e-learning and e-teaching was not going to be a straightforward area of enquiry. The staff groups surveyed had all expressed an active interest in learning and teaching by participating in the surveys, and the table below shows responses to questions about what they found most and least fulfilling in their early experience of using TEL.

Table 1: Snapshot of data from 2009 staff surveys showing most and least fulfilling responses to using learning technologies for the first time. (Codes denote respondents).

MOST FULFILLING ASPECTS	LEAST FULFILLING ASPECTS
A1: learner responses	A1: colleague inertia
A2: really getting into using ICT with my students and completing a PhD.	A2: staff development ICT sessions (at request of senior management)
A3: advanced learning	A3: time-consuming.
A4: it was fun	A4: that there's a danger not to be considered proper learning.
A5: I love being able to access online databases from home daytime.	Nil response
A6: student involvement, motivation and improvement	A6: time consuming (not credited within workload)
A7: learning with the students and developing/expanding my knowledge at the same time	A7: finding the time to do it
A8: no need to photocopy handouts	A8: the fake sense of security it instills in students (slower)
A9: student reaction	A9: fixing technological inadequacies.
A10: sharing experience of learning	A10: time spent preparing classes face to face.
A11: new things	A11: learning new skills takes time,
A12: feedback	A12: college access to web
A13: seeing technology take off	A13: lack of appreciation for time and effort.
B14: to see it was being used by the students	B14: that students didn't use it anymore
B15: saving of previous work	Nil response
B16: real time interaction	Nil response
B18: variety/pacing	Nil response
B19: new forums for collaborative learning	B19: unreliable access to technology
B20: ease of studying	B20: lack of technology support, some equipment still not used!
B21: empowerment of students	B21: extra work load, clumsy operation
B22: creative process of designing material	B22: lack of time to experiment, carry it through
B23: seeing mature students engage in new technology	Nil response
B24: students love it	B24: it takes hours
B25: getting it right	B25: not knowing how to complete tasks
B26: seeing it up there and having a student say it was really useful!	Nil response

Table 1 gives a flavour of a range of factors considered relevant to the experience of using learning technologies. There are some familiar joys such as empowerment of students, creativity, innovation and some familiar sorrows such as technology difficulties and time taken to prepare the design. In an initial review of these and other findings from the surveys (Greener and Rospigliosi, 2009), the aim was to explore differences between respondents who were personally stating they were early adopters and enthusiastic about new technologies, and those who considered themselves mainstream in relation to innovation adoption. The expected differences were not as clear as expected. While the self-professed early adopters did focus more on the technical software issues of adoption, and the mainstream group focussed more on time and workload issues, there were few other distinctions between the two groups.

Discussion

This leads us to look more closely at the way staff might be responding to innovation in learning and teaching. Liao and Lu (2008) discuss the Davis' Technology Acceptance Model (1989) and alternatives to TAM's perceived usefulness and ease of use and derive "relative advantage" and "compatibility" as drivers to new technologies adoption by teachers. Relative advantage can be easily understood as perceived advantages offered by the technology in comparison with alternatives. Compatibility relates to the relationship between the technology and the adopter's beliefs, values and philosophy of teaching. The variation in teaching beliefs and personal pedagogies which might affect the pedagogic use of learning technologies seems logical, but this analysis alone could easily lead to the labelling of staff as for or against technologies on the basis of apparently static pedagogies. It would be easy for enthusiastic adopters to suggest that those who did not adopt technologies were in some respect worse teachers with didactic and outdated beliefs about learning and teaching. This idea does not stand up to scrutiny, since in our HEI there are several known teachers who are respected for award-winning teaching in the classroom and who are nonetheless opposed to the adoption of learning technologies.

If we return to the Sheth and Sisodia model we can see that from a user's perspective, innovations in technology for learning suffer differing levels of acceptability. This latter dimension of the model refers to both functional acceptability, including how easy it is to use, quality and reliability, and psychological acceptability, including social and emotional value and perceived risk. The common concern over time to implement new innovations in Table 1 relate to functional acceptability (and to some extent psychological affordability), and the concern that such teaching will not be taken seriously relates to psychological acceptability. Technology access and availability concerns relate to the model's dimension of accessibility.

This suggested that a search was needed for other possible distinguishing factors within the academic population, factors which might help us understand responses to TEL adoption with sufficient depth to enable improved ways of interpreting and supporting this kind of change. One such distinguishing factor was proposed by Trowler's work (2009) on sub-disciplines, which introduced distinctions between subject disciplines relating to dimensions such as hard/soft, urban/rural, convergent/divergent, and pure/applied focus. Could such differences help to explain responses to technology? Another factor to be considered in future research would be general experience of internet use. A useful paper by Eynon focussing on young people offers a simple typology of internet usage: peripherals, normatives, all-rounders and active participants (Eynon, 2009). It could be argued that the active participants category, who represented 14% of her data based on over 1000 participants, and were regularly communicating, seeking information, using entertainment, using creative sites for writing or music and participating in blogging, wiki editing, podcasting etc, could be a similar category to Drent and Meelissen's "personal entrepreneurs" (2008) in terms of technology usage and exploration – activities confined to early adopters.

One further factor from current literature which may help us to distinguish amongst the academic population is the digital skillset available to them. Van Deursen and van Dyk (2009) discussed skillsets to do with internet use and identified four groups of such digital skills: operational, formal (e.g. navigation), information (search and evaluation) and strategic (pursuing and solving a problem or goal through use of internet skills. It could be hypothesized that active participants/personal entrepreneurs would be high scorers on all four skillsets but that other groups such as those opposing the use of technology were lower on information and strategic skills. All these distinguishing factors: subject sub-disciplines, internet usage, digital skillsets, as well as personal beliefs about teaching are hypothesized as potentially helpful in mapping the academic population in relation to e-learning adoption.

Next stage of research

Informal and unstructured interviews were carried out among Business School academic staff to test the possible relevance of these divergent factors among a set of the population which was least enthusiastic about learning technologies. This was done informally as a pilot study to explore the viability of this line of enquiry. All interviews were recorded and subjected to thematic analysis. Early results show the following themes.

Table 2: Themes from interviews with reluctant users of learning technologies and their relationship with hypothesized factors differentiating the academic population in relation to learning technologies adoption.

Themes arising from unstructured interviews	Hypothesized factors differentiating academic population in relation to learning technologies adoption	Sheth and Sisodia model (2012) dimensions implicated
Lack of interest and curiosity with regard to learning technologies	Internet usage, teacher role? self-efficacy?	Awareness: product knowledge Acceptability: psychological acceptability
Strong core pedagogic beliefs, often drawing on personal experiences of learning	Subject sub-disciplines, teaching beliefs	Acceptability: psychological acceptability
Difficulties with navigation on web and VLEs	Digital skill set	Awareness: product knowledge Acceptability: functional acceptability
Aiming to reproduce face to face teaching paradigm online	Teaching beliefs / digital skill sets	Accessibility: convenience
Focussed on the learning value of face to face interaction in the classroom	Teaching beliefs	Acceptability: psychological acceptability
Persuaded of view that uploading materials would decrease class attendance	Teaching beliefs	Awareness: product knowledge
Belief that they are lazier than those who use learning technologies, justifying this on time grounds	Digital skill set	Affordability: psychological affordability
Unhappy about sharing materials on web or VLE	Internet usage, teacher role?	Acceptability: functional acceptability
Association of web usage with surface learning for students	Teaching beliefs	Acceptability: functional acceptability
Often last minute preparation of teaching	Teaching beliefs, teacher role?	Affordability: psychological affordability

Concluding comments

These findings so far suggest that our hypothesized factors may help to explain some of the divergence in the ways academic staff relate to technology-enhanced learning. Teaching beliefs appear to be most clearly represented in the themes arising from the data, while subject sub-disciplines so far are proving less helpful. An additional factor, that of teacher role, has been applied to try to understand the degree of openness or preparedness to share materials either with colleagues or on the web. It could be argued that this is strongly related to the sense of connectedness experienced by many regular web users, so that in fact this is a product of internet usage. The ideas relating to a teacher's role also seem relevant to the theme of last minute preparation. The latter point is doubtless not confined to reluctant users of technology, however their lack of use of technology may contribute to the need for last minute preparation. Alternatively this could be explained by an attitude or belief about pedagogy.

It may be, however, that in this analysis we are putting too much emphasis on teaching beliefs. The difficulty in Higher Education is to find a way to change them. While new academic staff are generally required to undertake courses in learning and teaching to help develop and challenge their personal pedagogies, existing academic staff have little incentive to review and challenge these beliefs. The rapid growth and spread of digital technology has tended to paint these teachers into a corner – either they embrace change and see this as a professionally rewarding move, offering them learning and improved achievements with students, or they may feel cut off from the growing move to use VLEs as more than repositories for materials, and dig their heels in as enthusiasts try to "convert" them – a form of inoculation theory as discussed above. It is clear from the early findings that staff who say no to technology do show strong beliefs about pedagogy. These are frequently related to the member of staff's own prior learning experiences, which did not involve such digital technologies and are not simply a rejection of the new, but a statement of belief and value, particularly evidenced in strong defences of the importance of classroom interaction to produce insight and deeper learning behaviours from students. When things do go "wrong" for these teachers, they are less likely to seek help from colleagues or rethink their pedagogy, believing that they can put things right by sticking to what they know that works for them or, in just a few cases, blaming the students and the technology they are using.

The above table also demonstrates some possible relationships between factors affecting adoption of technology with reluctant users and their relationship to the 4As model of Sheth and Sisodia. The latter model offers a simpler way of understanding the criteria which are being used for technology adoption and can offer a way forward for demonstrating value to such reluctant users through concentrating on Acceptability, Awareness, Affordability and Accessibility of technology tools for learning.

The research so far has been limited to small scale unstructured interviews with staff who were kind enough to take part and happy to consider themselves reluctant users of learning technologies. This preliminary study has helped us to explore factors which might be used to map the academic population in relation to the use of technologies in learning and teaching. The methods used have been qualitative as what we are exploring here are differences of perceptions relating to beliefs, behaviours and educational environments. Further research is suggested which explores a broader, more representative sample of academic staff, perhaps controlling for subject discipline in the first instance, and attempting to build profiles of responses to technology on the basis of pedagogies, digital skillsets, internet usage, views on teacher roles in HE and self-efficacy in relation to technologies.

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Mathematical Competence Development with the Use of E-learning

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Abstract

The changing market conditions relating to globalization processes cause changes in human resource management. Employees wishing to retain their job must be flexible and capable of quickly adapting new technologies, especially information technology. Standard qualifications, especially in the area of advanced technology, are not sufficient any longer, which forces people to use new techniques and technologies of teaching, especially in sciences directly related to information technology. Learning throughout the life has been noticed and appreciated by the European institutions. They have defined eight key competences that are needed by everyone for self-fulfillment and personal development, for active citizenship and full social inclusion and employment. These include, inter alia, mathematical competence. It has been described very accurately described by Mogens Nisse. The idea of mathematical competence exists in the Polish and Czech standards of examination requirements. This article presents doctoral thesis research tasks undertaken at the Faculty of Education, University of Ostrava in the field of development of mathematical competence in students of secondary schools with the use of e-learning. This article presents present condition of the problem and the AIMS study.

Keywords

Key competences. Mathematical competences. E-learning. Information and communication technologies in education.

Introduction

Contemporary education process, which is inter alia aimed at establishment of an interaction enhancing relationships between the participants and ensuring adaptation of the students to modern social and economic conditions and at personal fulfillment and development of creative potential of a particular person, requires development of innovative educational technologies, including extensive use of contemporary information and communication technologies for personal and professional development. Currently, it is identity of the learner that is the focus of all stakeholders of the educational process. More and more emphasis is being put on the need and necessity of development and improvement of individual creative and intellectual abilities and on shaping and strengthening competences.

Standard professional background, especially in the area of advanced technology, may be not sufficient anymore, which makes it necessary to use new techniques and technologies of teaching, especially in sciences directly related to IT.

Fast obsolescence of information and knowledge gained by employees which occurs during the very process of learning makes it necessary for information and knowledge to be constantly updated and enhanced.

One of the next stages in the development of computer-assisted teaching is development of a proprietary theoretical and methodological computer-oriented system for development of mathematical competence of students with the use of selected computer software and distance education and preparation of the learner for the final secondary school examination in mathematics.

Mathematical competence (Heba, Smyrnova–Trybulska, 2011)

In a well-known document (Recommendation 2006/962/EC of the European Parliament and of the Council of 18 December 2006 on key competences for lifelong learning [Official Journal L 394 of 30.12.2006]) adopted in 2006 eight key competences that are needed by every person for self-realization and personal development, for being an active citizen and for achievement of full social integration and employment are defined. Competences are defined as a combination of knowledge, skills and attitudes appropriate for the situation. Key competences are those which are needed by all individuals for personal fulfillment and development, active citizenship, social inclusion and employment. The following key competencies have been established:

1. Communication in the mother tongue,
2. Communication in foreign languages,
3. **Mathematical competence and basic competences in science and technology,**
4. Digital competence,
5. Learning to learn,
6. Social and civic competences,
7. Sense of initiative and entrepreneurship,
8. Cultural awareness and expression.

Mathematical competences are ranked third among the key competencies – **'Mathematical competences and basic competences in science and technology'.**

Mathematical competence is very precisely defined by Mogens Niss (Niss, 2001). He has identified **eight elements of mathematical competence.** *He has defined* it as 'the ability to understand, judge, do and use mathematics in a variety of intra- and extra-mathematical contexts. The necessary but certainly not sufficient prerequisites for mathematical competence are extensive factual knowledge and technical skills. (...). Mathematical competence includes two overarching sorts of capabilities. The first is to ask and answer questions about, within, and by means of mathematics. The second consists of understanding and using mathematical language and tools.' *He has identified the following eight competencies:*

- Thinking mathematically (mastering mathematical modes of thought);
- Posing and solving mathematical problems;
- Modeling mathematically (i.e., analyzing and building models);
- Reasoning mathematically;
- Representing mathematical entities;
- Handling mathematical symbols and formalisms,
- Communicating in, with, and about mathematics;

- Making use of aids and tools (including information technology).

Mathematical competence, defined in the document **'Key Competences for Lifelong Learning - A European Reference Framework' (MKKE),** is defined as a combination of knowledge, skills and attitudes appropriate for the situation. (European Parliament legislative resolution on proposal for recommendation of the European Parliament and of the Council on key competences for lifelong learning, 2006)

Knowledge:

- W1. understanding mathematical terms and concepts;
- W2. well controlled numeracy;
- W3. knowledge on measures and structures;
- W4. knowledge on basic operations and basic mathematical presentations;
- W5. awareness of questions to which mathematics can offer answers.

Skills:

- U1. applying key principles and processes of mathematics in everyday situations at home and at work (in a mathematical way to reason);
- U2. monitoring and evaluating argument strings (understanding mathematical proof);
- U3. transmitting messages with the use of mathematical language;
- U4. using mathematical text.

Attitudes:

- P1. showing respect for the truth;
- P2. striving to search for causes;
- P3. evaluating validity of inferences and actions.

Selected mathematical competences have been included in the new Polish and Czech standards of examination requirements for the final secondary school examination in mathematics.

According to **the Polish standards of examination requirements in mathematics** (the Ordinance of the Minister of National Education changing the ordinance on standards of requirements being the basis for conducting tests and examinations dated of 28 August 2007 (Journal of Laws No. 157, item 1102), the candidate shall have skills enabling her / him:

- to use and create information;
- to use and interpret representation;
- to use mathematical modeling;
- to use and develop strategies;
- to reason and to present arguments.

Taxonomy of educational objectives

Any education is focused on goals. Purpose of education is defined as intentional result of the student and the methods and work organization are subject to the teacher understanding the defined objective. In other words, there are some intended characteristics of students in terms of their mastery of specific activities. General objectives indicate directions of teaching aspirations. Operational objectives mean a description of the results to be achieved and shall be construed as objectives intended to be achieved by the students. The hierarchical classification purposes are called taxonomy of learning objectives. This name (Gr. taxis – order, nomos - law) stresses that the categories of objectives are in some way ordered. The purpose of taxonomy is that the higher categories are included in the lower categories, and thus achievement of the higher ones indicates that the lower ones have been achieved. It was Benjamin S. Bloom (Bloom, 1956) who started to popularize taxonomy in education and who published the first paper on this topic as early as in 1956.

It has identified six categories of cognitive objectives:

- messages;
- analysis;
- synthesis;
- understanding;
- applicability;
- evaluation.

Another famous kind of taxonomy is taxonomy of learning objectives ABC (Niemierko, 1973) which consists of two levels of objectives - messages and skills, while each of these levels consists of two categories.

- Category A – Storage of messages;
- Category B – Understanding of the message;
- Category C – The use of messages in typical situations;
- Category D – The use of messages in problematic situations.

Current data on mathematical competence level among Polish high school students

The report on matura examination in 2010 and the 2011 report of the Central Examination Commission (sprawozdanie z egzaminu maturalnego w 2010 roku oraz 2011 raport Centralnej Komisji Egzaminacyjnej) presents the current data on the level of mathematical competence among Polish high school students.

Closed tasks tested mainly knowledge and understanding of mathematical concepts, definitions and theories as well as ability to use that knowledge in practice. Open tasks checked ability to analyze and interpret mathematical problems and to formulate mathematical description of the situation.

The table presents conclusions on mathematical competence level relating to individual skills that are the least mastered by the students. Ease indicators allow for grouping the tasks into categories of difficulty. The indicator interpretation below was given by prof. Boleslaw Niemierko (Niemierko, 1973).

Table 1: Interpretation of task ease indicators by prof. Boleslaw Niemierko

Ease index task	Interpretation of the task
0.00-0.19	A very difficult task
0.20-0.49	A difficult task
0.50-0.69	A moderately difficult task
0.70-0.89	An easy task
0.90-1.00	A very easy task

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Preliminary conclusions

After the analysis it can be noticed that the ease index level of the entire examination for the school year 2009/2010 was 0.63 which means that it was moderately difficult for the students while in the school year 2010/2011 it decreased to 0.48 which means that the exam was difficult for the students. The students showed the least skills in reasoning and argumentation, mathematical modeling and the use and development of strategies. The level of ease of individual tasks ranged from 0.08 to 0.94 in the school year 2009/2011 and from 0.07 to 0.91 in 2010/2011. The least mastered skills of the students were:

Table 2: The least mastered skills at matura exam in mathematics.

Mathematics department	Least mastered skills during the matura examination in mathematics in the school year 2009/2010 and 2010/2011	Task ease level
Functions	reading the graph: a set of values and the maximum interval in which the function is decreasing;	0.49
	solving the tasks placed in a practical context, leading to a quadratic equation with one unknown;	0.38
Analytical Geometry	use of equation of a circle and checking whether a straight line is a tangent;	0.40
	determination of coordinates of the point of tangency with the circle;	0.20
Planimetry and Stereometry	use of relation between the central angle and inscribed angle;	0.41
	justification that the indicated angle is simple;	0.07
	measuring the use compounds in an equilateral triangle and square;	0.46
	use of simple relation between the trigonometric functions of acute angles;	0.32
	metric determination of compounds in a cube;	0.34
	calculating the volume of a polyhedron;	0.47

Objectives

The expected PhD thesis aims to improve the learning process in terms of:

- better results in the subject 'Mathematics': we assume that the final test results of students using the author's program named 'Mathematics of Moodle' with computer software 'Geogebra' will be better than the ones of the students who did not use the author's program;
- increasing the level of selected competencies in mathematics, in particular of the ones that are least mastered by students in the following sections: 'Functions', 'Analytical Geometry', 'Planimetry and Stereometry'

Why ICT and e-learning

While teaching mathematics in the secondary school (as proved by analysis of the matura exam results), the teachers spend too much time on simple skills, routine checks and reasoning which is in

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its nature boring and tedious when done more times than necessary. Such 'memory checking' destroys interest in mathematics and desire to deal with the problems seen for the first time (which is the essence of 'checking reasoning') in gifted students. For students less gifted in science, even a low threshold requirement is a too high barrier preventing them from achieving even small successes often enough to have an incentive to gain higher powers with more effort. Teachers focused on the 'average student' have no time to grade students' core competencies and are less able to develop mathematical interests of the brightest students. In the classical system of mathematics learning, a large part of the course must be dedicated just for the 'training' - for the use of known formulas or methods. Available computer technologies such as Moodle learning platform automate this kind of exercising through an interactive e-training or e-task. Through its functionality student's activity on the platform in the various modules can be tracked. Auditorium classes and teacher qualifications can be used in order to discuss more advanced topics and applications.

Research tasks

1. Analysis of literature, foreign and national experience in the study area, software for learning mathematics and distance learning.

2. Development of proprietary program for development of mathematical competence of students named 'Mathematics with Moodle', including:

- development of educational requirements for distance teaching of mathematics to students;
- development of theoretical and methodological requirements for e distance teaching of mathematics to students;
- development of study materials for students;
- development of teacher guide;
- development of distance mathematical course preparing students for the final secondary school examination in mathematics and developing mathematical competence of students with the use of selected computer software;
- development of organizational details of the distance course curriculum.

3. Conducting teaching experiments to verify effectiveness of the proposed methodology.

Characteristics of the mathematical competence development author's program named 'Mathematics of Moodle'

Mathematical skills development author's program named 'Mathematics of Moodle' (Heba, Smyrnova–Trybulska, 2011) is based on the ADDIE model, whose name is an acronym of the English words (analysis), (design), (design), (implementation) and (evaluation). This is a relatively simple model that can also be used when designing and implementing any type of learning – not just circuit training. ADDIE model consists of analysis phase, assumptions and conditions, course design, course development component, implementation and evaluation.

Construction of a good e-course run under ADDIE model is an ongoing process. The next stage after the evaluation stage is the stage of analysis which begins the next phase of work on the course aimed at creation of a product which is bug-free, efficient and most user-friendly.

One of the major components of a proprietary program for development of mathematical competence of students named 'Mathematics with Moodle' is a **methodological teacher guide**, which contains sample lesson plans detailing learning objectives, learning content, teaching technologies, methods and organizational forms of learning process based on the use of e-learning course and selected computer software The system also provides a detailed description of the developed remote mathematical course preparing for the final secondary school examination in mathematics and developing mathematical competence of students with the use of some computer software.

E-learning course preparing for the final secondary school examination in mathematics was available on the e-learning platform of the Faculty of Ethnology and Education Sciences University in Cieszyn Silesia in Katowice (http://el2.us.edu.pl/weinoe).

The course has a modular hierarchical structure and consists of several standard blocks (Smyrnova-Trybulska, 2007):

- **Introduction to distance course:** Course description, Literature, Glossary, Forum, Registration Survey;
- **Thematic Module:** Pre-Test (diagnostic test); basic teaching materials in the field in question (presentations, text files, videos, etc..). Block of tasks, check, knowledge testing (educational testing). Creative Task Pad, interactive communication block for the lecturer and the students and the students among themselves; Additional resources relating to the learning field in question; knowledge testing (control tests).
- **Module Summary:** Test, Final survey, Reflection survey (evaluation).

I. Topics of thematic course modules:

1st Real numbers.

2nd Algebraic expressions, equations, inequalities and their systems.

3rd Functions.

4th Strings.

5th The geometry of the Cartesian plane.

6th Planimetry, stereometry.

7th Elements of descriptive statistics. Probability theory and combinatorics.

8th Sets of mathematical problems from the final secondary school examination in mathematics in previous years.

9th Computer software used in e-learning course.

Conclusion

This article addresses the use of a proprietary theoretical and methodological computer-based system for development of mathematical competence of high school students. The authors first present: present state of the problem and AIMS study, research tasks and brief description of mathematical skills development author's program named ‘Mathematics of Moodle’. These were used for the research carried out as a part of a PhD thesis which is being elaborated at the Pedagogical Faculty, University of Ostrava.

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New Forms of Education in the Field of Radiation Protection

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Abstract

We are looking for a new form of education and popularisation of natural sciences and presentation of the science and research results of our faculty by solution of the project "Physics and Chemistry in our life today and tomorrow", supported by Slovak Research and Development Agency. Our main goal is an increase of the motivation and interest of young people in natural and technical sciences generally. We apply various means of transfer of information towards the secondary schools. Every year we organize "Days of open Door" at our faculty – Faculty of Chemical and Food Technology (FCHPT). We regularly participate in "Night of Researchers", "Weeks of Science and Techniques" and in the further training of the secondary school teachers. The lecture-experimental tours at the secondary schools appear to be one of the most effective forms for an achievement of our goal. In the subject area of these lectures there are involved also the themes about ionizing radiation and radiation protection. Firstly the study materials were prepared: e-textbook, as well as university textbook with many solved and unsolved problems and controlling questions, so they can be used for a self-controlling for students, or for a task defining for teachers. Besides text materials there was created the video-film library, which consists of 9 video-films of our production, concerning the topic of ionizing radiation. We use these study materials at our lecture-experimental tours at the secondary schools. Until now we realised 23 lectures with the topic of ionizing radiation during 2011 and 2012, besides of the other lectures with the topics of physics and chemistry. During this period we visited secondary schools all over Slovakia. Number of secondary school students that attended these presentations from the field of radiation protection was about 700. Very positive response of our presentations can be confirmed by the fact that we are again asked for the next presentations at schools, where we had lectured.

Keywords

Ionizing radiation. Radiation protection. Video-film library. Lecture-experimental tours.

Introduction

The question about an influence of ionizing radiation on people and on environment is very often discussed nowadays also with connection to the nuclear accident in Fukushima. First, mostly negative influences of ionizing radiation, people became aware at the end of the second world war when the atoms bomb were applied, then after tests of nuclear weapons and after accidents in nuclear power stations. On the other hand, in the last century there began the enormous development of the applications of ionizing radiation mainly in medicine, biology, chemistry, techniques and in material sciences. Ionizing radiation became a basis of many new fields, e.g. nuclear medicine. Nuclear energy became for mankind an irreplaceable source of energy. All these factors – positive and negative – contributed to the fact, that public began to interest in the heart of the matter – what is ionizing radiation, what are its influences on the man and what is radiation protection. We must emphasise that the ionizing radiation has great importance nowadays. As we mentioned above it is applied in many fields, by science starting, through the different industrial branches, nuclear power engineering and by medicine ending. Besides of many positive characteristics, the ionizing radiation has sometimes a negative influence on our health, so we must avoid damages caused by it. We must strictly observe the rules of the radiation protection at the work with irradiators. The principles of the radiation protection are based on knowledge of physical substance of the matter and on the chemical and biological influences of ionizing radiation on men. The inseparable condition of understanding of the philosophy of the radiation protection is perfect knowledge of physical principles of origin of individual kinds of ionizing radiation, their interaction with a matter. Also the basic methods of detection of radiation are necessary to know.

Many scientists all over the world are looking for new forms of the education or popularization of these questions concerning the ionizing radiation and radiation protection. Many conferences are devoted not only to the professional topics but also to pedagogical and didactic questions of radiation protection. Also there exist many forms of popularization of the natural sciences generally and topic of ionizing radiation individually, presented e.g. at conferences (Šípoš, et.al., 2010), (Dobis, et.al., 2007).

We search for new forms of education of young generation as well as general public in this field too (Holá, 2009), (Holá, Lukeš and Ilčin, 2010). It is necessary to educate students on the secondary schools and on the universities, as well as to provide information to general public about the physics of ionizing radiation - in order the ionizing radiation not to be a public menace, but contrariwise to be a useful tool. For the first time, a suitable study material, as well as promotional and information material must be prepared for a fulfilment of this goal. Then the various activities like lectures for public, Informative Days, Nights of Researchers and Weeks of Science and Techniques could be organised. One of the ways to achieve these goals is the realisation of lecture- experimental tours at secondary schools with various presented topics.

Study materials

Textbooks and DVD

In our contribution we inform of some study materials and about some activities which were prepared in the field of the applications of ionizing radiation and radiation protection during the recent period.

In the scope of solving the project: “Multimedia programme of education in the field of ionizing radiation and radiation protection” the team cooperation of many workplaces was arising. This project was supported by Slovak grant agency KEGA (2005-2009). The multimedia textbook: “Ionizing radiation and radiation protection” (Holý, et al., 2008) was the output of this project. This textbook consisted of text part, multimedia part and informative part. In the text part there were elaborated 25 chapters with quantity of hypertexts. The multimedia part contained 12 video films and 43 presentations. The informative part provided the information of authors and co-authors (18 authors) and their workplaces (Fig.1).

ISBN 978-80-558-0092-9

Figure 1: Title page of multimedia textbook and actuating elements.

This e- book was meant to be a basic study material for teaching on such colleges and universities, where the subjects concerning the ionizing radiation and radiation protection were introduced into study programme. Only some text parts of this multimedia book could be suitable also for general public. As for multimedia part, the video films as well as many of presentations can be used also for informative purposes generally.

One of the informative activities, where we also participated, was organized for mayors and city managers as well as the next those interested from the municipalities nearby nuclear power station Jaslovské Bohunice. This activity, named “Informative day of SNUS” was arranged by Slovak nuclear society (Slugeň, et al., 2009). Besides of presented lectures, the participants obtained DVD materials with text part and with video films about applications of ionizing radiations.

Our next material, which we prepared, was the university textbook “Radiation protection” with the subtitle: “Ionizing radiation, its effects and protection of it” (Holá and Holý, 2010 a). This textbook (Fig.2) was created primarily for students of Faculty of Chemical and Food Technology as a study material of the subject “Radiation protection”. This textbook deals with an explanation and classification of ionizing radiation and its interaction with the matter. There are described various sources of radiation – natural but also industrial sources, various detectors of radiation and methods of detection. One of the chapters deals with the applications of ionizing radiation in research, industry and medicine. The attention is given also to the radioactive waste and disposal of it. The last chapter is devoted to the radiation protection on the basis of biological influences of the radiation on people. The organizational and technical assurance of radiation protection is mentioned there. In this textbook there is many solved also unsolved problems and many qualitative questions, which can serve for self-study. This textbook obtains also DVD, where the illustrative video films as well as colour figures attachments are presented. For this reason we can use that textbook also out ff the school department as a promotional-informative material.

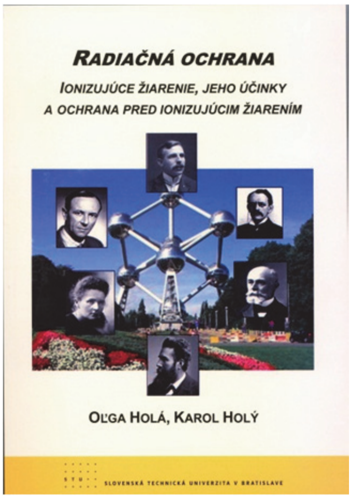

Figure 2: Study material „Radiation protection".

Video film library

Video-clips provide an illustrative approach to the investigated physical phenomena for students. Some years ago we began to prepare our own video-clips at our Department of Chemical Physics of FCHPT (Holá, 2006), (Holá O. and Holá, K., 2006). These video-clips record various real life situations as well as laboratory experiments. We created also some video-clips recording unique workplaces. Finally, we continued in making our own video films. These short video films have the Slovak voiceover providing professional comment. In the Table 1 there is given the list of our video films from the field of Ionizing radiation and Radiation protection. Some of these video films were also used as DVD attachment in above mentioned textbooks.

Table 1: Video-film library.

No	Video-films name
1	Radioactivity
2	Irradiator
3	X-rays and diffraction device
4	Application of X-rays in medicine diagnostics
5	Modern techniques in radiology and nuclear medicine
6	Nuclear medicine – open radiation sources in diagnostics and therapy
7	Ionizing radiation and radiation protection
8	Days of radiation protection
9	Proton synchrotron in Ružomberok

Brief content of individual video films are as follow:

1. The video film „**Radioactivity"** deals with the basic defined notions like the natural and artificial radioactivity, law of radioactive decay, the various types of radioactive irradiation and their penetration through the different materials and most important are the conclusions – three main principles of radiation protection.

2. **Irradiator** – is video-film about our workplace, where cobalt source is used for a scientific research. The usage of gamma irradiation because of the study of its influence on the various materials, on the changes of chemical and physical characteristics is shown**.**
3. In the video-film „**X-rays and diffraction device**“ we inform what is ionizing radiation and especially X-rays, how we can produce two types of X-rays and principle of X-ray tube. Second part of this film is located in the workplace of our Department – X-ray diffraction spectrometer workplace (Fig.3). There are described individual parts of this device and principle of its operation.

Figure 3: X-ray diffraction spectrometer.

4. Video-film „**Application of X-rays in medicine diagnostics**“ (Fig.4) was recorded at the Oncological Institute of Saint Elisabeth in Bratislava. In this video we can visit the individual workplaces of Radiological Clinic with a voiceover providing by chief physician of the clinic. We can see classical X-ray apparatus, sciascope, dental X-ray tube, mammograph and most modern device of vacuum mammothomy, used not only for diagnostics, but also for removal of small tumours.

Figure 4: Video-film „Application of X-rays in medicine diagnostics”.

5. In video-film „**Modern techniques in radiology and nuclear medicine“**(Fig. 5) we are familiarized with the various modern projection techniques, e.g. tomographical projection, which are used in medicine, mainly in radiology. We are guests at the computer tomography (CT) workplaces, where we are acquainted with the oldest device as well as with modern multislice tomograph. Then we visit the magnetic resonance imaging (MRI) as well as ultrasonography workplaces. These projection techniques do not used ionizing

radiation, but they are the inseparable parts of diagnostics. In this video we have also the explanation of the principles of CT, MRI and Doppler Effect.

Figure 5: Video-film “Modern techniques in radiology and nuclear medicine“.

6. In the video-film **„Nuclear medicine – open radiation sources in diagnostics and therapy**“ we are visitors of Clinic of Nuclear Medicine. In a preparatory room we can see the work with radio pharmaceutics in protection boxes. Radio pharmaceutics are open irradiators, which are applied intravenously into patient body before a medical examination. There are explained the principles of scintillation detectors – the detectors that are usually used for detection of gamma radiation. We pass through the workplaces (Fig.6) of scintigraphy, SPECT (single photon emission computer tomography) and PET (positron emission tomography).

Figure 6: Video-film „Nuclear medicine – open radiation sources in diagnostics and therapy“.

7- 8. The video-films „**Ionizing radiation and radiation protection**“ and „**Days of radiation protection**“ discuss the questions of radiation protection generally and in medicine particularly. There are depicted various protective appliances that are necessary for patients to be used at the medical examinations, as well as protective cabins and other safety precautions for personal.

9. In the last mentioned video-film “**Proton synchrotron in Ružomberok**“ we are present at the ceremonial delivery of proton synchrotron device for medicine aims in Ružomberok.

Methods of education

Publicity campaigns

Besides of the above mentioned "**Informative day of SNUS**" prepared mainly for mayor city managers and people lived nearby power station Jaslovské Bohunice, we participated on the following publicity campaigns:

Our faculty organized first in 2010 and then in 2011 "**Days of open doors"**. During this day the 4 parallel lectures were carried out. Students had a possibility to choose the topics they were interested in. Our contribution was the lecture: "Radioactivity around us". In one of the lecture hall there were screened our video films also about an ionizing radiation. The chemical and physical "fair" with more than 20 "market stands" with attractive demonstrations - that was the continuation of these Days. Our stand was devoted to the detection of the radiation (Fig. 7). Students could participate in a competition, the answers to questions they could find at these stands. Culmination of Days was an evaluation of the competition and the winners were awarded by symbolic prizes.

Figure 7: Our market stand at Day of open doors.

The next action in which we regularly participated is "**Night of Researchers**" (Fig.8). Last year we had the lecture: "Radioactivity –fellow of our life" for about 70 students of secondary schools, arranged at the Museum of Natural Science in Bratislava.

Figure 8: Night of Researchers in Museum.

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Training of teachers

Our faculty organized further training for teachers of chemistry and natural sciences every year during holidays. Last year *"The XXIV. Seminar for secondary school teachers of natural sciences subjects"* took place and also our working group prepared study materials and DVD with some video films about radiology and nuclear medicine.

The lecture-experimental tours

The main planned activity of above mentioned project is realization of the lecture-experimental tours at secondary schools. We addressed a letter to some secondary schools, in which we offered our lecture-experimental activities from the field of Physics and Chemistry and especially Ionizing Radiation and Radiation Protection.

These lectures consist of power-point presentations, virtual as well as real demonstrations (if it is possible), our video clips or video films, internet applets concerning the theme of lecture. The simple experiments or demo exhibit of various types of detectors and dosimeters are inseparable part of these lectures.

Until now we have prepared 6 themes from the field of ionizing radiation, in the next table 2.- there are given their names. According to requests of schools, the content is adapted to the changing conditions – either undemanding or more sophisticated.

Table 2: Lectures from the field of Ionizing Radiation.

1.	Radioactivity – a threat for mankind or an inseparable part of our life
2.	Origin of X-rays and their use
3.	Do you know working principles of CT, MRI, ultrasonography, PET?
4.	Nuclear medicine – open irradiators in diagnostic and therapy
5.	Multi-purpose utilization of strong magnets – MRI, cyclotrons, synchrotrons
6.	Radiation protection

Results and discussion

The above mentioned study materials can be used as a teaching aid in lectures at the various natural science faculties, health and medical faculties as well as at technical universities in every subjects which deals with ionizing radiation, radiation protection, radioecology, radio pharmacy, biomedicine chemistry and physics and so on. These study materials were prepared in such a way, that they can be used not only in attendance study but also in distant and external study (Holá and Holý, 2010 b; c). These materials contain many solved as well as unsolved problems and exercises; every chapter ends with a great number of controlling questions, so they can be used for a self-controlling for students, or for a task defining for teachers.

More over some parts of these materials, first of the entire video library, can be applied also at secondary schools, technical and health colleges.

Various presentations, imagines, video clips and video films from our study materials can serve as very suitable promotional and informative material during activities that are devoted to general public. The more professional parts of presented materials are predetermined to the further education of teachers also by distant form.

As for our lecture-experimental tours at the secondary schools, until now we realised 23 lectures with topic of ionizing radiation during 2011 and 2012. During this period we visited secondary schools all over Slovakia, we were in Púchov, Prievidza (Fig.9), Slovenská Ľupča, Liptovský Mikuláš, Nová Baňa, Žiar nad Hronom, several times in Krompachy and Košice, and at several schools in Bratislava. Number of secondary school students that attended these presentations was about 700.

Figure 9: Presentation in Prievidza and prize award.

We can summarize our experiences in the following remarks:

1. To supply the power-point presentation of lecture directly by demonstrations, experiments
2. To combine the power-point presentation with the video clips and video-films
3. To allow a pause during a lecture
4. To assign a written questions, tasks at the beginning of lecture – it helps to maintain the attention during the whole lecture
5. To give a time for discussion and for “playing” with demo tools
6. To evaluate the student’s answers of written quiz and to reward some students with symbolic prizes (Fig.9).

We can state that our presentations achieved a great success, we are again asked for the next presentations at schools, where we lectured. The curiosity and interest that had stirred in students – it is for us a great satisfaction and motivation for analogical activities.

Conclusion

Our experiences in an application of above mentioned study materials for an education as well as for propagation are very positive. Also the new forms of an education – on the one hand - the activities for general public, on the other hand - our lecture–experimental tours at the secondary schools, have very kindly response to our presentations not only of teachers, but first of all of students. The great asset of our lectures is a familiarization of such fields of application of ionizing radiation, which are not freely accessible, e.g. workplaces of Radiology and Nuclear Clinics, international centres of nuclear research in Dubna and Cern, nuclear power stations and the like. It is obvious, that if the public will be more informed of the versatile use of ionizing radiation and of an improvement of quality of life owing to the applications of ionizing radiation, an aversion and fear of “invisible radiation” will decrease.

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E-learning Environment in Multimedia and Internet Technologies Teaching

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Abstract

The aim of this article is to bring some of the experience we have got from teaching the subjects Multimedia and Internet Technologies which are part of both teacher training and applied informatics study programme. Students of teacher training do not get so much possibility to have the teacher's role and are not much confronted with own responsibility for creating presentations, tasks, seminars and evaluation of them. They also know the work with learning management system only as a student. We have given them the opportunity to try their teaching skills. They could try the role of teacher in the LMS Moodle, created interesting tasks for younger colleagues, students of applied informatics, they learned to evaluate and take responsibility for it. The results were striking. We use the experience with such system also in the subject Internet technologies where the students get experience with programming activities which are part of such system.

Keywords

Multimedia. Internet technologies. LMS Moodle. E-learning.

Introduction

Development and progress in the area of digital technologies allows faster access to information. Connection between computer networks facilitates communication and provides access to multimedia databases for a wider audience. Increasing capacity of storage media and CPU power opens up new possibilities for more sophisticated use of human knowledge. Informatization, digitalization and visualization bring current overlaps of basic human literacy. Perhaps it is not even possible to avoid a graduation of these processes and their conscious or subconscious application in our lives.

The most important learning tool is no longer blackboard and chalk these days. Modern school cannot make it without modern technology, such as in particular the Internet and multimedia. These two phenomena have become a common part of our lives and in significant way they also affect the learning process. The priority of us teachers is not only to monitor developments in these areas, keep pace with constant change and rapid development of technology and skills for the 21st century, but also to apply this modern knowledge in our own teaching methods.

Even though schools have new technologies, in many cases the teaching methods are still old-school, without changing the mindset of the process. This action called the process of learning may also be active, creative, productive, vibrant, based on a relationship of the student and the teacher.

They participate in the process, which should be beneficial for both of them. The quality of human resources at each university is a prerequisite for university development, teaching process and research activities.

Other idea we try to put into the teaching of subjects at our department is also the cooperation between the students of applied informatics and the students of teachers training. The teacher should be able to express its needs for the software he uses or would like to use in education. These are of course given by his experience with such software or environment where he can see which tasks are beneficial and the software should contain them or which are not that necessary for environment used at basic or secondary school. The student of applied informatics on the other hand should get some experience with different technologies to be able to fulfil the needs of somebody who is ordering some product from him.

Invisible civilisation

Some aspects of the information boom, such as for example, quantitative and qualitative abundance of information now cause, "that no man can engage in a long time, which can ultimately lead to spectacular curiosity to a deeper interest" (Horváthová, 2012). We are talking about so-called dispersed curiosity that many of us could feel at first hand. It is also pervasive in the school environment where it becomes increasingly difficult to attract, motivate, and "impress" students in terms of giving more enthusiasm for the subject of their activity. The use of multimedia is one of the things in the educational process which becomes a factor that „raises the bar“ for traditional teaching methods. The world of school gets in motion with them the same way as our living-space, where we have almost overwhelmed the number of passing images and surfaces, fancy flash animations, or "perfect" media images. This raises almost a primary need to be able to work with different types of information, to be able to read, understand, select and even create it and not just let it manipulate ourselves.

Multimedia

This word has become not only part of our informatics library but has its place also in human dictionary occupying our consciousness and thinking. If we think of multimedia as the source code for our journey, it cannot be taken isolated without taking the complex world view in mind.

Multimedia technologies are influencing and changing countless areas of human activity, not excluding education. That is why we portray their actions in all possible variability in the full context of education, showing the multimedia application potential especially in the educational process. Although we have to realize that the mere use of new technologies in education will not bring the expected changes in traditional classes. This should be done hand in hand with transformation of the customary methods of teaching and thinking of teachers about the process, pupils and the priorities of the time.

According to the Theory of dual coding (Horváthová and col., 2011) multimedia activate multi-sensory abilities of a man and increase the possibility of understanding and re-equipment of the subject area. Their use as a presentation tool makes presentation easier and more effective. The use of multimedia in education has quite a long history. The main reason for it is the different expressing possibilities of multimedia which make it perfect for use in education. This gives also the possibility to make the process more individual and more effective. One can say that they are suitable for e-learning.

The subject Multimedia has its place in both teacher training and applied informatics programme which are studied at The Department of Informatics at Faculty of Natural Sciences in Banská Bystrica. The subject was created by the editor of this article more than fifteen years ago. It is still in progress of modification and every year it is adapted to the needs of new knowledge. Few years ago it was also put into the environment of so called „Virtual Department of Informatics“ where it is used not only by students of distant forms of study but also full-time study students find positive opportunities of this source of information. The rapidly changing content of the subject requires a change in approach and the use of modern methods of education.

Experiment in teaching of multimedia

The transition to an electronic learning environment at our department is a long process, but in recent years this trend has intensified. At first it was only accessible through lectures that served distance education students as help to draw content of the object. Today, each topic has a presentation prepared, specific multimedia applications, test, one or more tasks, and many other resources and recommended links to supplement the knowledge base. Discussion forums are launched with some topics where students engage in when they are interested in the topic and they found on the Internet some other interesting things.

The content of the subject is the same for both teacher training and applied informatics, the only difference is the semester in which the subject is placed. In applied informatics it is the fifth semester of the bachelor degree whereas in teacher training it is the third semester of master degree. We realized the different possibility of teaching the subject after connecting these two studying programmes. Students of the teacher training were given the teacher role in LMS Moodle (Fig.1) of our virtual department environment with already implemented course of multimedia. This course was tested and improved for years, but this was the first time, when we tried this method of learning and teaching through such experiment. Authors didn't meet with any approach published in other available articles.

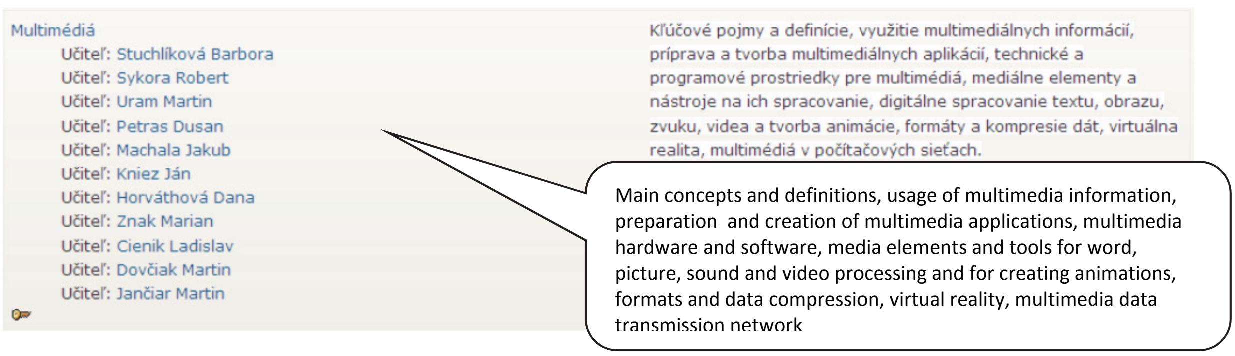

Fig.1 The Multimedia course

The students know the environment for longer time but they never had the opportunity to see it as a teacher. Teacher can make any modification of the course; he can upload files, create activities, make tests and assess the students of the course. The task given to the students was to take care of one topic in the course. They had to improve it, add presentation, create task and evaluate it. Students themselves were assessed how they could manage the task in the role of teacher. That combined their activity in managing the topic, how interesting and hard the task was and how could they communicate with "their" students.

To fulfil the whole task they needed to combine not only the knowledge from multimedia, but they had to use and apply them into education, therefore also their didactic skills were trained and tested. Therefore in the preparation period we had also discussion about tasks which were prepared, if they are suitable, what are the threats and complications in them, and how can they be assessed. Students - teachers could advise each other, which of the alternatives would be more appropriate, or what could be the reaction of their students. Each task had to be checked also how much time-consuming it is because it had to be solved in one hour limit and they had to check also the necessary software to be available on all system platforms (Windows, Linux, Mac OS)

All tasks in the course had approximately same form. There were also some voluntary tasks with some topics where the students could show their higher interest with that topic. These tasks helped them then in the final assessment.

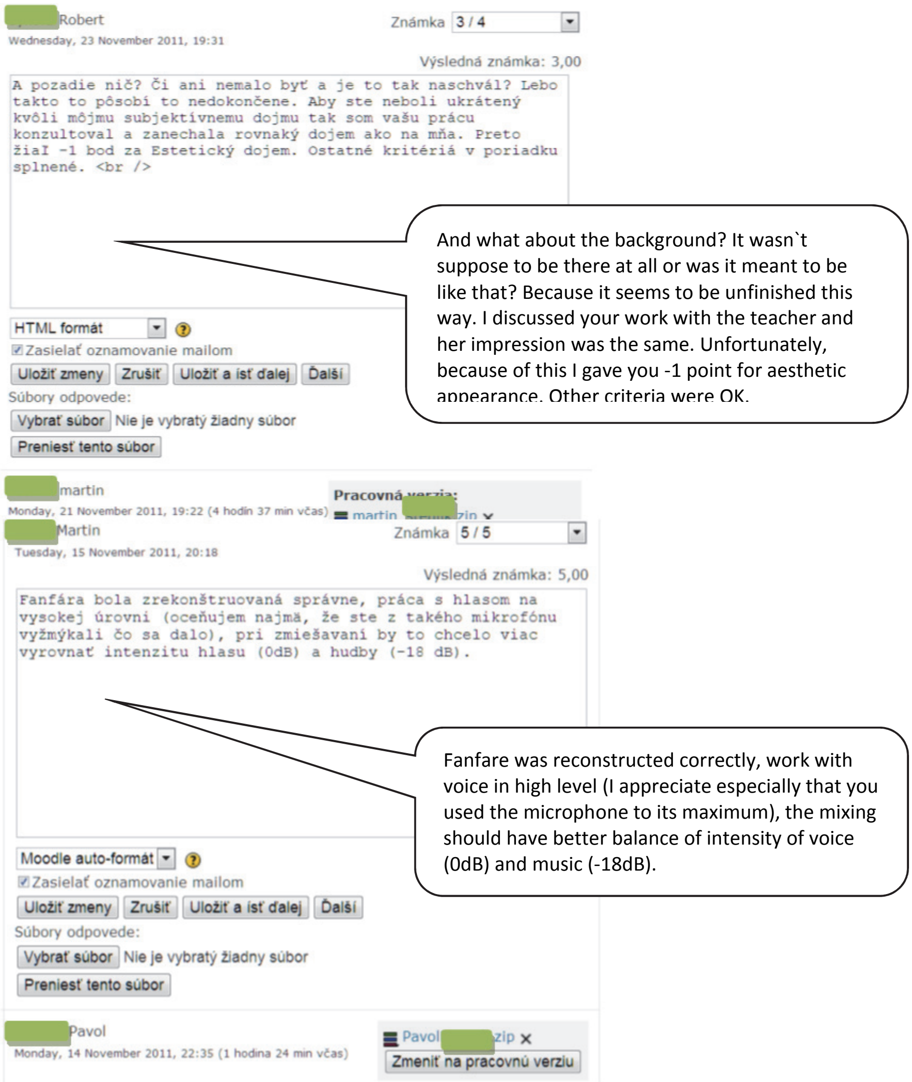

Fig. 2 Assesment and positive motivation

There was a time limit after giving the task to the students to solve and upload it to the system Moodle. After this the evaluation process started. Any reduction in the number of points had to be justified. Good teacher also encourages with positive motivation. In this way some teachers were so consistent that, in addition to the allocation of points, they assessed also verbally all their students.

We can say that both students and teachers have done their work responsibly. Teachers had to do much work in short time, they had to invent, organize and evaluate everything. This was done teacher after teacher, each with new topic. Students had to work systematically on each topic and task and had to comply with the deadline. From the communication with both sides we found out, that this kind of work and the work load was acceptable for them. Many did it really with enthusiasm because the tasks were adapted to the young generation because the creators were in almost the same age group as the solvers. The tasks were interesting, amusing, appropriately challenging and enlightening.

Assessment

The real teacher (one of the authors) had all the documents (given and solved tasks), time information, score, communication between students and their teachers to her use. There was a possibility to speak with both groups of students and obtain the feedback during the lectures, led by the real teacher. Interesting was that nobody complained on the workload although much work has been done. It was also possible to follow the whole course in LMS Moodle, to see how the students can solve the tasks and to compare how they can handle them.

Odovzdávanie úlohy č. 1	Odovzdávanie úlohy č. 2	Odovzdávanie úlohy č.3	Odovzdávanie úlohy č.4	Odovzdávanie úlohy č.5	Odovzdávanie úlohy č.6	Odovzdávanie úlohy č. 7	Odovzdávanie úlohy č.8	Odovzdávanie úlohy č.9
3,00	4,00	2,00	4,00	0,00	4,00	4,00	2,00	-
3,00	4,00	4,00	3,00	2,00	3,00	5,00	5,00	3,00
3,00	4,00	4,00	3,00	4,00	5,00	5,00	5,00	4,00
3,00	3,00	4,00	4,00	4,00	4,00	5,00	5,00	2,00
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
3,00	4,00	4,00	4,00	5,00	5,00	4,00	5,00	3,00
3,00	4,00	4,00	4,00	5,00	5,00	5,00	5,00	3,00
3,00	3,00	4,00	3,00	4,00	-	-	5,00	-
3,00	4,00	4,00	4,00	4,00	4,00	5,00	5,00	4,00
3,00	3,00	4,00	4,00	4,00	4,00	5,00	5,00	4,00
-	-	-	-	-	-	-	0,00	-
3,00	4,00	4,00	4,00	5,00	5,00	5,00	5,00	4,00
2,00	3,00	4,00	4,00	5,00	3,00	5,00	5,00	4,00

Fig. 3 The tasks in LMS Moodle

If we talk about assessment, the main task of students-teachers was to prepare the teaching process which included the practical tasks, evaluate these tasks and communicate with students. Each group of students had the same subject at the same term, they had the same criteria, the same requirements of knowledge and skills, but they were expected to have different levels of experiences. Competencies of AI students should be more professional in depth and future teachers should have more pedagogical experiences. The subject of multimedia was previously taught to both study programs together at one time, even in the same year of study (third year Bc.), which, although saved the teachers time, it did not allow the individual access to each group according to its needs. Comparing the method where students teach other students using virtual environments with the method used before, we consider this new way more prospective. We are just somewhere at the beginning of examining the efficiency of this teaching method, but the situation requires to accomplish also such experimental research and look for new ways so that we come to know the correctness or incorrectness as soon as possible.

Internet technologies in distance learning

If we talk about internet technologies in combination with distance learning, we may look at it from two points of view, both giving us the possibility not only understand the principles of given technology but also experience how to give these to someone who wants to learn it. One of them is the already mentioned idea of giving the role of the teacher to the student to explain the basic terms, tasks and knowledge, usually also with the use of some e-learning environment. The other point-of-view is based on the fact, that the user of them should know what to expect from such application and what would be necessary to ask for if he would need to create some new application of this kind. This gives the possibility to combine the use of different internet technologies to design the basic tasks used in such environments.

The knowledge of different internet technologies is split into three subjects in our Applied Informatics studying programme. This gives us the possibility to look at the design of internet applications from the very beginning, creating just static HTML pages with CSS design, continuing with client-side scripting language oriented mostly on data using the XML technologies and concluding with preview of server-side scripting languages which are used for dynamical web pages and applications.

The content is of course consulted with knowledge brought from secondary schools from which the students come. From here we can see the fact that with different „School Educational Programme“, also different students with different knowledge of internet technologies come into our course. This starts at web pages made by text-editor and saved as HTML document and ends with very good knowledge of web management using PHP or other scripting language or content management system.

This wide range was also the reason for splitting the contents into more terms. From the pedagogical point of view we try to give „hands on“ sessions as much as possible and try to avoid the so called „cleaning of the empty room“ problem which may arise when we try to cover area in which students do not have that much experience to organize all the knowledge given to them from beginning.

Idea of this section is not to go deeply into all the topics of this internet technologies course, it is not necessary to give week-after-week contents. Generally speaking our aim is to cover as many applications as possible to cover the possibilities that internet technologies offer today. And to do this we give students possibilities to try as many functions they might be asked to implement in the system they will work on. This also covers different learning management systems for different types of schools or educational organisations. Of course one has to have in mind the complexity of such system and serve all the tasks gradually but also give students chance to express themselves and award their creativity in final assessment. Some of the ideas and final products can be seen in the following list and figures:

- create table with 8 rows and 8 columns each cell with white background, when you click on any cell it should change its background from white into black and vice versa,

- using two buttons --> and <-- simulate switching between multiple pages, actual page will be shown between the buttons,
- create array with random numbers and simulate its sorting using some standard algorithm,
- find daily EURO rate on the pages of Central European Bank and create PDF version of exchange rates,
- create timetable for school in XHTML format and transform it into XSL-FO and create PDF document,
- find interesting article about internet technologies on the Internet and without rewriting make a DOCBOOK document from it,
- using JQuery create following effect: you have a list of elements placed in a table, each element can be highlighted, you will be able to highlight more elements until you reach maximum which is given as a constant, when you highlight maximum number of elements all of them unhighlight and some action will be done with them.

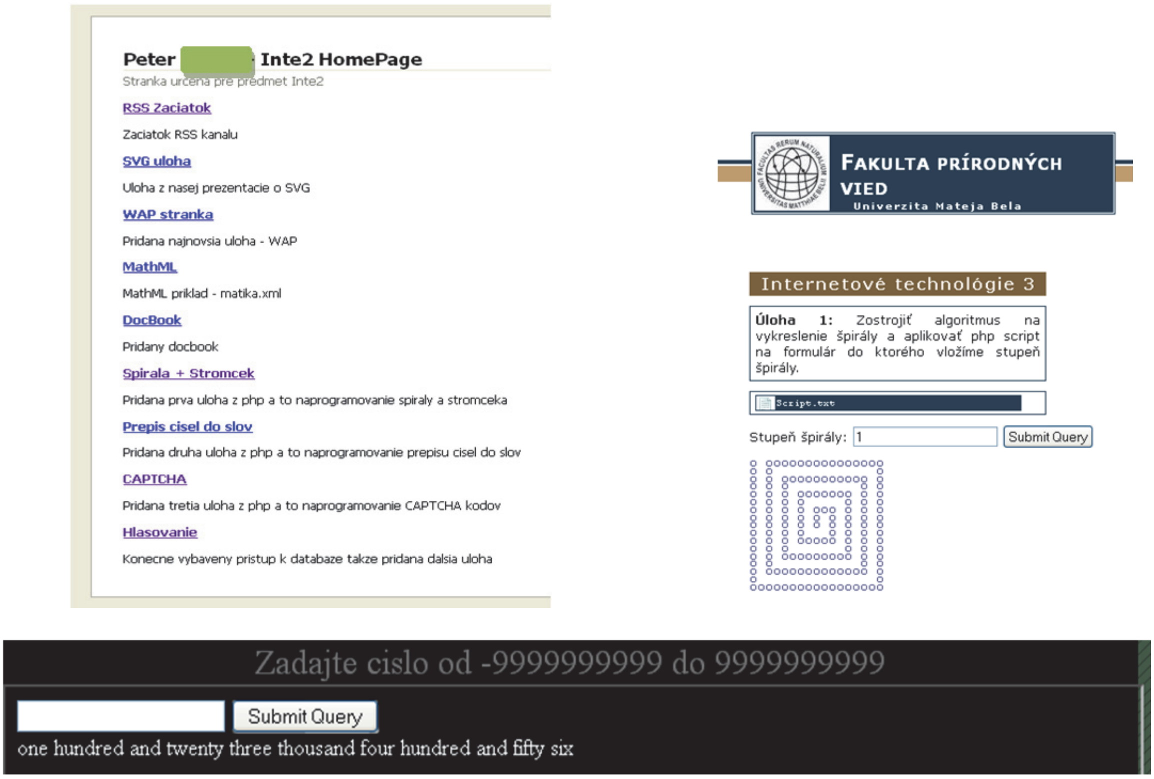

Fig. 4 Some of the homeworks presented by students

Conclusion

Although the real teacher apparently left a significant part of her educational tasks to older students, there was no time to spare. The number of students on both sides (10 future teachers and 53 students of applied informatics) and the managing of the teaching process were posing quite a difficulty. AI students knew from the beginning, that they were a part of some "game" and that their older colleagues, who invented those tasks and will evaluate them later, will take care of them. Based on an interview with them, it was clear that they enjoyed such an unconventional education and maybe they expected from their older colleagues kind of a “student solidarity”.

Students - teachers were often more strict than experienced teacher. They were not inclined to tolerate any exceptions, no inconsistency. The only excuse to allow such non-compliance deadline was the illness of the student. It was interesting to see how sensitive some future teachers were with their task. We believe that some of them can be extremely good teachers, if they remain faithful to their profession.

The best thing at this whole experiment was a good feeling at all sides. Students - teachers had a good feeling, because in the last year of their study they finally became a part of real learning process and had also the opportunity to influence this process. AI students had a good feeling about this demanding, but interesting subject, where they could demonstrate their skills and creativity. And teacher had a good feeling because it was fun and interesting for all her students.

The use of virtual environment which is common to both teachers and students has a great potential. Thanks to it the organisation of education is easier and quicker, we have better overview over communication and it is something natural and obvious for the young generation. The effect that we expected at the beginning of the term, far exceeded our expectations. Not only the students managed to get theoretical knowledge of the subject and showed it in the final testing, they could manage also many hard practical tasks. In addition, the students of teacher training could also try the teacher role of the learning management system. They have seen the teaching process and could realize one part of their future career.

From the applied informatics point-of-view we should be able to prepare the students not only to use learning management systems but also to be able to create such, of course with the help of the teacher who knows what to await from such a system and can express its needs for the topics he teaches at the given school type. We think that this is also possible and shown methods help it at least a little bit.

Modern education depends on how to utilize various possibilities of modern technology to improve learning and teaching and therefore it is very important to prepare the younger generation of teachers to best use of modern technologies in the teaching process. Our contribution can serve as a sample of successful launch of prepared educational models into practice.

Acknowledgement

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Research of Methods of a Multidisciplinary Approach in the Teaching of Algorithm Development and Programming

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Abstract

One of the most important tasks in teaching of algorithm development and programming is to use a suitable method of developing theoretical knowledge of algorithm development and programming. Drawing on his experience, the author has found that the best method to be used is the system, multidisciplinary approach. The paper focuses to introduction the system and multidisciplinary approach to education of algorithm development and programming and development of algorithmic thinking as well as to methods of elimination of problems associated with the practical skill and techniques of structured and object oriented programming. The methodology of research investigation by evaluation of the errors in principles of object oriented programming is presented too. The results of the research investigation confirmed positive effect of system and multi-disciplinary approach to the correct use of algorithmic design, development of algorithmic thinking and development of thinking in principles of object oriented programming.

Keywords

Education of algorithmic development. Multidisciplinary approach. Object oriented programming. Programming. System approach.

Introduction

Teaching of the basics of algorithm development and programming is realized not only at universities but also in secondary schools. To a limited extent these issues can be also met in some primary school, especially in specialized classes or extracurricular activities.

The output of the process algorithm development and then programming is computer program - computer simulation. Computer program is an application that runs on a computer and that has the standard user interface. Standard user interface is based on the windows (forms) in which other active elements (objects) are located - the application must be in accordance with the principles and paradigms of object-oriented programming.

The results of the research conducted among students of specialized secondary school and university students are discussed in the paper. In the research we have studied influence of two seemingly unrelated aspects that affect the teaching of algorithms and programming.

The first aspect is related to discussions on whether it is better to teach the algorithm development and programming either step by step from algorithmic constructions through structured programming to object oriented programming or to start with object-oriented programming and structured programming understand as only like subset. Both alternatives of teaching have their opponents and proponents. Proponents of structured approach proceed mainly from their practice, which in teaching algorithms and programming has been working for decades. The proponent of OOP based teaching is e.g. (Pecinovský, 1999).

The second aspect influencing the teaching of the algorithm development and programming is the choice of methods. In principle, it can be chosen between two fundamental, opposite methods. The first is primarily based on mono-disciplinary approach, where teaching is clearly structured and the emphasis is on interpretation and understanding of algorithmic structures. Understanding the algorithmic structure is the primary objective of the teaching. In contrast, teaching can be based on a multi-disciplinary approach. The understanding of the algorithmic structures is secondary, but significant issues. In this context, we can talk about the systems approach. Algorithm development and programming becomes more of a means to reach the goal end, not its own goal.

System approach in education

System approach is closely related to the concept of system. The system in general terms can be based on e.g. understood as a defined set of elements and relationships that creates an integrated whole. The system is also part of external reality and communicates with its environment through its inputs and outputs. System with no links to the surroundings is *closed system*. In teaching practice, we find *open systems* i.e. systems with inputs and outputs.

In view of this perspective we can consider a system of class as a group of students who interact (communicate), and interact with its environment, i.e. the teacher, other classes using the inputs and outputs. Under the system, rather a systemic approach, however, can be understood also abstract issues like learning style. For a system approach is generally considered such way of solving the problems, where phenomena and processes are studied comprehensively in their internal and external contexts (Wilson, 2001). System approach in pedagogy means formulation, understanding and solutions of the studied problem under the consideration that the corresponding processes, events and phenomena that objectively exist in the world and which are transformed into the model learning situations.

In connection with the concepts of system and system approach is necessary to mention the other term that is commonly used in pedagogy – interdisciplinarity. This concept can be understood e.g. based on (Checklan and Poulter, 2006) as a method of linking and active cooperation between different sciences in order to achieve an integrated and synergistic results in theoretical and practical professional activities, science and research.

The systems approach rather than interdisciplinarity talk about multidisciplinarity. A multidisciplinary approach is used mainly in the method of solving problems and creating technically functional units, such as the creation of the computer program – see e.g. (Hubálovský, 2011). The main reason for the introduction of multidisciplinarity in connection with the system and a systems approach is that the research system as a whole requires a high degree of highly specialized knowledge in different disciplines and these specializations has to be closely linked by mutual connection. Only a multidisciplinary approach will ensure that the whole system will be studied systematically and comprehensively.

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Although the interdisciplinary approach in the context of learning process is frequently discussed, the concept of system approach in educational practice is not sufficiently specific and widely implemented (Checklan and Poulter, 2006). Unfortunately, this fact concerns also learning of algorithm development and programming, which from a practical point of view without the system and multidisciplinary approach cannot do.

In the following text the both aspects influencing the teaching of algorithms and programming, namely:

- structured form versus object oriented form of teaching and
- mono-disciplinary versus multi-disciplinary method of teaching

will be focused from a system approach point of view.

System approach and structured and object programming

As mentioned in the introduction, the first aspect that influences learning algorithms and programming is influenced by the form of performed teaching:

- structured form, that teaching is divided into learning algorithms, structured programming and object-oriented programming in the end;
- object oriented form, i.e. from the beginning of the instruction focuses on object-oriented programming, with the principles of the algorithms are part of this instruction.

Structured programming is programming based on the structure of the program, which comes strictly from the algorithm flowchart. From the system approach point of view the algorithm as well as structured program (written in any structured language - Pascal, C++, VB Script) can be understood as system, because they have properties of the system – algorithm interacts with its environment through inputs and outputs, consists from elements that are affected by interactions. Another division algorithm to subsystems is possible, from a practical perspective, however unreasonable.

In this context it is necessary to mention what types of exercises are used for training the algorithm development and structured programming. The exercises reflect two facts. Firstly, in the past, early in the courses of programming (mainly structured programming - Pascal, Basic, etc.) has been teaching of programming realized by teachers who also taught mathematics, or had to mathematics very close. Second, math problems are basically the simplest tasks, can be clearly described, defined and then developed by algorithm and rewritten to the program structure. That, however, seems at first glance a logical and simple, brings disadvantages. Algorithm development and structured programming explained by the mathematical tasks usually focus on rewriting the mathematical equations and formulas to the algorithms regardless of their complex systems integration with the exercises from real life. Used tasks are often artificial and divorced from reality. System and multidisciplinary approach is missing. Students, who do not have sufficient mathematical skills, do not understand the task and it can result in resistance to the algorithm development and subsequently to programming.

In contrast, the basic paradigm of *Object oriented programming (OOP)* is to model on the computer the real-world situation. The OOP applications are developed based on already created components. The basic terms of OOP are object, event abstraction, encapsulation, inheritance and polymorphism. From a system approach point of view the objects can be understood as open sub-system of whole application. Every object - the subsystem is a complete system - consisting of elements (a list of properties, event handlers), communicates with its environment through inputs (events, parameters) and outputs (methods and parameters).

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From the above mentioned it is clear that both the structured and object-oriented programming can be viewed using the systems approach. The difference is in complexity of ”result“ of activity. In the structured approach programmer creates the system – i.e., links connecting the elements and creates a system - program (application). In object oriented programming, programmer works with already made objects (subsystems) and defines their properties, inputs and outputs, i.e. links to the external environment. Here he creates a system - a program (application) but by means of the ”connection“ of the subsystems (objects).

Multidisciplinary approach in education of programming

The second aspect influencing the development of algorithmic thinking is the choice of methods. As mentioned in the introduction, we can choose between mono-disciplinary and multidisciplinary approach.

Multi-disciplinary approach according to (Milková, 2011) is closely related to a systems approach, modeling and computer simulation.

Modeling

Modeling is a method that is often used in professional and scientific practice in many fields of human activity.

The main goal of modeling is not only describing the content, structure and behaviour 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 models are always only approaching of the reality, because the real systems are usually more complex than the models are. The model is always to be understood as simplification of the original – see e.g. (Kučera, Houška and Beránková, 2008; Houška and Beránková, 2007).

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 equitation;
- process charts.

Simulation

The process of modeling is closely related to the simulation. Simulation can be understood as process of executing the model. Simulation enables representation of the modelled real system and its behaviour in real time by means of computer. The simulation enables also visualization and editing of the model – see e.g. (Sokolowski and Banks, 2009).

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 and spreadsheets (MS Excel) - see e.g. (Lovászová and Hvorecký, 2005).

The whole process of transformation from a real system, the simulation model and its visualization is shown in Figure 1.

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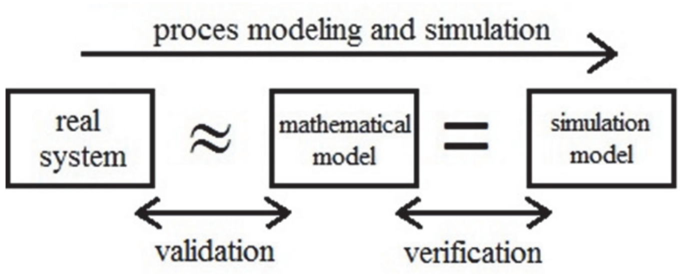

Figure 1: Process modeling and simulation

Another important trend that follows from the paradigm of object oriented programming is that the learning is fundamentally accompanied by multidisciplinary approach. Exercises are based on the modeling of real phenomena, events and processes. Using object oriented programming, it is possible to create complex tasks in which students have to first define the problem, i.e. create simplified model and would be able to describe this model using the principles of the algorithm, i.e. determine the input and output variables and the process by which input data are transformed into output data. Finally, the student should be able to create object oriented application in the appropriate programming language as a computer simulation of the model.

The exercises realized by the multidisciplinary principles can be applied:

- In the field of sciences - in case of models of physical and chemical 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.

Mathematical calculus is essential in a “model” method, but only as a secondary issue. The standard method of a simple rewriting of mathematical expressions and equations into algorithms and then into the programs is maximally eliminated while using this approach.

Research investigation

Let us return now to the questions of the influence of both the above discussed aspects of the development of algorithmic thinking and learning algorithms and programming. The answer to this question we find in research investigation conducted among secondary school students and high school bachelor students. Students were divided into three groups.

The first group (hereafter designated as Group 1) were taught in three stages from the theory of algorithms (1st semester), through structured programming (2nd semester) and object oriented programming (3rd semester).

The teaching the students in the second group (Group 2) were based on object oriented programming approach. Algorithms development and structured programming principles have been an ongoing part of teaching object oriented programming.

In both groups, lessons proceeded by mono-disciplinary approach without application of methods of systematic and multi-disciplinary approach. The workshops of these two groups were primarily based on the standard basic algorithmic structures, which are mentioned, for example (Milková, Hubálovský and Pražák, 2010).

In the third group (Group 3) the teaching were based on the object oriented approach and by the method of system, multi-disciplinary approach. The seminar of algorithm development is practiced within the implementation of computer simulations of conceptual model of the real system.

At the end of the course program of study all students were asked (in the final essay) to create object oriented application. The essence of this *final seminar work* is create a mathematical model of real system and corresponding simulation program in form of object oriented application, in which there are assessed not only application functionality but also

- *errors in the principles of object oriented programming* and
- *errors in the principles of algorithm construction*.

Errors in object oriented programming

These are the errors by which we assess how students manage the principles of the object oriented programming.

Errors, which students engage in their application, can be divided into a number of criteria – see e.g. (Hubálovský and Šedivý, 2010).

First, they are the **errors essential for program running**. Most of these errors are detected by the compiler during the translation process; others are detected during the testing process.

Second, they are the **errors which do not shape the program functionality**. These errors arise during the program's structural development. These types of errors, in many cases, are not recognized by programmers, because the program appears to work properly. These errors, however, are fundamental, because of cooperation in program-creating team. These errors were focused in our research investigation. These types of errors are detailed specified in Table 1 in the section *Results of the research investigation*.

Errors of algorithm development

Within these errors, we perform the evaluation of errors committed by students in algorithmic structures, i.e., how the basic properties of the algorithm are complied. The main emphasis in the evaluation was placed on the correct identification of *inputs* and *outputs* of the algorithm and *generality*.

Within the errors of algorithm development the errors in declaration of variables are evaluated too. Each variable should represent some aspect of the real system as well as conceptual (mathematical) model. We distinguish three types of variables:

- *Input variables* represent the inputs of the real system. There is a need to have really chosen those variables which are focused during the description of the real system. It makes no sense to choose such an input data variable that the simulation does not change, or which does not affect the simulation process. On the other hand, the number of input variables must be sufficient so that the simulation model is as general as possible, i.e., solve a whole class of similar models.
- *Output variables* represent those features of the studied system that led to the creation of simulation model, i.e. the output variables provide information that is either explicitly or implicitly necessary to achieve the objectives of process modeling and simulation. Here again, similar considerations for choice and number of output variables are valid as input variables.

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- *Auxiliary variables* are for user of simulation program unavailable, only serves to temporarily preserve the values of quantities needed to run the simulation program.

These types of errors are detailed specified in Table 1 in the next section.

Example of final seminar work

Problem definition

A homogeneous cylinder of radius *r* rolls the plane from the left to the right with velocity *v*. With respect to *r*, *v* and α it has to be decided whether the cylinder rolls over the edge or rebounds from the edge. The situation is shown on Figure 2. If the cylinder, under specified conditions, rebounds, it is necessary to find a place on the inclined plane where the cylinder snaps. The situation has to be analyzed on the basis of available physical laws.

Full solution of this task is shown e.g. in (Hubálovský, 2010). In this paper the solution will be only hinted.

In the first step the student should provide kinematics analysis find mathematical model of the trajectory:

$$\begin{aligned} &x \in (-\infty; 0\rangle: && y_p(x) = r \\ &x \in (0; x_{Impact}\rangle: && y_p(x) = r - 5\left(\frac{x}{v}\right)^2 \\ &x \in (x_{Impact}; \infty\rangle: && y_p(x) = (-\alpha)x + \frac{r}{cos\alpha}, \end{aligned} \qquad (1)$$

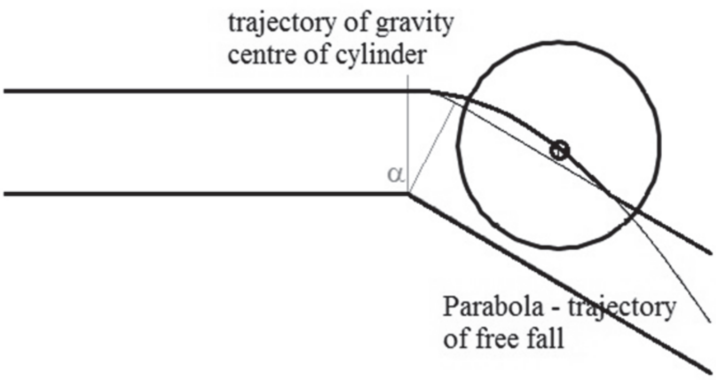

Figure 2: Example of entering seminary work

In the second step students should define the appropriate algorithm, input, output and auxiliary variables of the problem solution and the whole situation should be animated with appropriate tools.

Source code of the solution in Pascal programming language is as follows:

```
begin
  read (r, v, α)
  Rebound := False;
  I := 0;
  while I <= 200 do
  begin
 X := I * 0.075;
```

```
       Yc := fC(X,r,v,a)
      Yp := fP(X,r,v,a)
      if Yc < Yp then
      begin
        Rebound := True;
        Ximpact := X;
      end;
      I := I + 1;
    end;
    write (Rebound, Ximpact);
  end.
```

Results of research investigation

Evaluation of errors was done so that if the same errors repeat several times in the computer application, repeating the same errors several times, it was counted only once.

Types of errors and their percentage in the three groups of students are summarized in the Table 1.

Table 1: Percentages of errors of object oriented programming and algorithm development.

Type of Errors			Percentages of errors		
			Group 1	Group 2	Group 3
Errors of OOP	Errors in design	Complex classes	23 %	12 %	14 %
		Inheritance	45 %	27 %	30 %
		Labelling	12 %	13 %	10 %
	Errors in implementation	Encapsulation	21 %	08 %	12 %
		Complex method	19 %	13 %	13 %
		Repeating code	22 %	10 %	11 %
		Working with exceptions	15 %	14 %	12 %
		Logic in the presentation layer	21 %	06 %	05 %
		Difficulty managed code	23 %	08 %	10 %
		Encapsulation	25 %	12 %	10 %
		Complex method	12 %	13 %	09 %
Average percentages of errors of OOP:			***22 %***	***12 %***	***12 %***
Errors of algorithm develop-ment	E. in algorithm construction	Definition of inputs / outputs	21 %	18 %	08 %
		Errors of universality	25 %	22 %	08 %
	Errors in variables	Errors in quantity of variables	15 %	14 %	10 %
		Errors of type of variables	18 %	12 %	14 %
Average percentages of errors of algorithm development:			***20 %***	***17 %***	***10 %***

Discussion of the results

The above results indicate that students taught by the principles of object oriented principles (Groups 2 and 3) make mistakes in object-oriented applications to a lesser extent. This is clearly demonstrated by roughly half and a lower incidence of errors associated with pure object oriented approach - errors in the inheritance, encapsulation, logic in the presentation layer, etc. The problems in object oriented approach in Group 1 can be explained and related to the bad habits fixed in the course of teaching structured programming and their transfer into the object oriented programming.

Furthermore, the results of the survey confirmed the positive effect of system and multi-disciplinary approach to the correct use of algorithmic design and development of algorithmic thinking. By analysis of these types of errors were found that students whose learning of algorithm development and programming is done by mono-disciplinary form (Groups 1 and 2) are not able to identify inputs and outputs, and often make mistakes in generality.

We can say that the optimal solution for education of algorithm development and programming is object oriented approach together with a multidisciplinary approach.

Conclusion

Traditional education of algorithm development and programming in the form of algorithm construction and structured programming fixes in students habits that are hard to overcome the object oriented programming. On the contrary, teaching programming from the beginning of the object oriented approach fixes the students' systems thinking and systems approach, which just creates in students attention shift from parts to whole, from elements to objects and relationships between them and from structures to processes. The optimal solution of teaching of algorithms and programming is system and multidisciplinary approach that is based on identification real systems, processes, events and interaction. Without this broad-based systemic approach is education of programming and algorithm development inefficient.

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Analysis of Study Activities for Better Education Supporting Communication

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Abstract

This paper is centred on an analysis of study activities for suitable communication between students and teachers. The main objective of paper is to seek the optimal application structure of available study activities for effective learning. The multidimensional and object approach were selected as background for analyzed study activities with the support of Petri Nets. These activities are various exploration types from the Moodle system as a way to obtain student opinion about learning. The "Operating system" course and its students were dedicated for practical realization. The students evaluated, among other things, the analyses of operating system layers and Wiki or Glossary study activities via explorations. The result of this work is an analysis of available types of explorations in the Moodle system and their comparison with other study activities. Teachers can select from five pre-defined explorations in a short or long version. Quick access to student opinion and view on learning is comprised in the short version of exploration in seven items. Navigation is intuitive, for example Glossary or Wiki study activities creation. A good option is the ability to create one's own exploration based on experiences with pre-defined explorations from the Moodle system. This analysis helps to better explore implementation in practice for optimal learning with communication. Linear and matrix algebra have a suitable place in this analysis of created simulations to general formal description. Given simulations were created based on the Petri Nets principle.

Keywords

Analysis. Education. Information systems education. Moodle. Petri Nets. Simulation.

Introduction

Learning and education uses specific activities with the aim to develop key skills and knowledge for all individuals. An important feature is the ability to communicate between students and teachers. Special skills are needed for communication in the virtual environment. (Bauerová, 2006; Horovitz, 2006) This ability carries appropriate significance for daily activities in firms and organizations to gain a competitive advantage in the global and information society. (Bonus adaptability, 2008) It is true that those who cannot perceive their actions, analyse and learn from them do not develop a personality. (Řehánek, 2009) The market press is strong and ruthless; therefore, there is no place for mistakes and misunderstandings.

For objective transmission of information to improved knowledge, a high level of communication, presentation, and cooperation is needed. Teachers must understand student requirements and expectations in university environments. They must use appropriate communication styles with interpersonal situations and know results of their communication (education) with links into practice and satisfied students. (Oblinger, D., G. and Oblinger, J., L., 2005) In this case we must think about the situation when student requirements are unrealistic or without interest to a given theme. On the other hand, teachers can rely on the fact that constant internal change and continual learning processes are based on both internal initiatives within the organization as well as external stimuli. (Pokorná and Sojková, 2009; Dlouhá, Zahradník, Hattanová, Dlouhý, 2006)

Effective communication in education must respect individual preferences and student abilities. It is important to realize that our conscious does not register everything, but only things we focus our attention on and what we can perceive. (Brixí, 2010; Eger, 2005) The required knowledge and skills effective in education are:

- Communication skills for effective contact with students,
- Presentation skills for ability to convince the other,
- Teamwork and ability to work in heterogeneous teams,
- Ability to solve problems and conflicts,
- Willingness to take risks, experiment, be creative to innovations,
- Perfect knowledge of technologies for combined usage by needs,
- Knowledge of the services provided,
- Knowledge of standards. (Zelený, 2011)

The optimal way to understand student opinion about educational materials, preferences, and priorities are various types of surveys, lists of questions, or explorations like study activities. As one of the well-known educational systems for educational support via web pages, the Moodle system offers these forms. (Moodle, 2011)

Study activities for supporting communication

Teachers can implement various types of study activities into a course for communication support between teachers to students. One of the needed study activities is exploration. Surveys like ATTLS (Attitudes Towards Thinking and Learning Survey) or COLLES (Constructivist On-line Learning Environment Survey) are accessible. The ATTLS activity contains suggestions of questions to get opinions that differ by empathy. COLLES offers the ability to evaluate course learning. Moodle (Moodle presentation, 2011) accesses a few variants:

- ATTLS with twenty items, Critical Incidents,
- Experiences, Ideas, Experiences and Ideas (COLLES).

Implementation is intuitive. All methods are based on completing the required fields like Name, Exploration type, Introductory text, Group mode, Visible, Identifier, and Mark category. Items Exploration type, Group mode, or Mark category allow easy selection through the use of menus. The use of these explorations brings question examples for surveys or lists of questions like:

- I spend my time looking for the problem.
- When I analyse something, it is important to remain as objective as possible.
- What helped you most for communication?
- What event surprised you the most.

Additional inspiration is form in the of answers, for example Almost never, Rarely, Sometimes, Often, Almost always, or the fact that questions with answers are grouped in the following sections: Severity, Reflecting the thinking, Interactivity, Support for teachers, Support for students, Interpretation. The question for this analysis is its usefulness and teacher perception in connection to other study activities in the accepted structure of the course.

Selected methods as background for analysis

Realized analysis is centred on optimally used accessible study activities from the Moodle system in order to support communication with students. The starting point for analytic work is the multidimensional approach and object access. Reasons for activation these ways have basic in needs the global and information society. The multidimensional approach brings a wide range of dimensions that affect information technology development. These dimensions are information, procedures, finance, organization, legislation, social and ethical aspects, software and hardware, and methodology. Object access is useful for work with Petri Net objects (Gold, 2004) like places, transitions, and edges.

The created model specifies the main characteristics of a given reality for the creation of explorations like ones from available study activities. This access enables to know the studied system better. The realized analysis is focused on the description of parallelisms for selected teacher activities with a classic analysis via linear and matrix algebra.

An analysis of study activities for the support of explorations

The realized analyses use Petri Nets in order to demonstrate offered activities and their mutual comparisons. The object of analysis was the exploration with links to other study activities like Glossary, Exploration, or Wiki. From this perspective it is interesting how the students perceive this method of analysis. The mentioned analysis is used for the formal description of selected layers of the openSolaris operating system.

The aim of this analysis is to evaluate education materials (analysis for the openSolaris operating system based on Petri Nets) and to clarify their perception by students. The benefit of this approach is that there was a mutual learning process with positive response. Students in communication with the teacher learn new theoretical knowledge and skills about operation systems.

Student perceptions of Petri net simulation in learning

New changes and the course of instruction were subject to review based on an exploration that students filled out at the end of the “Operating systems” course for full-time study. Several questions were asked and students chose from answers: Yes, Rather Yes, I do not know, Rather No, No. One of the questions was centred on Petri Net simulations that were added into the course within innovation: “*How do you rate the usefulness of analysis using Petri Nets with animation?*”. Petri Net simulations were created in the HPSim environment (Petri Nets Tools Database Quick Overview, 2011) in order to create models using Petri Nets. The selected topics include architecture, file system, process management, security, and user environment in the openSolaris operating system. The result of the student answers is given in Table 1 and Figure 1.

Table 1. Student opinion about Petri Net simulation with support animation.

Yes	Rather Yes	I do not know	Rather No	No
5	6	7	2	0

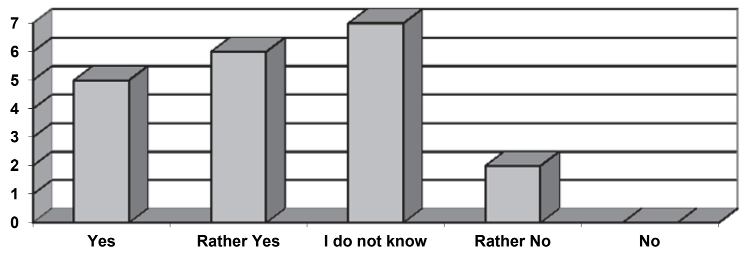


Figure 1: Graphical presentation of student opinion about Petri Net simulation.

The realized exploration shows that students received this way of analysis in the area operating systems well. On the other hand, accessed simulations need more interpretation and clarification because some students do not understand these models with links to theory and practice in the "Operating systems" course.

Exploration study activities from the moodle system

The above-mentioned exploration was accessed with the support of the Moodle system. On the basis of past experiences, the next step is naturally an analysis of available options from the area of surveys, and comparing with other study activities from the teacher's point of view. The following rows show a practical application analysis with Petri Nets for creating an Exploration as available activities of the Moodle system. The given model describes reality with support of Petri Nets. Please see Figure 2. The start point is place P1_ListCourses. This place displays the screen with registered courses of teacher. The next route leads through the transition T1_Select_Course to place P2_Course_Identification. The transition rests in the selection of a course by the mouse and the scroll-bar. Place P2_Course_Identification displays on the screen a visually marked record of the course. Realized steps are intuitive. Model build follows defined places:

- P1_ListCourses – displays a list of registered courses.
- P2_Course_Identification – displays a visually marked name of the specified course.
- P3_Course_Information – displays specified groups of information, materials, and activities for editing.
- P4_Study_Activities – accesses offered activities.
- P5_Exploration – accesses needed information about Exploration.
- P6-1_Name, …, P6-7_MarkCategory – accesses items for the creation of Exploration.
- P7_Course_DisplayContent – displays actual information about the course.

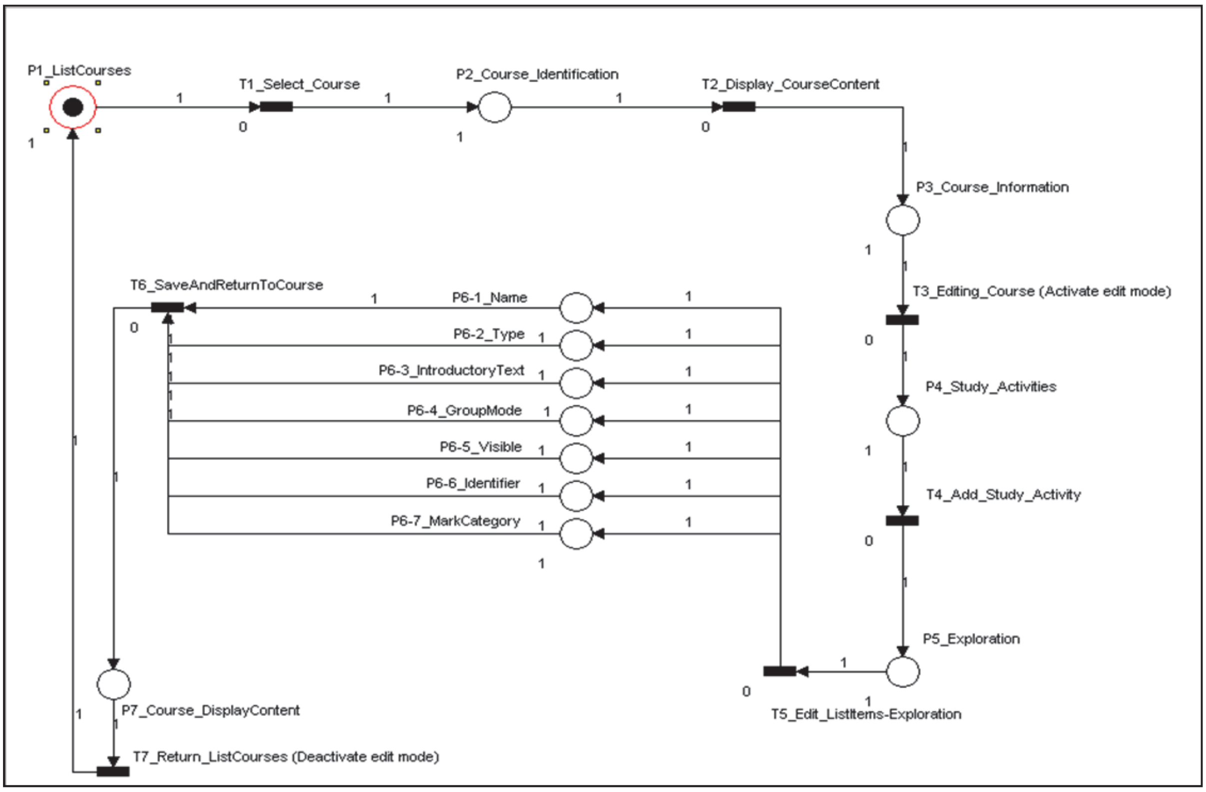
Needed transitions of the defined model are:

- T1_Select_Course – searches specified course (specified via scroll bar).
- T2_Display_CourseContent – selects needed information about selected course (selects course by mouse).
- T3_Editing_Course – specifies the edit mode of needed information, materials, and activities of a course (button Activate edit mode).
- T4_Add_Study_Activity – specifies the menu for the creation of a chats, database, exploration, forums, glossaries, lessons, list of questions, public inquiry, SCORM, tests, and Wikis (menu Add an activity).
- T5_Edit_ListItems-Exploration – accessible items for Exploration creation.

- T6_SaveAndReturnToCourse – confirms registered information created by edit process (button Save and Return to Course).
- T7_Return_ListCourses – displays all registered courses of teacher for next course select (button Deactivate edit mode to end the editing, select next course via mouse and scroll bar).

The validity of the defined model is verified by starting the given simulation. A route cycle is built from place P1 via specified transitions and places. Places P6-1 to P6-7 illustrate items for Exploration editing. If the teacher ends the edit mode, it is important to confirm the "Deactivate edit mode" button. This activity is represented by transition T7. The next route returns to place P1.

Figure 2: Method simulation for creating an Exploration in the Moodle system.



Liner and matrix algebra for Petri nets simulation analyses

The above-mentioned model is a good way for further professional analysis based on linear and matrix algebra. The realized analysis of Petri Nets uses methods of linear algebra for work with matrix representation given structures (Markl, 2006) to describe the properties of these nets. Default structure of Exploration is defined as:

$$\text{Exploration} = \sum_{i-1}^{7} P_{6-i} \qquad (1)$$

where P6-i (pro i=1-7) are items for Exploration definition in the Moodle system. Further analysis uses an incidence matrix and set of reachable markings. To illustrate the incidence matrix and the reachable markings, please see Table 2.

Table 2. An analysis for a model with an incidence matrix and reachable markings.

	Incidence matrix							t1→M1	t2→M2	t3→M3	t4→M4	t5→M5	t6→M6	t7→M0
	t1	**t2**	**t3**	**t4**	**t5**	**t6**	**t7**	**M0**	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**
p1	-1	0	0	0	0	0	1	1	0	0	0	0	0	0
p2	1	-1	0	0	0	0	0	0	1	0	0	0	0	0
p3	0	1	-1	0	0	0	0	0	0	1	0	0	0	0
p4	0	0	1	-1	0	0	0	0	0	0	1	0	0	0
p5	0	0	0	1	-1	0	0	0	0	0	0	1	0	0
p6-1	0	0	0	0	1	-1	0	0	0	0	0	0	1	0
p6-2	0	0	0	0	1	-1	0	0	0	0	0	0	1	0
p6-3	0	0	0	0	1	-1	0	0	0	0	0	0	1	0
p6-4	0	0	0	0	1	-1	0	0	0	0	0	0	1	0
p6-5	0	0	0	0	1	-1	0	0	0	0	0	0	1	0
p6-6	0	0	0	0	1	-1	0	0	0	0	0	0	1	0
p6-7	0	0	0	0	1	-1	0	0	0	0	0	0	1	0
p7	0	0	0	0	0	1	-1	0	0	0	0	0	0	1

Incidence matrix C is a matrix which makes the relation:

C = C+ - C- (Papík, 2010), (2)

where C- is a backward incidence matrix, and C+ is a forward incidence matrix. The set of all reachable markings characterizes a set of all existing states. Specified places (p_i for i=1 to 7) contain status information in the form of brands - tokens, and defined transitions (t_j for j=1 to 7) reflect available changes. Incidence (amendment) matrix represents for the place as a whole (a positive number, negative number or zero) change in the number of brands located there. The set of reachable marking provides all states which the system can reach from the initial state.

Discussion

Accordingly, the analysis of other teacher activities from Moodle (such as Forum, Glossary, Survey, Test, or Wiki) is available. For example, creating the Glossary element involves a greater volume of work. Sixteen items are required to specify the Name, Description, Number items on page, Glossary type, Display alphabet, Evaluation with mark, or Common Settings. This study activity has an influence on the possibility to repeat, for example, main terms from the selected theme. The benefit is that students accept this activity very well, and they do not doubt its usefulness.

Anther study activity for comparison is Survey. This study activity enables the creation of quick answers or feedback from students on needed matters like preferred test dates. This activity is also defined via sixteen items like Name, Describe, Choice limit, Option 1, …, Option 5, or Common settings. The benefit of this activity is inconsistent based on links to the exploration. The Exploration study activity is very easily implemented via only seven items: Name, Type, Introductory text, Group mode, Visible, Identifier, and Mark category.

Conclusion

The realized analysis focuses on the usefulness of implemented study activities in the “Operating systems” course. The aim is to offer optimal educational materials and animation for the effective description and interpretation of the given theme including evaluation. Students have various educational materials available in standard PDF documents. Other added activities are Glossary, Wiki, video-simulation for demonstration of practical work with UNIX operating systems, or simulations of selected operating system layers based on Petri Nets. A teacher's natural requirement is being interested in the value for students with links to future innovation for better education and communication with students.

The analysis of available study activities from the Moodle system uses Petri Nets. This approach combines the advantages of graphic entry and simulation capabilities to easy comparison with other study activities. Presented analysis describes the complexity of the learning activities in order to facilitate better implementation of exploration in education. The teacher can select from five forms like ATTLS or COLLES. The required method is easy to implement into a course via only seven items by mostly predefined menus. This simplicity is visible with links to Glossary or Survey. These study activities are defined via sixteen items. The benefit of these activities is positive perception of education by students. The negative characteristic of exploration is the fact that the teacher cannot edit created explorations, but the teacher can use these activities for the inspiration of his or her own surveys or explorations. It is a way to identify and solve problems with links to theories in practice.

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The Use of Multimedia in Technical Education

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Abstract

The paper focuses on the specifics in the educational process of the topically oriented part "Electricity" in the Technology course at lower secondary schools in Slovakia. Due to the unsatisfactory situation in the availability of textbooks, teaching aids and technical equipment, the issue of technical education and the implementation of new teaching aids in the teaching/learning process is considered. The attention is drawn to the design, methodology, development and the implementation of one component of the multimedia educational aid (MEA) with the elements of e-learning. After completing the concept of MEA, its effectiveness and validity in educational practice is going to be consequently verified by the pedagogical experiment.

Keywords

Multimedia. E-learning. Interactive course. Multimedia educational aid. E-material. ICT.

Introduction

In recent years, under the influence of the societal, political and global changes, the educational system in Slovakia has undergone several transformational modifications that are reflected in different areas. In terms of restructuring the course subjects at lower secondary schools, also in technical education as part of general education, the significant content and organizational changes require to pay increased attention from various perspectives (e.g. development of materials and procedures for technically oriented subjects, application of various forms and methods of education as an integral whole, the specification of tasks at all levels of significance, the active use of ICT, etc.).

Digital technologies seem to be a potential means for change and innovations in the educational process. A few years ago, the access to computer facilities was the main problem of primary and secondary schools. Today, the meaningful use of technology in teaching process and the existence of properly processed didactic e-materials appear to be a topical problem. Therefore in current conditions, teachers are looking for the ways to enable pupils to acquire competences and practical skills of approaching the life at higher technological level.

Restructuring of national economy in the post-communist years has influenced not only the economy sector. Besides these problems, the fluctuation of the global economic environment, as well as the economy crisis has significantly affected the educational sector. Although declared but financially undervalued, the transition from the industrial society to the information and learning-based society has had no solid foundation in the material base (Turek, I., Miština, J., 2007). The priority has been given to universities, while the ICT support, as well as teacher training at primary and secondary schools started in early decade of new millennium being supported mainly by

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structural funds of EU. In this demanding situation, as mentioned above, technical education did not achieved sufficient attention at the administration authorities, sponsors, parents and students as well. Although it is difficult to compare because of the principal differences, both in general and technical educational systems in the EU countries including Slovakia (Kozík, T., Pavelka, J., Miština, J., 2004), teachers and researchers have been searching for solutions in the development of effective teaching tools in the completely new environment since the Internet, ICT and electronic multimedia systems have been implemented in society and education. “Successful multimedia programs achieved specific goals, clarified abstract topics that are difficult to understand using traditional teaching media, available to both teacher and student, provided an effective evaluation platform and focused on reaching the concepts rather than entertaining the student with shallow special effects. They provided a visualization tool that can transform abstract concepts into simple demonstrations. They also accommodated individual learning styles and evaluation needs. Students evinced strong acceptance and improved learning, when their instruction included programmes developed with the above principles” (Owen, E. F., Helps, C. R. G., 1996). The growing concern of teachers to improve their theoretical classes together with the revolution in content and methods brought about by the new information technologies combine to offer students a new more attractive, efficient and agreeable form of learning. Technical education is particularly special, since the main purpose of subjects in this area is not only to provide students with theoretical knowledge, but also to enhance their practical skills. Looking for similar multimedia teaching tool in similar educational fields we have been inspired by the programme of interactive multimedia animation with macromedia flash in descriptive geometry teaching (Garcia, R. R. et al, 2007). The software used in the development of the animations was Macromedia Flash; a tool that allows very small vectorial graphics files to be created, thus facilitating their electronic transmission to any user connected to the network, what was the aim of our Multimedia Educational Aid (MEA). Many other experiments, methodologies, implemented teaching tools and multimedia programmes for technical education (e.g. England, E., Finney, A., 2001; Balazinski, M., Przybylo, A., 2006; Frick, T., 2007, etc.) have confirmed the educational value of digital technologies.

Materials and methods

Since the computer equipment and ICT resources at lower secondary schools in Slovakia have a short tradition and the use of multimedia teaching tools applied in the educational process as a means of interconnection of ICT, e-learning, didactic and practical teaching patterns in technical education is not sufficiently addressed yet, the basic research question that we ask is: *How the use of Multimedia Teaching Aid (MEA) will affect the cognitive and psychomotor level of pupils involved in the technical subject based courses?*

The basic research sample will consist of lower secondary pupils of elementary schools (upon ISCED2 recommendations, the subject "Technology" is included in the 5th-9th grade). Therefore, considering the age of the target group (10-15 years), our ambition is not to eliminate the personal contact with teachers, as well as classmates who are the source of many other pupils’ experiences, conducive to learning. What we have in mind is to avoid losing personal contacts and discussions, possibility of learning by observing others, possibility of comparing their learning steps, proceedings, opinions and values with others and seeing if they are right or wrong, and so on. As we know, the quality of education is conditional on the presentation of knowledge, information and facts in various forms, their management and administration, the possibility of communication, cooperation and mutual confrontation, the environment for individual or team activities, practical activities, games, etc. For this reason, we assume that the use of MEA wit elements of e-learning in technical education could positively influence cognitive knowledge, psychomotor skills as well as socio-affective values of

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pupils. The content of MEA will be focused on the thematic area of electricity. Given the wide range of the thematic unit by ISCED2, we focus on health and safety in working with electrical equipment, identification of wiring accessories and their installation, residential wiring, the technologies in electrical installation, the calculation of energy consumption and the related parts because of the evidence of an adequate amount of available materials in the remaining parts of the thematic unit. The content of MEA, we will try to process so as to ensure the curriculum transformation into e-learning elements, and there has been identification of a part of educational content especially suitable for virtual visualization, based on animation and simulation modelling and technology of visualization based on hypertext, video sequences, etc. The concept of the MEA structure is designed in a modular way. It should consist of five modules, which should correspond to the main thematic sections. These would then be divided into particular topics characterizing smaller logically interconnected sections of the relevant modules. Detailed general structure of the modules and topics, which we follow in the design and implementation of the whole MEA, which is currently in the process of development, testing and evaluation, have been presented in Jurinová, Depešová (2011). Besides the detailed explanation and illustration of the basic facts and functionalities processed within the framework of particular modules by means of the: text - hypertext, images, animations and video sequences (clips), the MEA will contain interactive exercises, tasks, test questions, educational games and ideas for carrying out practically oriented tasks as an element of feedback for pupils. The text remains the essential media in this type of information carrier. The main difference compared to the classic text is its hypertext feature. The learners do not have to pass through the content linearly, but they can jump between different learning parts, or bounce to external materials, so as the hyperlinks allow. Although the hypertext takes the largest part of subject matter content, an important part of providing the content are the information through other media. These are pictures, sounds, videos and animations. For making animations we use Adobe Flash, to work with vector graphics we apply CorelDRAW, for raster graphics Adobe Photoshop and for processing the text information we use MS Word. For the MEA development we will use Articulate Studio '09, which allows the development of courses in the form of presentation. It allows to develop programmable courses, which are quite different from standard presentations created e.g. in MS PowerPoint. Then there is a built-in ability to insert different types of test questions, insertion of programmable objects, whether specific or predefined. The programme also allows exporting presentations into universally accepted Flash format, which can be presented on a web server or the LMS. It supports SCORM and AICC, making it easy, after integration into the LMS, to track results. The process of the MEA development is a part of the author's (Jurinová) doctoral research headed by her supervisor (Depešová) at the University of Constantine the Philosopher in Nitra, Slovakia. There have been involved undergraduates of Applied Informatics at the University of SS. Cyril and Methodius in Trnava, Slovakia. In implementation, testing, evaluation, adjustment and precision of the final product there will be involved teachers of technical courses at lower secondary schools throughout Slovakia, and, of course, their students. Consequently, carrying out the pedagogical experiment we aim to verify that the inclusion of MEA in the educational process as a part of the "Technology" course will increase the attractiveness and quality of education itself, along with shaping positive attitudes of pupils in this subject comparing to its current style, which has more or less theoretical character. Our goal is to work together on computer literacy of students and shaping a positive attitude towards lifelong learning. For this part of the research, the detailed methodological approaches in implementation of MEA into lessons and into various phases of the educational process will be proposed, so that, given the flexibility and complexity of MEA, they will be able to be modified or extended to include more options with regard to the needs of pupils, as well as to opportunities in area of material-technical provision of schools. But rather than the research itself and its organization we are facing the question of the development of MEA and its components. This paper is devoted to this problem. We focus on the methodology of electronic multimedia courses in general, as a basis for making individual components of MEA. As determined by the methodology, and as a result of our present work, we introduce a particular multimedia course designed to clarify the issue of lighting circuits in the home, which represents only one part of the prepared MEA.

The life cycle of the electronic multimedia course development

The mentioned multimedia educational courses, whether in the form of MS PowerPoint presentations, web pages, instructional videos, self-initiated applications, or CD/DVD media can be characterized by three phases during their "life cycle":

1. Development

Multimedia course is a programme that combines text explanations with animations, video, audio, graphics, diagrams and testing objects. Consideration should be given in addition to the diversity of content processing, also to the integration of basic documents, task subjects and ideas for different organizational forms of teaching appropriate to pupils' abilities, together with illustrative logical and practical and practical procedures, while respecting the taxonomy of objectives. Course format is specified by a number of criteria, such as: profile of potential users (pupil, student, teacher, parent - age specificities, relationship to ICT and experience with them, school environment, acquired knowledge and skills, etc.); the aim, the mission of the course; content and its didactic and methodical processing; type of teaching content (theory, practical work, procedures, tasks for the team or individual work, safety rules at work, general, specific and extended subject matter, etc.); technological options (PC, local network, Internet connection, transmission speed of networks, ICT, etc.); skills, competences and opportunities (time, financial, professional), of the author of the course.

E-materials currently represent one of the main sources of information. There are several forms of electronic multimedia course: from the linear, hierarchical and web presentations of the subject content, through interactive presentations and tutorials, up to the complex simulations of real phenomena, objects, devices and situations. Similarly, like other text based teaching aids, it must comply with various patterns. According to own research, Allen, M. W. (2007), Clark, R. (2002), and others we can characterize the general principles of the course design as follows:

- suitable, logical structure and organization of the subject matter,
- providing and provoking the curiosity (motivation),
- verbal resources and non-verbal resources (schemes pictures, diagrams, tables, procedures, animations, video, etc.),
- small units,
- planned cooperation,
- completeness,
- repetition,
- synthesis,
- stimulation and variability,
- feedback,
- compliance with ergonomic parameters.

2. Distribution

After creating this course it is necessary to distribute it to the computers of potential users or into specialized classrooms. The basic methods of distribution of such courses include CD/DVD media, Local Hard Drives, USB, Local Area Network, Intranet/Internet or the hybrid methods. CD/DVD ROMs, USB and Local Drives can store a large amount of data. However, the disadvantage is more difficult updating of subject matter. The trend is therefore the distribution of courses via Intranet or the Internet. These means bring common standards, environment and security, the possibility of regional expansion and almost immediate distribution of the finished course to the user. The hybrid methods combine the advantages (but disadvantages, too) of the data storage for various types of user disk storage with the benefits of the Intranet/Internet.

3. Management

The process of the teaching/learning management occurs after the distribution of e-learning courses to pupils. This process provides access to the proper parts of the e-course at the right time, guidance how to navigate in the e-course, what are the options of e-course, etc. As a part of the course management, the outputs of individual users including the test results (number of points, time spent on each section, responses to individual questions, the task solution state, etc.), statistical evaluation of particular parts (average success rate, e-course task, the number of trainees, etc.) are monitored. Currently, most of the mentioned activities can be comfortably, without specific knowledge and skills implemented through the available LMS systems.

Results

The former research showed that multimedia involvement into teaching/learning process contributes to the clearness, greater activity and concentration of pupils in learning as well as to better results (using digital technology, pupils perform better in communication, collaboration and problem solving, are more computer literate). Technologies combined with multimedia educational materials can greatly facilitate and streamline the learning process (creating wider opportunities for teaching preparation, revising the subject matter and testing of pupils). They also contribute to the development of thinking and creative activities of pupils. The teachers themselves reported that thanks to modern technologies, preparation for teaching is more effective and they can better focus on the didactic aspects and methodology in the preparation for teaching. They can apply different methods and innovative ways of working with ICT, with more space and opportunities for individualization of work in class, etc. Using of digital technologies, however, does not necessarily lead to improved results. The technology itself and the access to information do not have a direct impact on pupils' knowledge. It is very important that the means of ICT in the teaching process teaching would be properly applied and their potential utilized. The basic assumption is setting goals corresponding with the content the students should learn, know or do at the end of the lesson. Creation of electronic multimedia materials is subject to a number of criteria, which are detailed above.

The presented method of processing multimedia materials we applied in creating a partial module of MEA, clarifying the principles and patterns of lighting circuits in the home in an interactive form. It is a process that requires consistent application of several patterns. Within its development it is important to focus primarily on two areas (didactic and technical), which have to be followed and combined for overall effect.

From the didactic point of view, using the literary method and the method of content analysis of pedagogical documents and technical text, the issue of lighting circuits in the home has been processed. The part of the theoretical interpretation is the classification of basic types of switches and their connections, presently valid colour coding of cables and wires, electrical lighting and switches, along with the basic principles of installation according to ISO, the classification of the wiring location zones, levels of protection (IPX) of electrical appliances defined by international standards IEC 60529 and below. This section has undergone a rigorous logical and didactic analysis of the subject matter, which reflected the age level of the target group, the psycho-didactic requirements of the specific learning environment in the course. Many of the concepts the pupils will meet in this area are difficult for imagination and require a great deal of abstraction. Therefore, the course offers a processing of subject matter so that the concepts and principles are appropriately visualized, and allows experimenting. Pupils are offered the opportunity to actively explore the properties of lighting circuits and related relationships between the functionality and their technical implementation.

At the technical part of the development of multimedia educational aid, we have complied with following sequence of steps:

1. Providing the technology support - hardware and software

Here we understand the selection of appropriate technologies for the course development and their implementation to educational reality. Before we start, we should consider the following questions:

- What technologies to use in the development of the course and for its operation?
- In what form will the course be distributed to the pupils?

The presented educational multimedia aid was processed in Adobe Flash, using the above mentioned set of graphical editors for creating and editing graphics. For 3D rendering of the house, the Rhinoceros tool designed for the 3D modelling and conceptual design was used.

2. The course design, the content and additional parts

It consists in transforming the content or the subject matter into a suitable form. It is a combination of appropriate methods and forms (application of multimedia), so that the course would address the target group. The structure of the course should be logically arranged in a sequence of lessons. It is displayed in Figure 1.

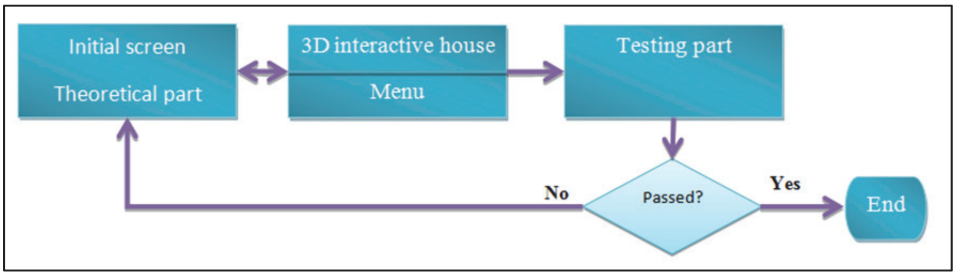

Figure 1: Structure of multimedia educational aid

Very important is the learners' first impression and their intuitive approach to working with the objects, as well as the course itself. One of the most important parts of the course is a feedback between pupils and the subject of their learning. This part is managed in a form of tests at different levels in terms of difficulty, processing, importance, but also the learner success in the continuation of the study. Since in this case the rule "it is better to see once than hear a hundred times" is valid, we took the opportunity of animation for clarifying individual lighting circuits, and thus we increased the sake of clarity, but also the pupils' interest in the subject. The course should be easy to use and intuitive. The aim is to minimize the time required to manage the control of the programme. Navigation should enable the users to know at any time where they are and feel that they can navigate the application by themselves. For this reason, the concept of multimedia educational aid is divided into three blocks:

- introductory – theoretical part – containing elaborated above thematic parts,

- 3D interactive house – with a menu of five basic types of the switch connections. The house is interactive and any switch in the house can be activated by using the mouse. The used switch and any other switch associated with it are automatically highlighted. After clicking on the switch light in the house comes on, while on right side of the screen, a window with a functional scheme and a theoretical description of the connection appears. The functional diagram is accompanied by the slow flow of the electric power after switching the circuit.
- testing part – accessible to pupils after introducing all provided of types of connection. It is designed to be easily modifiable. Teachers therefore can modify the test questions to individual needs as required. It consists of a closed multi-choice. Upon completion the tests are evaluated and the learner is offered two options:
  1. Passed – The learner has sufficient knowledge. The application according to the achieved results will evaluate the pupil (in % and a mark).
  2. Failed – The learner will be returned to the beginning to try to complete the knowledge and pass the test.

3. The design of multimedia application

The design of the multimedia application itself, proportional layout of various elements and the intuitive control of application are the essential factor influencing the motivation of pupils. Figure 2 presents the initial screen with explanatory text, an example of the testing part with a feedback opportunity and also the other screen, which displays the 3D interactive house. All the lights are off. For the intuitive control, the active switches are highlighted, and at the bottom part, the menu with different types of lighting circuits is available.

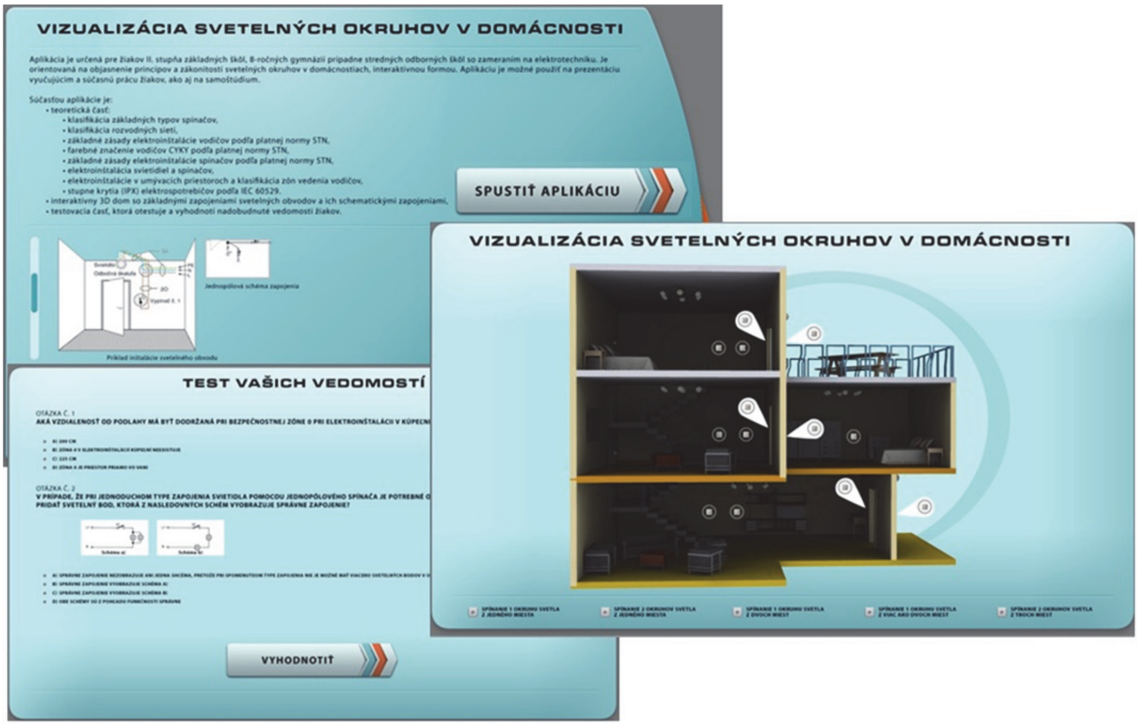

Figure 2: Initial screen, testing part and initial screen of 3D house

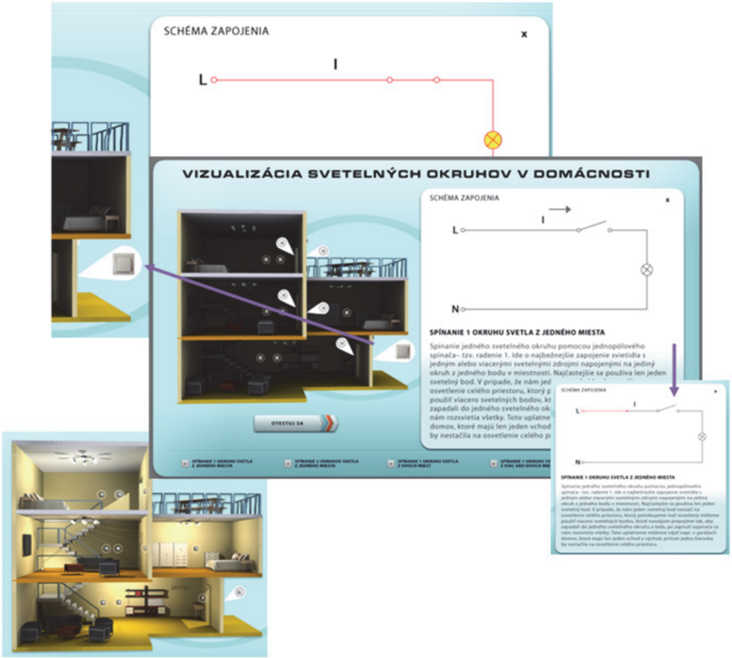

Figure 3: 3D house

Discussion

The information explosion brought by the quantitative growth of Internet use showed that the information society has its limits, at which just an amount of information can become a societal problem. The key process when working with information is no longer the amount of data, but the ability to convert most appropriate information into the required knowledge. The courses, in addition to the transfer of subject matter to pupils, in a variety of attractive forms that take into account different learning styles of pupils, should always to provide feedback to learners, using a variety of tasks (test questions: closed, dichotomous question, a simple choice, multiple choice, sequential hierarchy and open or semi-open questions, didactic games) and ideas on practical, or project activities, leading to active acquiring of the subject matter by pupils, as well as their motivation to be involved into the educational process. We assume that the above presented designed aid that is a part of the prepared multimedia educational aid satisfies the mentioned criteria.

The indisputable fact is that into the process of electronic media application development intended to promote education, should be involved teams of psychologists, educators, methodologists, programmers, graphic designers and other specialists in the field. There would thus create a quality product, which long after its completing could find application in the teaching. Since MEA is the project of local/national importance, in future we would like to modify it for an English version either for the international purposes or for the purpose of CLIL (Content and Language Integrated Learning).

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User Session Identification Using Reference Length

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Abstract

One of the methods of web log mining is also discovering patterns of behaviour of web site visitors. Based on the found users' behaviour patterns that are represented by sequence rules, it is possible to modify and improve web site of the organization. Data for the analysis are gained from the web server log file. These anonymous data represent the problem of unique identification of the web site visitor. The paper deals with less commonly used navigation-driven methods of user session identification. These methods assume that the user goes over several navigation pages during her/his visit until she/he finds the content page with required information. The content page is a page where the user spends considerably more time in comparison with navigation pages. The content page is considered to be the end of the session. Searching of the next content page using navigation pages constitutes a new user session. The division of pages into content and navigation pages is based on the calculation of cut-off time C. The verification of exponential distribution of variable that represents the time which user spent on the particular page is coessential. We prepared an experiment with data gained from log file of university web server. We tried to verify, if the time spent on web pages has exponential distribution and we estimated the value of cut-off time. The found results confirm our assumptions that the navigation-driven methods could be used to proper user session identification.

Keywords

Web Log Mining. Session Identification. Reference Length. Cut-off Time.

Introduction

Log file of the web server is a source of anonymous data about the user. These anonymous data represent also the problem of unique identification of the web site visitor. If we want to analyse the users' behaviour on our web site, it is not necessary to know the identity of each visitor, but, it is very important for us to distinguish the web site visitors. The finding of the user behavioural patterns that are represented as sequence rules is based on the data from log file created by the web server. Sequence rules analysis is useful for further modification or optimisation of the web site.

Literature overview

If we want to use methods for user session identification we have to choose from these two options:

1. All activities realized by one user may be aggregated.
2. All activities which belong to one user session have to be aggregated separately.

We have to bear in mind that the visitor can visit the web site more than one time. It means that the log file can contain multiple records that represent several user sessions.

Individual visitors can be differentiated also based on the identification of sessions. The aim of session identification is to divide individual accesses of each user into separate relations. These relations can be defined in various ways (Cooley et al., 1999).

The reconstruction of individual visitor activity is relatively complicated process. The separation of 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. Authentication mechanisms can facilitate identification of the user. However, their usage is undesirable due to privacy protection (Berendt and Spiliopoulou, 2000).

The basic session identification method comes from the assumption that the session is represented as a bounded set of clicks realised in defined time.

As we mentioned earlier the main method for session identification assumes that the session is the bounded set of user's clicks realized in defined time interval. The second method expects that the session is identified on the basis of sufficiently long interval of time among two recorded visits of the web page.

The identification of web site visitors with regard to used web browser belongs to the next method of user identification. This method allows dividing the records from one IP address into several sessions using information about used web browser.

We verified the importance of above mentioned pre-processing methods in several experiments. We described them in detail in (Munk, 2011, Munk et al., 2010), (Munk et al., 2009). We examined different steps of the analysis of the anonymous web site visitors with the aim to recognize the most important one. Observed results are very important from the web site administrator point of view, because they can approve the structure and content of the web site.

Described experiments have been realized since 2009 and they have been focused on the comparison of results of sequence analysis of the log files with different level of data preparation. The examined log files came from the university web site. The aim of the experiments was to examine the necessity of particular steps of data preparation and subsequently their integration and automation.

Web site searching model

The model of web site searching and model of user behaviour are fundamental to correct aggregation of individual user's clicks to meaningful sessions that are sometimes referred to as transactions. We can organize individual web pages of the examined web site to three groups in term of model:

1. content pages,
2. navigation (auxiliary) pages,
3. multiple purpose pages.

The content pages are web pages where the user can find required information. These pages are the reason of visit of individual user throughout his browsing of web space. Therefore we can say that in the case of association rules searching content pages is the most important and our objective is to discover useful rules among those pages.

The other mentioned groups of web pages are necessary for successful site navigation or as sources of auxiliary information (Figure 1).

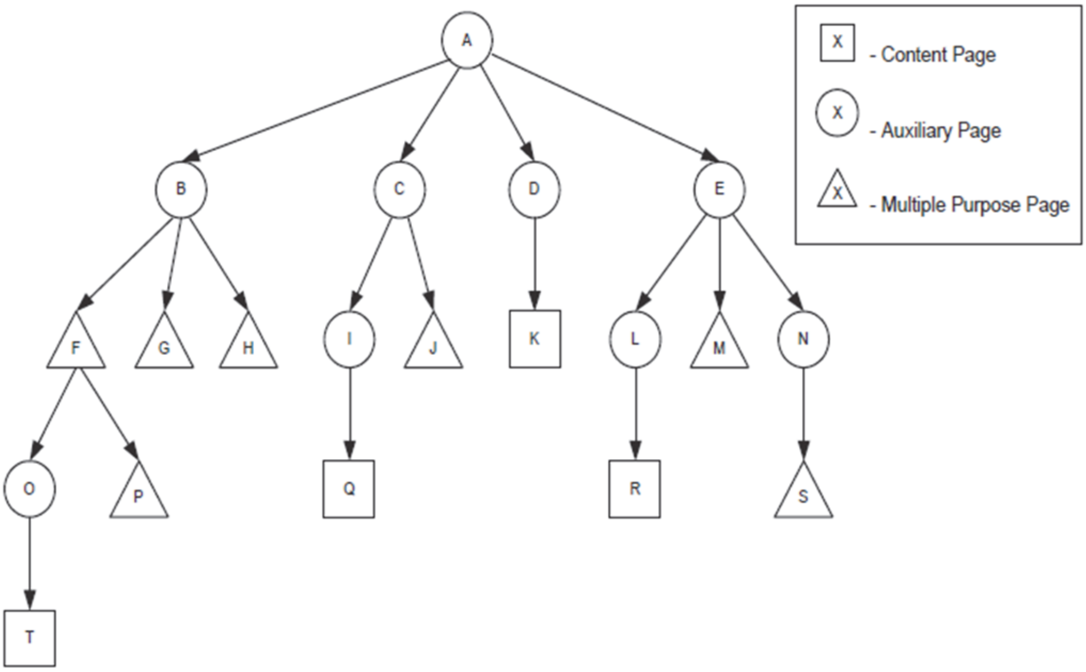

Figure 1: The example of web site map in consideration of different types of web pages (Cooley et al., 1999).

We have to note the fact that the division of web pages into above mentioned three groups may be very individual in term of user model, i.e. particular content page defined by one user can be considered by another user as an auxiliary page (Cooley et al, 1999).

In order to group individual web page references into meaningful transactions for the discovery of patterns such as association rules, an underlying model of the user's browsing behaviour is needed. For the purposes of association rule discovery, it is really the content page references that are of interest.

The other page types are just to facilitate the browsing of a user while searching for information, and will be referred to as auxiliary pages. What is merely an auxiliary page for one user may be a content page for another one. Transaction identification assumes that user sessions have already been identified.

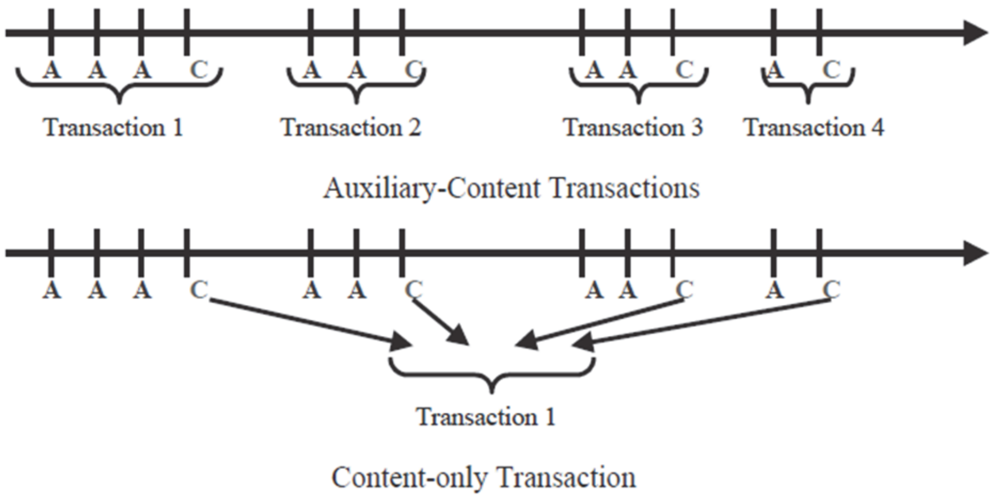

Figure 2: The session of individual user: the path through the navigation pages to the content page (Auxiliary-Content) and session focused merely on the content pages (Content-only) (Cooley et al., 1999).

Using the concept of auxiliary and content page references, there are two ways to define transactions, as shown in Figure 2.

1. The first would be to define a transaction as all of the auxiliary references up to and including each content reference for a given user (Auxiliary – Content Transactions). Mining these auxiliary-content transactions would essentially give the common traversal paths through the web site to a given content page.
2. The second method (Content-only Transactions) would be to define a transaction as all of the content references for a given user. Mining these content-only transactions would give associations between the content pages of a site, without any information as to the path taken between the pages.

The first method of session is important for searching of user behavioural patterns as well as discovering errors in navigation or inaccuracies on the web pages.

We consider necessary to remark that the methods of navigation-driven user identification suppose that individual user pass through several navigation pages until she/he finally finds required content page. The found content page is the end of the session. The next searching of another content page using auxiliary pages is considered as a new session. The path through the auxiliary pages is often referred to as transaction in scientific literature.

The methods of navigation-driven user session identification

We describe two navigation-driven methods of user session identification. Both assume that two sets of transactions, namely auxiliary-content or content-only, can be formed. The first one, the maximal forward reference approach has an advantage over the reference length method in that it does not require an input parameter that is based on an assumption about the characteristics (type of statistical distribution) of a particular set of data (Cooley et al., 1999).

Maximal forward reference transaction identification method

The maximal forward reference transaction identification method is based on the work presented by Chen (Chen et al, 1996). Instead of time spent on a web page, each transaction is defined as a set of web pages in the path from the first page in a user session up to the page before a backward reference is made. A forward reference is defined as a web page not already in the set of web pages for the current transaction.

Similarly, a backward reference is defined as a web page that is already contained in the set of web pages for the current transaction.

A new transaction is started when the next forward reference is made. The underlying model for this method is that the maximal forward reference pages are the content pages, and the web pages leading up to each maximal forward reference are the auxiliary pages. Like the reference length approach (a method described later), two sets of transactions, namely auxiliary-content or content-only, can be formed. The definition of a general transaction is used within the maximal forward reference method.

Again, using the Figure 1 example, auxiliary-content transactions of A-B-F-O, A-B-G, L-R, A-B, A-C-J, and A-D would be formed. The content-only transactions would be O-G, R, B-J, and D. The maximal forward reference approach has an advantage over the reference length in that it does not require an input parameter that is based on an assumption about the characteristics of a particular set of data (Cooley et al., 1999).

Reference length method

The reference length transaction identification method is based on the assumption that the amount of time a user spent on a web page correlates to whether the web page should be classified as an auxiliary or content page for that user. Qualitative analysis of several other server logs reveals that like Figure 3, the shape of the histogram has a large exponential component (Cooley et al., 1999).

If we defined the assumption about the portion of navigation pages in surveyed log file, we can define the cut-off time *C* that separates the content pages and other types of pages.

When the cut-off time *C* is known the session can be created in such manner that we compare the time of particular web page visit with the cut-off time *C*. The session is then defined as a path through the navigation type of pages (duration of time spent on this web page is less than *C*) to the content page (the user spent there more time than *C*). We can claim the content page is the last page of session. The subsequent page is the first page of a new session.

The calculation of cut-off time

The calculation of cut-off time *C* is the most important if we want to use the reference length transaction method for user session identification. The verification of exponential distribution of variable *RLength* obtained from the log file is also coessential. We took this assumption into consideration and verified it on the data obtained from the log file of university web site.

Analysed records were created during the period of 12 days in October, 2011. Records were cleaned using conventional log file pre-processing methods. Redundant data about requesting other file types (.js, .css, .gif) as well as records about crawlers were removed. The final log file contained about 210 000 records that represent individual clicks of web site visitors.

In the next step, we analysed the log file and we added the information about time spent by individual user on the web page into each record. This time was calculated as the difference of two consecutive records from one IP address. We did not realize the user session identification by the reason that we use the calculation of cut-off time *C* for reference length transaction identification.

Figure 3 depicts the histogram of the distribution of variable *RLength* that represents time spent on the individual web pages.

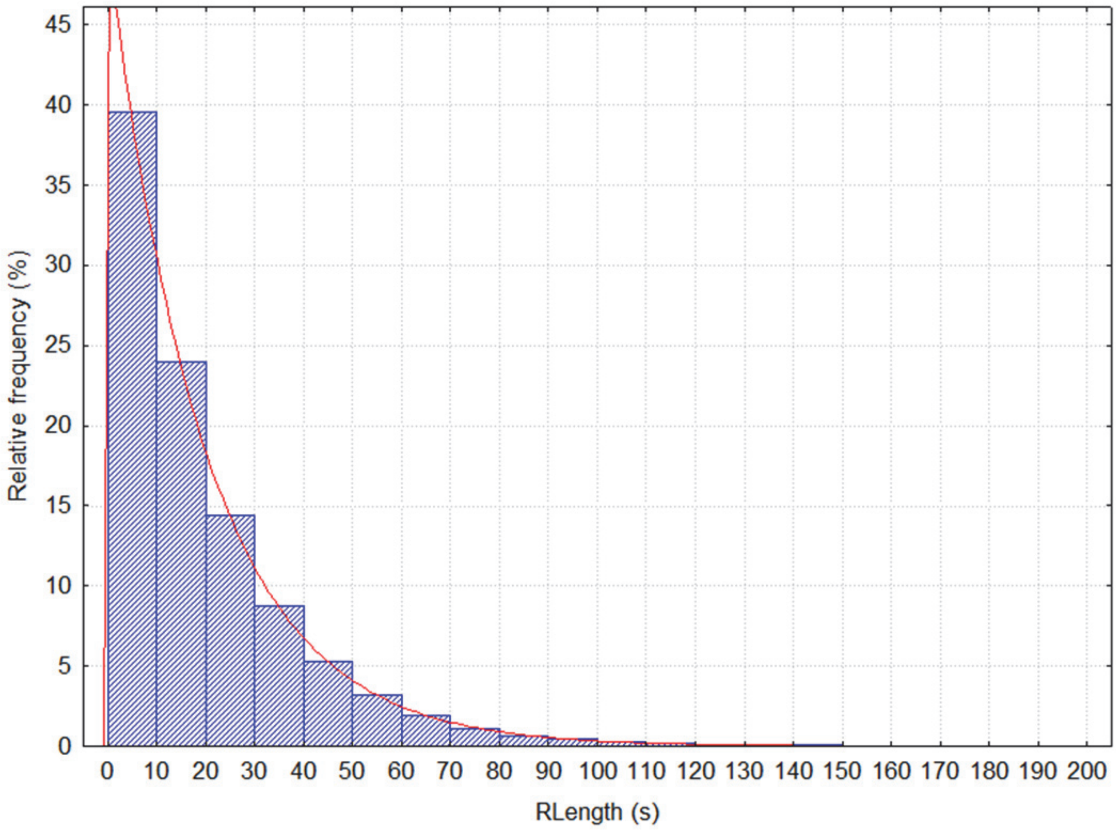

Figure 3: Exponential distribution of variable *RLength*.

We assume that the variance of the times spent on the auxiliary pages is small because the visitor only goes through them with the objective to find required information on content page. Therefore the auxiliary references make up the lower end of the curve (Figure 3). The variance of the times spent on the content pages is wide and we assume that they make up the upper tail that extends out to the longest reference.

If the assumption about the proportion of navigation pages in log file exists we can calculate the cut-off time *C* that divides web pages into navigation pages and content pages. We do not reject the null hypothesis which claims that the variable *RLength* has assumed distribution (Figure 3).

The variable *RLength* has exponential distribution.

$$f(RLength) = \lambda e^{-\lambda RLength}, \tag{1}$$

$$F(RLength) = 1 - e^{-\lambda RLength}, \tag{2}$$

where $RLength \geq 0$.

If *p* is relative frequency of navigation pages we can apply the quartile function (inverse distribution function) to estimate cut-off time *C*.

$$F^{-1}(p, \lambda) = C = \frac{-\ln(1-p)}{\lambda}, \tag{3}$$

where $0 \leq p < 1$.

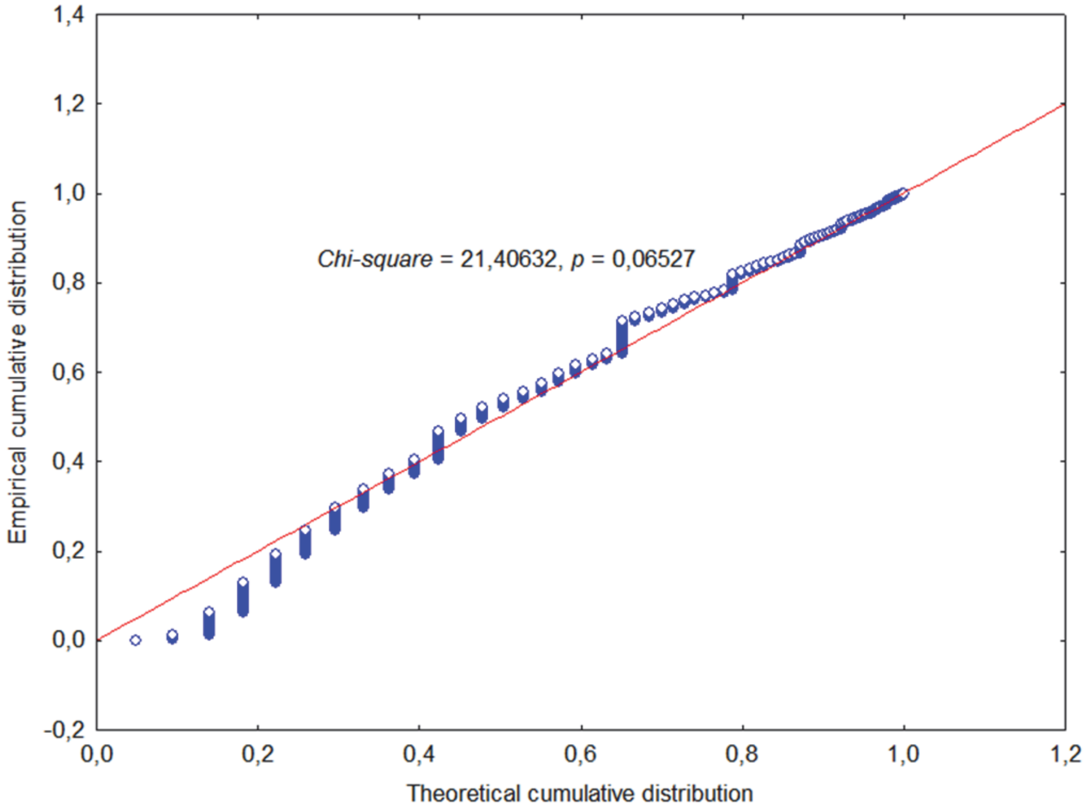

Figure 4: Probability of exponential distribution of variable *RLength*.

Maximum likelihood estimation of parameter λ (mean intensity of events) is

$$\hat{\lambda} = \frac{1}{\overline{RLength}}, \tag{4}$$

where $\overline{RLength}$ is observed mean length of visits. (Inverted value of mean time spent on the web pages).

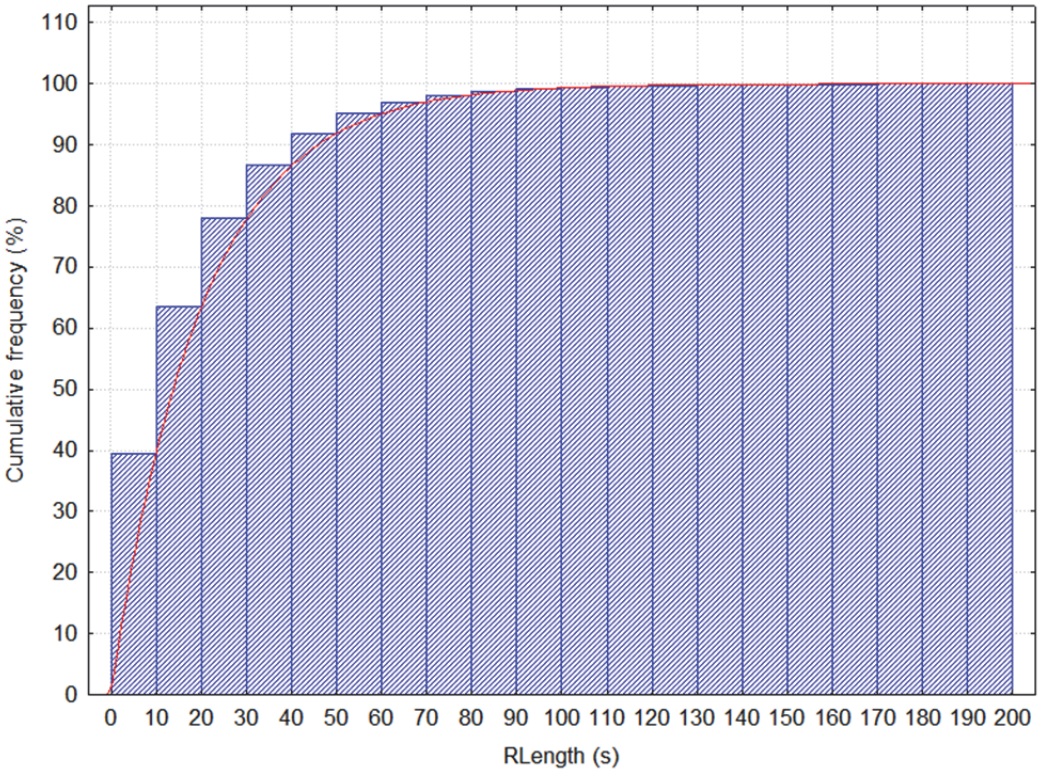

Figure 5: Cumulative frequencies of variable *RLength*.

Figure 5 describes cumulative distribution of time spent on the web pages expressed as a percentage. If the proportion of navigation pages were 70 % the cut-off time *C* would be between 20 and 30 seconds.

Once the cut-off time is estimated we can identify the session by comparison of each time with the cut-off time. The value of cut-off time divides the web pages into two groups – navigation and content pages.

If we have cut-off time estimated the session can be defined as a sequence of visited web pages with timestamp for which:

$$\langle USID, \langle URL_1, DTime_1, RLength_1 \rangle, \dots, \langle URL_k, DTime_k, RLength_k \rangle \rangle, \tag{5}$$

$$RLength_i \leq C, \tag{6}$$

where $1 \leq i < k$.

For the last web page of the session:

$$RLength_k > C, \tag{7}$$

The web page with the property (7) defines the next session. The first k-1 web pages are classified as navigation pages. The time spent on them is less or equal to cut-off time. The last k-th web page is classified as a content page. The time spent on this page is greater than the cut-off time.

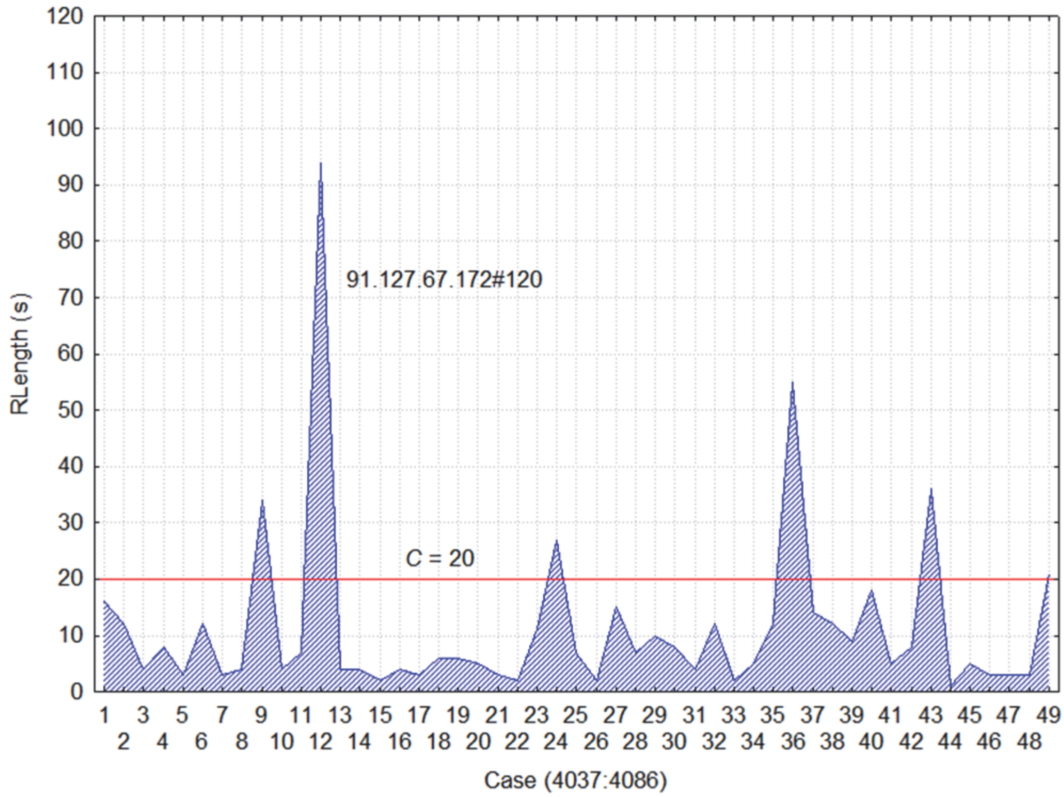

Figure 6: Session identification based on cut-off time.

The x-axis (Figure 6) depicts the sequence of web pages visited from particular IP address and agent. The sequence is ordered by the time. The y-axis represents the time spent on the web page. We estimated the value of variable *C* to 20 seconds.

The sequence of web pages with numbers 1 to 9 create the first session – pages 1 to 8 are navigation pages, the ninth web page is classified as a content web page. The next session is defined as the sequence of web pages with numbers 10 to 12 (Figure 6).

Discussion and conclusions

The length of each reference is estimated by taking the difference between the time of the next reference and the current reference. Obviously, the last reference in each transaction has no “next” time to use in estimating the reference length. The reference length method makes the assumption that all of the last references are content references, and ignores them while calculating the cut-off time. This assumption can introduce errors if a specific auxiliary page is commonly used as the exit point for a web site.

While interruptions such as a phone call or lunch break can result in the erroneous classification of an auxiliary reference as a content reference, it is unlikely that the error will occur on a regular basis for the same page. A reasonable minimum support threshold during the application of a data mining algorithm would be expected to weed out these errors.

We have to say that the assignment of particular page to the group of navigation or content pages may be different for each user. In order to group individual web page references into meaningful transactions for the discovery of patterns such as association rules, an underlying model of the user's browsing behaviour is needed.

For the purposes of association rule discovery, it is really the content page references that are of interest. The other page types are just to facilitate the browsing of a user while searching for required information, and will be referred to as auxiliary pages. What is merely an auxiliary page for one user may be a content page for another.

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Tools for the Electronic Learning Supports' Quality Assessment

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Abstract

At present, the use of information and communication technologies in education at all types of schools is becoming commonplace. Information and communication technologies bring many positive effects which appropriately complement and support the process of education. Some modern forms of study, applied at Czech as well as foreign universities, are even based on the use of information and communication technologies. Above all, this regards education realized through e-learning with information, curriculum, control incentives and communication being transmitted by means of modern communication technologies and using the World Wide Web, called simply the Internet.

The paper deals with the possibility of assessing the quality of electronic learning aids designed for distance learning and carried out through e-learning, on the basis of the already established system for the evaluation of electronic learning aids. Thanks to the relatively easy use of the established assessment system, a software application facilitating the whole evaluation process could be created. The present article deals with the description of the possible uses of this application in practice.

Keywords

E-learning. Electronic learning supports. System evaluation. Evaluation kriteria. Software tool.

Introduction

The perception of e-learning is often ambivalent and inconsistent, the main reason being an inhomogeneous terminology, to a great extent influenced by the linguistic impacts and by the diversity of approaches and technologies used (Saettler, 1990; Eger, 2004). Within the transatlantic space, activities related to the supporting of the education process by ICT (i.e. e-support) are not defined as e-learning, in favor of relatively set phrases of Computer-Based Training (CBT), Internet-Based Training (IBT) or Web-Based Training (WBT) (Lowenthal, Wilson, 2009). In Europe, a consensus was reached upon the use of a unified term of e-learning, which, according to the information at the e-learning portal for Europe Elearningeuropa.info, is understood as the application of new multimedia technologies and the Internet in education, in order to improve its quality by enhancing access to resources, services, the exchange of information and cooperation (Simonova, 2010).

According to this definition, e-learning covers not only a wide range of tools that are used for the presentation or the transfer of the educational content and for the management of studies, but also an entire spectrum of communication channels. The tools are used via LMS (Learning Management System), which is a prerequisite for the implementation of a truly effective learning process through e-learning. LMS thus represents a virtual ´classroom` environment comprised of tutorials, quizzes, study instructions, exercise plans or discussion forums (Mauthe, Thomas, 2004).

Apart from LMS, properly structured and didactically adapted educational texts, referred to as e-learning supports (Paulsen, 2003, Kopecký, 2006) contribute significantly to the implementation of e-learning. To get a clear and permanent definition of the term, it is therefore necessary to focus on the structure and the arrangement of individual elements that such a teaching material is composed of. Study materials for distance learning, in both classical form and the form of e-learning, have gradually evolved from textbooks. In terms of the text structure, a classical textbook (Möhlenbrock, 1982; Průcha, 1998) is composed of two basic components, i.e. text components (´written text`) and extra textual components (graphical components). It should nevertheless be noted that e-learning supports have their own unique characteristics as they are intended for a particular form study, characterized above all by a higher level of independence and individuality (Bates, Poole, 2003). A characteristic feature of thus structured electronic study supports designed for e-learning is the fact that their nuclear structure is enhanced by various interactive and multimedia elements, i.e. animation, multimedia records, dynamic simulation, sound recordings, etc., as shown in the figure number 1.

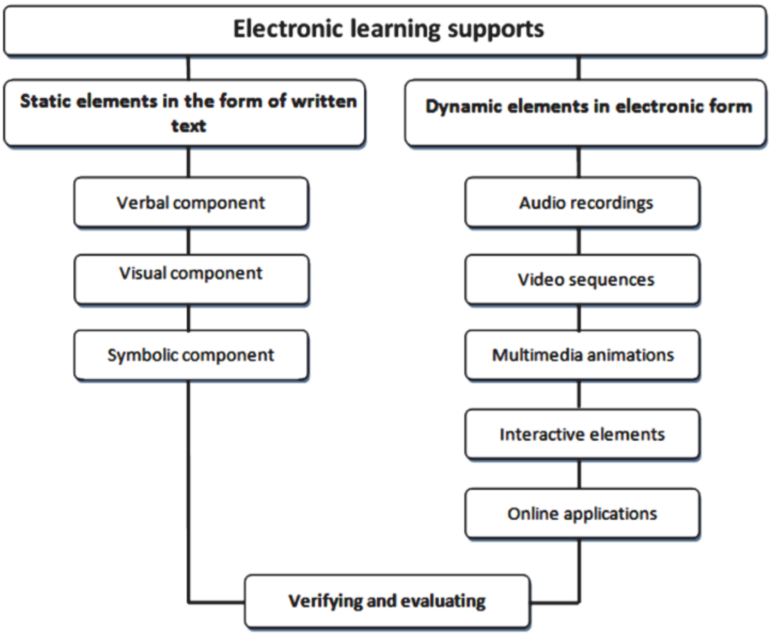

Figure 1: Electronic learning support structure

Possibile ways of evaluating electronic learning supports

After the analysis of the already existing systems for evaluating electronic learning supports (cf. Anderson, McCormick, 2005; Klement, 2011), it could be said that a completely suitable and effective system capable to meet the needs of practical, every day evaluation, has not been found yet. Numerous as they are, the existing evaluation systems do not provide us with a sufficient range of tools needed to evaluate such a complex training unit, as a high quality electronic learning support incorporated in the LMS system definitely is (Eger, 2004). Based on the above mentioned facts, a conclusion was reached that it was necessary to theoretically define and, through a pedagogical research, verify a completely new system for evaluating electronic learning supports. The later should allow a wide use of all necessary aspects of evaluation with an overlap to the support systems of management or control of the course of studies which are provided by LMS systems within the framework of distance learning implemented through e-learning (Klement, 2011).

Subsequently, an investigation research was carried out at the Faculty of Education of Palacky University, the outputs of which were processed using multivariate statistical methods of cluster and factor analysis. 734 respondents took part (Klement, Chráska, 2011). The research proved the existence of 6 main areas of evaluation, each comprising three to five most important evaluation criteria that are necessary for a relevant assessment of the electronic learning supports' properties in particular areas of evaluation. The situation is presented in Table 1, which lists all the main criteria.

Table 1 : The final structure of the electronic learning supports' evaluation

THE SYSTEM OF EVALUATION OF ELECTRONIC LEARNING SUPPORTS	
Evaluation area O1: Student's personality in e-learning	
Main criterion1	Inducing emotional reactions of the students.
Main criterion 2	Creating real concepts with respect to demonstrated phenomena.
Main criterion 3	Proposing multiple solutions (if possible).
Evaluation area O2: Student's learning within the framework of e-learning	
Main criterion 1	Segmenting the content to adequate steps, with respect to particular target groups of students.
Main criterion 2	Accentuating the application in practice of the knowledge gained.
Main criterion 3	Verifying in practice of the knowledge gained.
Main criterion 4	Presenting learning tasks.
Main criterion 5	Introducing learning objectives from the emotional and psychomotor domains.
Evaluation area O3: Educational content form with respect to e-learning	
Main criterion 1	Adequate frequency of abstract notions.
Main criterion 2	Presentation and demonstration using static images (pictures).
Main criterion 3	Presentation and demonstration using dynamic images (simulations, animations, etc.).
Evaluation area O4: Specifics of e-learning	
Main criterion 1	Navigation icons.
Main criterion 2	Summary of key words.
Main criterion 3	Number of key words and their relevance with respect to the presentation.
Evaluation area O5: Technical aspects of e-learning	
Main criterion 1	Quick navigation throughout the text (hypertext links).
Main criterion 2	Assessment of the partial results gained (continuous – final).
Main criterion 3	On-line testing via electronic tests.
Evaluation area O6: Ergonomic aspects of e-learning	
Main criterion 1	Approximate time limit for the study of particular chapters.
Main criterion 2	Graphical and probative value of the icons.
Main criterion 3	Length and probative value of marginalia.

There are two possible applications of the electronic learning supports' evaluation system in practice. The first one consists of evaluating the already existing e-learning supports. The other one makes use of the electronic learning supports' evaluation system at the very stage of their adaptation or design, which enables the authors to create e-learning supports endowed with all the required properties, defined by the particular evaluation criteria set by the evaluation system.

The description of the structure and the function of the application

The application allows archiving of the data concerning particular supports evaluated, and thus facilitates their comparison. The Figure 2 presents the user interface of the above mentioned application designed for the evaluation of modified as well currently created electronic learning supports.

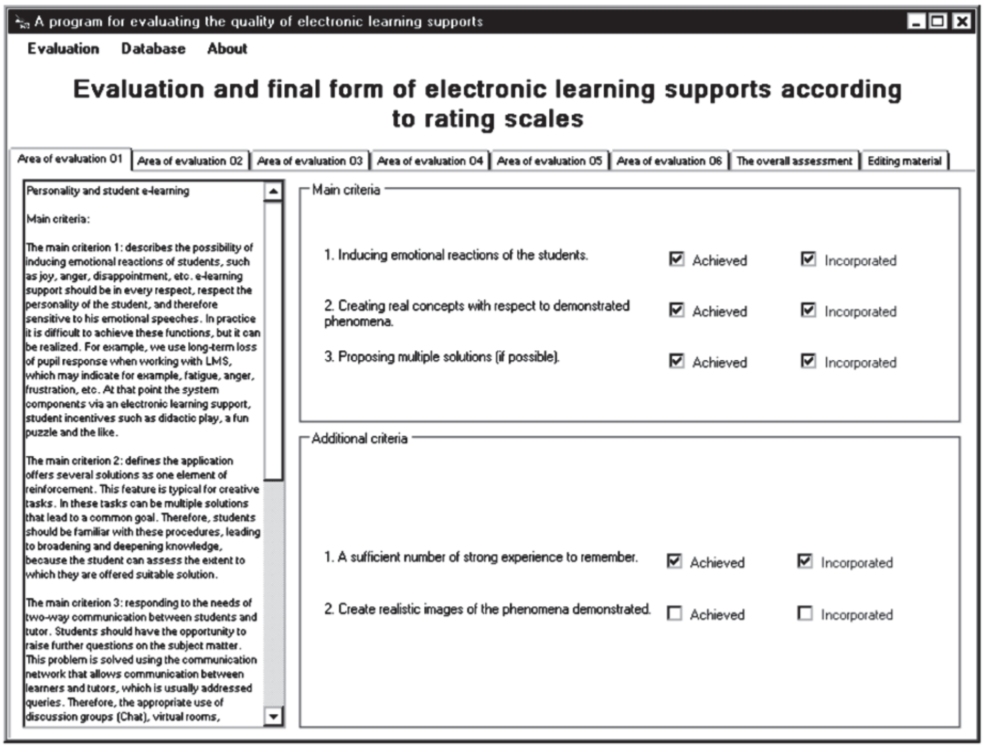

Figure 2: Application enabling evaluation, modification or creation of electronic learning supports

As shown in Figure 2, the users of the application can evaluate the creation as well as modifications done to the electronic learning supports within six areas of evaluation, numbered O1-O6. Each area comprises specific evaluation criteria, as well as a detailed description of the features evaluated, and their interpretation. The aforesaid description is always placed in the left part of the user interface. By clicking on the option of DONE, the user can confirm that the demands related to required properties of a currently created or modified electronic supports have been met. Having filled out all items on the tabs Area 1 to 6, an overall evaluation of the evaluated electronic learning support will take place.

The function of the application's evaluation module

Figure 3 indicates the evaluation of e-learning supports. This part of the application can be used only for the purposes of evaluating electronic learning supports, as it does not contain any information about the stage of incorporation of particular evaluation criteria to a currently created e-learning support. The evaluation module can be viewed using the bookmark ´Overall assessment`. The actual evaluation of the electronic support assessed is carried out immediately after a click on ´Evaluate`.

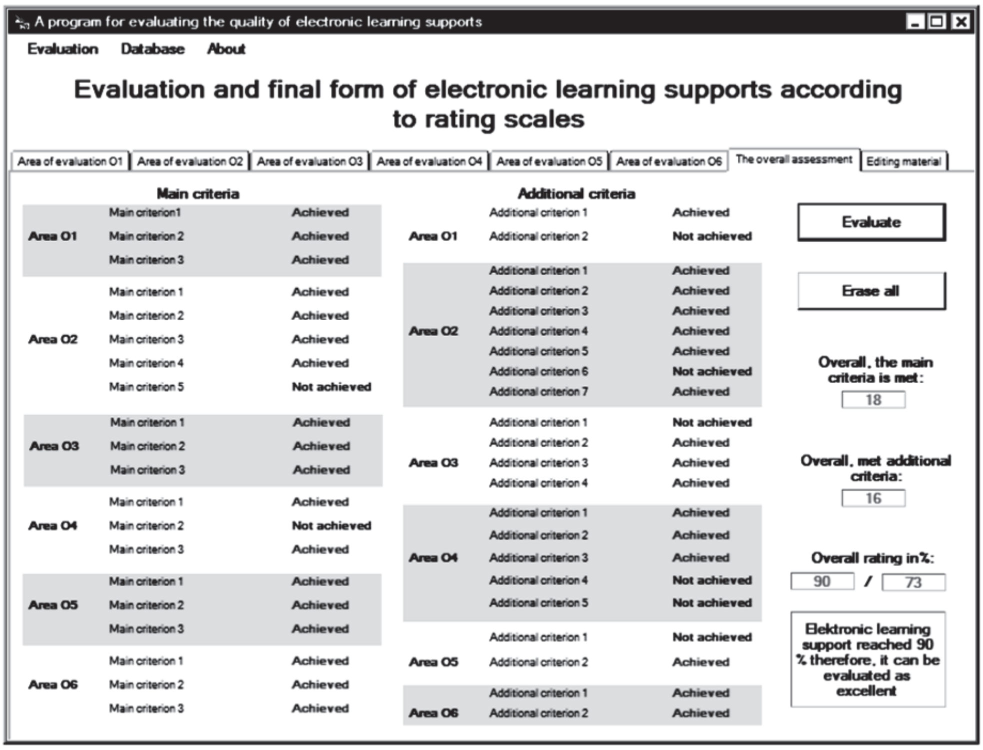

Figure 3: Application for the evaluation of the creation of e-learning supports - Overall evaluation of a support

Figure 3 thus shows in what way the individual data are evaluated by the user, who fills in tabs corresponding to the evaluation areas O1 to O6. The data concerning the compliance with particular criteria, as well as an overall summary of all data, in the nature of a verbal assessment of a particular electronic learning support on a preset evaluation scale, and situated in the right window of the application, are shown. The currently assessed electronic study support, shown in Figure 3, met the main criteria in 90% and the additional criteria in 73%. According to the established rating scale described hereinafter, it can be characterized as an excellent e-learning support.

Setting up of the evaluation scale

An appropriate evaluation scale is a means for assessing the overall level of e-learning supports or for its comparing with the results of the supports already evaluated. It is therefore necessary for the software application to comprise an evaluation module providing the user with a clear and quick overview of the results of the evaluation of the currently assessed electronic support.

Thus a rating scale must be set up, based on the reaction on either met or unmet evaluation criteria. The range of degrees was set up according to the author's experience, as he had had the opportunity to assess and create a variety of electronic learning supports before. It should be noted that during the use of the generated application, which will be the case within the framework of at least one GACR project, it will be possible to reevaluate the rating scale again. The evaluation scale in question has three stages:

- **A poor electronic learning support** is the one which meets less than 70% of the main criteria and less than 20% of additional criteria. Such e-learning support is particularly suitable for gaining knowledge. In order to better suit the conditions required for distance education realized through e-learning, it is advisable to further enrich such support with more multimedia elements of interactive character, and thereby expand its scope to all areas of learning objectives.

- **A convenient electronic learning support** is the one that meets more than 70% but less than 90% of the main criteria. The range of assessment criteria was set up to 40%. It is possible to make use of thus evaluated electronic support can be used, however, it is necessary to correct some of its parts, through a targeted activity of a teacher or lecturer. These e-learning supports are also suitable candidates for further adjustment of the structure or the content or by the incorporation of interactive or hypermedia elements.
- **An excellent electronic study support** is the one that meets more than 90% of the main criteria and more than 40% of additional criteria. Such electronic support can be applied within the implementation of distance learning through e-learning without the necessity of making any other major changes.

The function of the module monitoring the modifications

The next step of the application is the assessment to which particular features followed are incorporated into the created e-learning support. The creator of the latter can label the evaluation criteria on the tabs from 01 to O6 (this situation is shown in Figure 1). Every feature or property of the e-learning support can also be marked by switching ´Incorporated`. After pressing the ´Modifying the support` button, a complementary module of the application, along with a summary of criteria and the stage to which they have been processed, will be visualized. For the complimentary module see Figure 4 below.

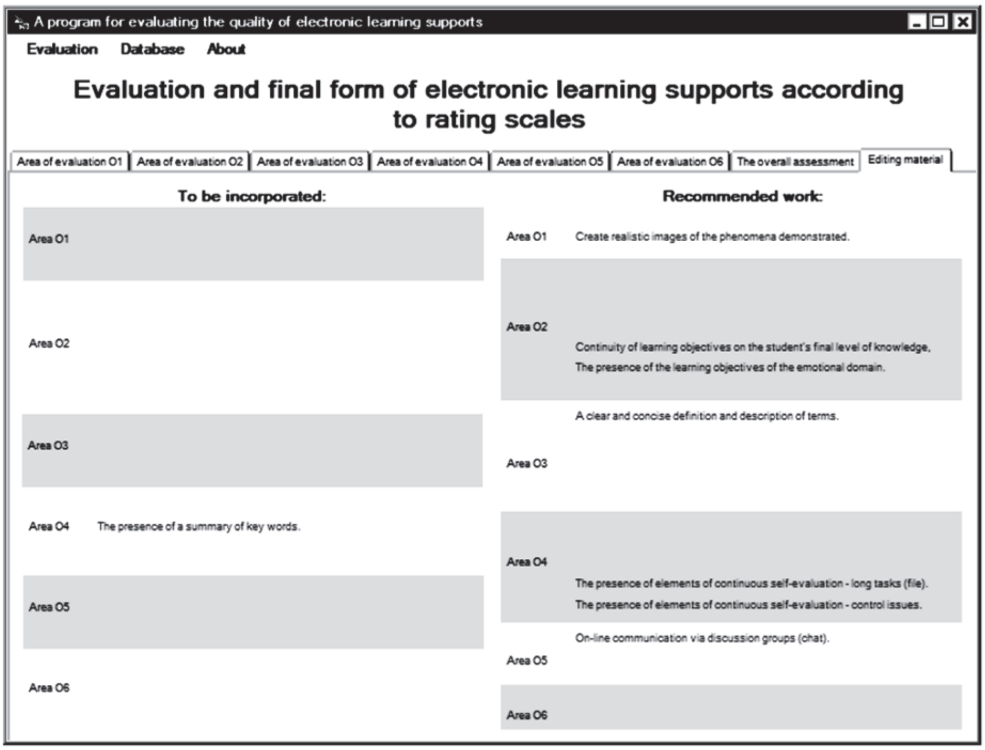

Figure 4: Complementary module – Modification of the support

The above mentioned module comprises two parts that are used to display the criteria that are to be incorporated into the program, i. e. main criteria. Furthermore, there is a list of criteria that can

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be incorporated into the program, i. e. additional criteria. The author may immediately respond to the situation displayed.

Conclusion

The application makes for a very fast and easy assessment of the extent to which e-learning support have been created or modified. The application has been freely distributed among expert through a web portal (http://www.kteiv.upol.cz) set up by the author of the article. The presented tool for assessing the quality of e-learning supports can help readers considering the options for the creation of quality e-learning tools, taking into account the views and needs of students. Although the presented application allows a relatively easy and rapid evaluation of the e-learning supports' properties, it is necessary, at the very moment of its design, to respect some important facts that may later on significantly contribute to the enhancement of the quality and efficiency of education through e-learning.

- It is vital to realize that e-learning facilitates the use of e-learning supports in the education process. These supports contain several carriers of educational content, which are very often of multimedia nature.
- It is essential to accept the fact that a simulation or virtual facilitates the enrichment of the area of achieving psychomotor objectives through e-learning with experimentation in virtual labs and simulations.
- It is important to have in mind that when applying the above mentioned forms of instruction, it is necessary to choose an appropriate training strategy, which would reflect the possible uses of particular carrier of the educational content, which should match the objectives achieved.

Acknowledgement

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E-learning Form of Adaptive Instruction

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Abstract

Nowadays, we can´t even imagine education in our information society without its electronic form. Some changes has been monitored in the field of study approach, which is gradual individualization of study for students of part-time as well as full-time study. Merging these two trends – electronic learning and individualization – there can be a new connection discussed "individualized electronic instruction".

This contribution will introduce a complex plan of the whole system for the individualized electronic instruction. The core of the system is a program to control teaching, so called „virtual teacher" .The virtual teacher automatically adapts to individual student´s characteristics and his learning style.It adapts to static as well as to dynamic characteristics of the student. To manage all this it needs a database of various styles and forms of teaching as well as sufficient amount of information about learning style, type of memory and other characteristics of the student. The information about these characteristics, structure of data storage and use by virtual teacher are also part of the contribution.

We will also outline a methodology of adaptive study materials.We will define basic rules and forms to create adaptive study materials.

In comparison to semantic web and other trends for individualized instruction, our approach in the field of individualized instruction is new and original that helps to adapt study materials to student´s needs.

Keywords

E-learning. Adaptability. Adaptive learning environment. Individualized instruction. Learning style.

Introduction

Individualized instruction is nothing new in the field of education. This approach in the form of principle has been recommended since the age of J. A. Komenský. The key point of individualized approach is student itself, studying. He is an individual from many points of view:

- his talent differs in different fields of study,
- his entry knowledge of the subject he currently studies can differ,
- he prefers different learning style than others,
- he can have different type of memory,
- his memory is better trained than the memory of others,

- he can have different motivation to learn, different family background, different study habits.

The ideal teacher is able to adapt to needs of a student. He knows preferences of the student and his permanent characteristics. He is also able to recognize his current shortage of knowledge and adapt the speed and style of teaching. Taking all this into consideration, there can be an optimal teaching instruction implemented.

In self-study students usually use textbooks. A good textbook can be understood as a different form of a teacher. The author put his optimal teaching instruction, his scope and detail of information presented.

It is necessary to create a teaching system that will take student´s preferences and absence of „alive“ teacher into account when presenting new information. To choose a suitable learning style for a student you need to know his characteristics.

Principle of making adaptive environment

These days, LMS systems are used for storage of study materials, control of instruction, evidence of students, evidence of students´ activities and their results. However, LMS systems don´t take learning styles into consideration.

A global approach to deliver a schoolwork to students is provided regardless of learning styles and level of knowledge [Brusilovský, 1998; Brusilovský, 2001]. If a student is not in a face to face communication with a teacher, he uses textbooks to study. The authors usually use global approach to make the structure of topics in the textbooks but neither in this case learning styles are taken into consideration [Kulič, 1980].

The electronic adaptive environment follows behaviour and characteristics of particular student. Before a student starts his study of a particular subject, he fills in a questionnaire to find out his preferences in different areas of study:

- sensory perception,
- social aspects;
- emotional aspects;
- learning tactics: ability to be systematic, study approach, study methods and self-regulation.

A study material is prepared for particular users in relation to their abilities, preferences and needs taking learning styles into consideration. To respect a difference among users, the system can´t be anonymous. Data collection about a student will be done in several steps.

The most important step is a self-evaluation of a student. It means that the student will be tested before entering the course (test results will be classified as „constant parameters“) and testing during the course (test results will be classified as „dynamic parameters“). These „dynamic parameters“ will be used for modification of course path.

The objective of adaptive instruction is not only to adapt the instruction to student ´s needs. In case the student has satisfying study habits, there is no need to direct his effort. More effective will be to offer him different methods and learning styles that he might find interesting and more effective for his study than those he had used so far. On the contrary, there are students having no satisfying study habits. Their study is superficial without understanding the core of the lesson and without ability to put into practice what they have learnt. In this case, the task of adaptive algorithms will be to teach the student better learning style.

Design of adaptive LMS structure

Electronic adaptive environment consists of three modules – student´s module, author´s module and adaptive module.

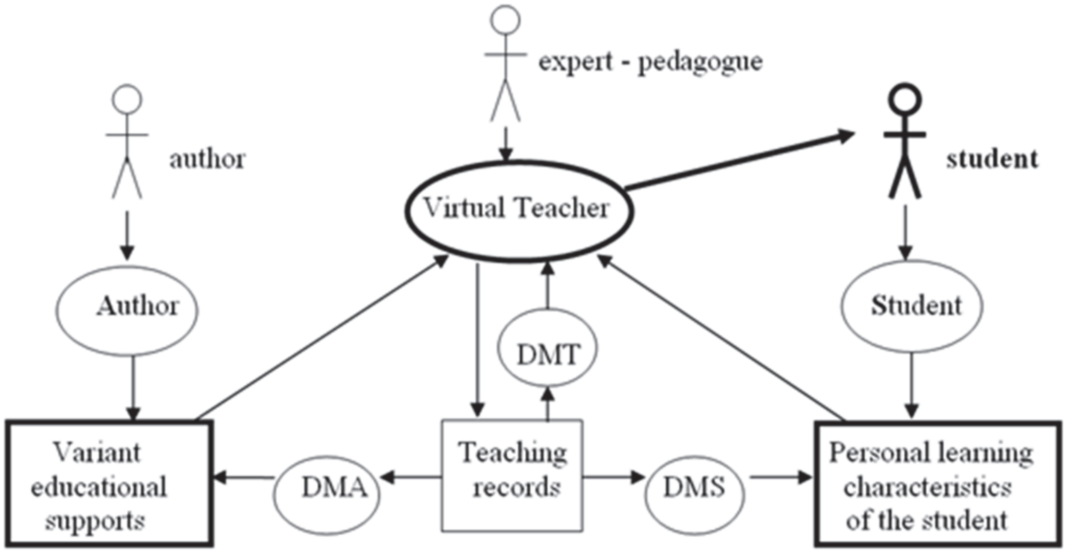

Figure 1: Model of adaptive learning environment

Student´s module

In this module, a student plays the key role. From all the characteristics of a student we should pay the most attention to his learning style. Nowadays, many classifications of learning styles exist. For this reason, the characteristics to be used in e-learning has been chosen. [Kostolányová, 2010; Kostolányová, 2011b].

The chosen characteristics were classified into these categories:

1) *sensory perception* describes prefered form to deliver the information to the student. Visual type of a student prefers schemes, pictures, tables and graphs. Auditory type of a student prefers spoken language and a contact with other people. Kineasthetic type of a student prefers demonstration, models and practical information. Verbal type of a student prefers information in a text form.

2) *social aspects* are dealing with the most convenient study environment for the student. Does he like to study with other schoolmates? Does he like to study with the help of a teacher? Does he prefer to study individually?

3) *emotional aspects* are dealing with feelings and attitudes of a student influencing the process of learning. The most important characteristics from this category is motivation where two parts can be observed – external and internal one. While external conditions as job or family requirements are the source of external motivation, the source of internal motivation is a student itself.

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4) *learning tactics* describe „technology“ of how a student´s study. Ability to be systematic describes how does a student study. Does he study step by step according to the instructions (pole: order) or does he study in random order (pole: free hand)?

5) *study approach* can be divided in two groups. In the first group there are tactics including theoretical deduction. Students who prefer these tactics like to focus on details. In the second group there are tactics including experiments. Students who prefer these tactics like to put their acquired knowledge into practice as soon as possible.

6) *learning strategy* can be divided in the detailed tactics with a focus on small parts of a particular information. From these small parts the whole „picture“ is made. The second is the holistic tactics with a focus on big parts of abstract information so the student works his way to details.

7) *study conception* can be divided in contemplative, strategic and surface learning. In contemplative learning a student aims to understand to what is he learning. In strategic learning a student aims to be effective in his learning and wants to achieve the best results. In surface learning a student aims to accomplish minimal requirements only.

8) *Self-regulation* defines how much is the student able to control his learning process. If he is able to control his learning process successfully, he doesn´t need any external help. If he is not able to control his learning process, he will need an accurate instruction.

Author´s module

A learning material is important for a student to be able to learn independently. The program must have different levels of a study conception and a sensual perception to correspond with learning style of a student.

Each chapter of a topic delivers instruction to a student well structured – chapters are divided into subchapters, paragraphs, etc. We call the smallest coherent part representing the unit of information a „framework“. The framework is identical to the lowest level of the text numbered. The particular framework is divided into explanatory part, testing part and others. The explanatory part is further divided into traditional parts of instruction – theoretical, semantic, consolidating and motivational. We get different ways of instruction when we combine the parts mentioned above. For the testing part different categories of questions, exercises and practical tasks have been chosen. Motivational, navigational and a layer of accomplishment are being put in the part „others“ of a particular framework.

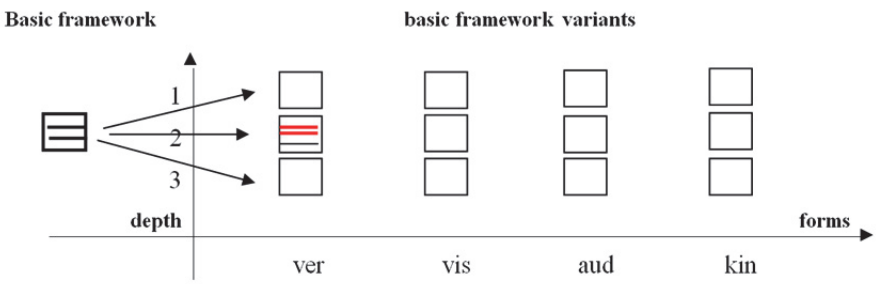

Figure 2: Variations of framework

Adaptive module

When we prepare adequate study materials (author´s module) including characteristics of a student (student´s module) we will lay the foundations of adaptive module. The creation of the adaptive module was the most demanding. The most important was to describe the rules. According to these rules the most suitable parts of frameworks are chosen. Afterwards the frameworks will be exposed to a student. His knowledge will be gradually tested in the form of theoretical questions and tasks. If a student finishes the framework successfully, he can continue in his study. Failing that, the student will be offered a different approach to learn what he hasn´t understood. There might be either detailed explanation or furher examples with more practice. This way student should be helped to finish the framework succesfully.

It is necessary to monitor all study activities of a student to know the progress of his study. Dynamic characteristics recorded from his study activities and from self – regulation should be added to static characteristics of a student entered at the beginning of his study. Information about his study activities will be gathered from progress tests.

Frequency of testing can differ – after each chapter, after a particular topic explained, after a study unit. From the test results we can find out if the student learnt something new or not, if he likes the suggested strategy for his study or not. Monitoring these dynamic characteristics, a good adaptive algorithm can change an instruction approach like changing the way of explanation, different way of practice. Above all that the adaptive algorithm should follow the objective of study and help the student to achieve the objective.

Design of adaptive textbook

Methodology for a design of adaptive textbook proceeds from general teaching principles of Jan Ámos Komenský, situated learning of Gagné and Bloom's taxonomy of learning objectives. These experts laid the foundation of learning style strategies. They defined the rules and principles suitable for effective instruction.

When creating the methodology for a design of adaptive instruction materials we took all these teaching principles and the methodology of distance-learning textbook design into consideration.

We used the principle of illustration, self-consciousness, systematic approach, adequacy and permanence of Jan Ámos Komenský. Instruction methods follow basic steps of study. The Gagné principle of situated learning was used in adaptive instruction as follows: introduction of the lesson, instruction, practise, testing and the end of the lesson. Bloom´s theory to define learning objectives in adaptive study materials was used with emphasis on cognitive area of knowledge. The objectives are defined in relation to the character of study. There are six categories – remember, understand, apply, analyze, evaluate, create [Gagné, 1975; Komenský, 1947 a 1948].

When considering the possibilities to be used in adaptive instruction we took the design of distance-learning study materials into consideration. One of these ideas is to divide a study material in smaller parts as chapters and subchapters. We call one coherent unit of study a „framework“. In one unit there will be one main topic included. Explanation of a subtopic will be in accordance with the theory of Gagné situated learning. A framework will be divided in smaller parts called „layers“. The layers will make it possible to adapt the style of instruction to student´s needs. A layer of a framework we call a part of a framework that is homogenous from the point of steps of a instruction process (instruction, theory, explanation, practice, testing of knowledge, motivation, control of the lesson) [Kostolányová, 2011a].

Types of layers:

- **Explanatory**– group of layers containing their own explanation of the material covered. This concerns the following layers:

  T Theoretical – containing theory: definition, terms, rules, algorithms, etc. In terms of education, this is the most important type of layer.

  S Semantic – explaining the introduced terms, formally described theory, containing additional information to the theoretical layer, explaining correlations arising from theory, etc.

  F Fixation – with the aid of repetition, other formulations and alternative concepts, implemented into the wider context to make it easier to remember the theory.

  R Resolved examples – contains examples of how to apply a theory, resolved “textbook” examples. For students, these are examples for solving given tasks.

  P Practical – contains resolution of examples from practice, which use theoretical knowledge.

- **Testing** – a group of layers for regular testing of acquired knowledge, to fixate this theoretical knowledge with the aid of tasks. *These layers are:*

  O Questions – theoretical questions from the material covered. Questions may only serve as checking questions for a student or adaptive algorithms use them to control the next instruction.

  U Tasks – “textbook” exercises to be resolved.

  X Practical exercises – tasks from practice.

- **Other layers**

  M Motivational – motivating information about the subject, lesson or framework, which would justify the benefit of study to the unmotivated student.

  N Navigational – didactic or organizational information, a kind of guide of lessons or material covered, recommended study methods, etc.

To understand the content of particular layers, below are the examples of some of them:

Example of a layer focused on objective of instruction

After a student finishes his study of a chapter, he will be able:

- to define basic characteristics of vector and bitmap graphics
- when solving practical task to define which type of graphics to use (according to advantages and disadvantages of each type)

Example of a motivational layer

Did you know that computers display the graphics either in vector or in bitmap form? Have you seen any difference between these two forms so far? Don´t worry and start our course. If you understand the difference between these two forms, you will become more effective while doing any graphics.

Example of a theoretical layer

Bitmap graphics depicts a picture with the help of pixels organized in the form of grid. Each pixel in the grid has a place and color defined so the picture is created as a mosaic.

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Example of a semantic layer

When we modify a bitmap picture, we change pixels, not line segments and curves. Bitmap graphics depends on resolution because data describing the picture relate to the grid of a particular size. When we modify a bitmap picture, a quality of image can change. The changes can be particulary seen when displaying a picture with a high resolution on a monitor with a lower resolution. The quality of image is low.

Design of adaptive textbook is more demanding than design of a regular text or multimedia instruction support. A template was created for the authors who decided to participate in designing an adaptive textbook. (Picture 1). In this template authors enter the text of instruction material and use of multimedia components [Kostolányová, 2011c].

For one thing an author enters a specialized content of an instruction (the major part of a template) and for another he enters relevant metadata needed to control adaptive instruction (right side of a template).

The authors of instruction materials in adaptive form create text content, well structured into this template. They also enter the use of multimedia components. Detailed scenarios about how to create adaptive instruction materials are part of adaptive textbook in the form of appendix.

Table 1 – Template to create adaptive study materials

Subject: Subject name
Lesson: Name of the lesson

Rtitle = Framework title					FNum = **n**			
	Variant - level:				VLevel = **1-3**			
	Variant - form:				VForm=Sver,Sviz,Saud,Skin			
	Layer Content						**LayerType**	**Layer Order**
	1. text of a layer T (text, picture, …)						**T**	**1**
	2. text of a layer T						**T**	**2**
	text of a layer S						**S**	**1**
	…						**S**	**2**
	text of a layer F						**F**	**1**
	Example:						**R**	**1**
	Practical task:						**P**	**1**
	text of a layer C						**C**	**1**
	text of a layer L						**L**	**1**
	text of a layer N						**N**	**1**
	text of a layer M						**M**	**1**
	Question 1	VrGroup=**1**	VrOblig=**O**	VrScore=**1**	VrResult=**P**		**O**	**1**
	Question definition … variable group 1							
					Question Score	**Question Type**	**Answer Correct**	**Question Order**
	Text of a variant 1				**0**	**Vnm**	**N**	
	…				**0**		**N**	
	Task 1	VrGroup=**2**	VrOblig=**P**	VrScore==**3**	VrResult=**P**		**U**	**1**
	Task definition… created group 2							
					Question Score	**Question Type**	**Answer Correct**	**Question Order**
	Answer 1 – correct				3	x	**A**	**1**

QReaction	Text - untypical verbal reaction to an answer 1				
	Answer 2 – partly correct	0	x	**N**	**2**
QReaction	Text – untypical verbal reaction to an answer 2, explanation				
	Answer 3 – incorrect, appears frequently	0	x	**N**	**3**
QReaction	Text – verbal reaction to answer 3, explanation				

Control of instruction by a virtual teacher

Each framework, divided into particular layers, will be created in four sensory forms (verbal, auditive, visual, kinesthetic) and in three levels of instruction (strandard, with extra support and with extra interesting details for a student). Variants that include a form (sensory forms) and levels of instruction arent´t able to cover all detected distinctions in a style of instruction. The way of instuction must react to other different characteristics of a student. Analyzing these students´characteristics we concluded that the instruction can also differ in order of particular parts of instruction and revise tests and organizational information if needed.

Adaptive algoritms will form the initial version of optimal instruction style . The algoritms function on the base of predefined rules. The rules are created by experts in the field of pedagogy and in the harmony of pedagogy and psychology principles. Below are examples of these rules:

- If a student´s characteristic in the area of „Study Approach“ = 75 (he is a detailed oriented student), then use the level of instruction = 2 and then the level of instruction 1 in the order defined by other rules.
- If a student´s characteristic in the area of „Motivation“ = -50 (strongly unmotivated), then use the „Motivational Level“ = 3 (describes a practical benefit of this knowledge in details).

etc. [Kostolányová, 2011a]

Intuitive rules are a mainstay to create other rules. The intuitive rules will come of analysis and research concerning of evaluation of instruction and test results. Principles of a good instruction style are defined in the rules. Such an instruction style should motivate students with bad study approach to use more effective methods and study approach.

The „virtual teacher“ is responsible for control of instruction as well as for measuring students´progress. Measuring students´progress, detecting their level of knowledge and comprehension of information presented is essential part of adaptive system. The whole instruction process is recorded. Every „click“ of a student, time spent in particular layers, changing of student´s strategy, test results, etc. Data recorded serve as a source to make different analysis.

- to verify settings of student´s characteristics;
- to verify a suitability of instruction support;
- to verify expert rules of a virtual teacher.

Conclusion

There is more to say in the conclusion. The adaptive instruction hasn´t been discussed on theoretical level only. The control system that controls the whole instruction process automatically is being analyzed

An adaptive LMS is implemented gradually on the base of analysis results and is ready to be tested. When testing the adaptive LMS, there can be some adjustments made in the area of student´s characteristics as well as in the area of virtual teacher rules.

The advantage of this control system is that theoretical parts implemented are of a dynamic and parametrical nature. It means that if some adjustment needs to be made, it will be made by data entry in a database and not by adjustment of the whole structure of the control system. Especially the rules of the virtual teacher are saved in special expert database. Except of standard user roles as „student“, „author“, „teacher“ and „administrator“ there is also a role of „expert“. The „expert“ is a specialist in the field of adaptive instruction having access to records and adjustments of parameters that control adaptive instruction. Then the „expert“can modify relevant data and instruction on the base of teaching instruction analysis.

Acknowledgement

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Promoting Active Learning Through Problem-based Discussion Forums

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Abstract

In this paper, the pedagogical potential of online discussion forum is discussed through the lens of constructivist and constructionist learning theories. The asynchronous online discussion forum is suggested as an effective tool for realizing collaborative learning activities that can enrich student's learning experience in many ways. The key attributes of online discussions and the factors influencing the discussion forum's design are identified. The focus is on study of students' behaviour during discussion and on recognition of some behavioural patterns of forum's participants. We mention also some implementation issues of discussion forums in LMS Moodle. An example of constructivist learning activity realized through an online problem-based discussion forum is presented in a case study. The case study shows how a well-designed online discussion forum can encourage students' activity, motivation, and other social-constructivist attributes of their learning. Discussion forum in course on functional programming is described in detail and our findings grounded in observations and data analysis are summarized.

Keywords

Online discussion forum. Constructivism. Teaching of programming. Blended learning.

Introduction

Global objective of all the research projects concerned with teaching and learning is to enhance the efficiency and quality of these processes. The blended model of teaching/learning has become popular, and at universities in particular, because it merges best practices applied in traditional face-to-face learning scenarios with new chances provided by digital technology and the online environment (Hadjerrouit, 2008). In our courses, we prefer the blended teaching/learning strategy too. When designing learning activities for lectures, seminars or lab sessions, we adhere to principles of constructivist and constructionist learning theories (Ackermann, 2010). Such learning activities are student-centred, problem-based, and collaborative. To learn in a constructivist manner, students should acquire knowledge actively, while solving problems, performing experiments or creating concrete artefacts. They should construct new concepts and reveal new connections individually, but with proper guidance of their teacher and/or in collaboration with fellow learners. The social and cultural aspects of learning are often underrated, especially by people who themselves lack the positive experience of collaborative learning. In learning communities (even when working in pairs or small groups), students can share their motivation, creative ideas, knowledge and skills and so they are able to benefit from the collective intelligence. The productive collaboration with more experienced learners can accelerate students' progress and fosters their communication, social and learning competences.

Nowadays, the idea of active learning that is shared with others can be accomplished also within the online environment (Rollet et al., 2007). Learning management systems, e. g. LMS Moodle, where developed and are used in order to make the social constructivism and constructionism manageable even in large-scaled groups or in distance courses that completely omit the personal contact of participants (Dougiamas, Taylor, 2003).

We use e-learning courses implemented in LMS Moodle also in full-time study programmes to supplement the classroom instruction (Palmárová, 2011). These e-learning courses

- provide students with information and study materials,
- are designed to promote active learning,
- facilitate students' self-paced learning,
- and are meant to strengthen the students' feel of being a friendly learning community member.

In this paper, we suggest the online discussion forum as an effective tool for realizing collaborative learning activities in courses on computer programming. At first, we analyse the constructivist potential of discussions forums. We identify key attributes of online discussions and consider behavioural patterns of their participants. Some implementation issues of the Moodle's Forum activity module are mentioned as well. The next chapter is dedicated to a case study. We describe the suggested learning activity in detail and summarize our findings grounded in observations and data analysis.

Constructivist potential of discussion forums

In learning activities based on personal contact of participants (e. g. joint problem solving, team projects, team competitions), the act of discussion occurs naturally. Students need to talk to their partners (classmates, teachers) in order to achieve the common goal. They can be even directly asked to present their answers, solutions or to express opinions. The face-to-face communication is interactive and so it is likely to result in some meaningful conclusion.

The asynchronous online discussion can enrich the learning experience in another way. Besides the community building aspect, the online environment:

- gives students more time to think about the topic,
- motivates students to interact with others (to learn from others),
- enable students to use their own, less formal language,
- make it easier for introvert or slower students to present themselves as active and valuable members of the group.

In pure e-learning scenarios, the online discussions should be seen as essential components of learning. The online forum usually provides the only way for mediating a classroom-like learning activity in distance courses.

Taxonomy of online forums

It is quite challenging to design an effective online discussion. There are more variants of asynchronous discussion forums and factors to consider (figure 1). In (Schellens, Valcke, 2005), the researchers investigated question, whether working in asynchronous discussion forums fosters knowledge construction. Garrison (2007) explores issues that have emerged from the research on social, cognitive and teaching presence in an online community of inquiry.

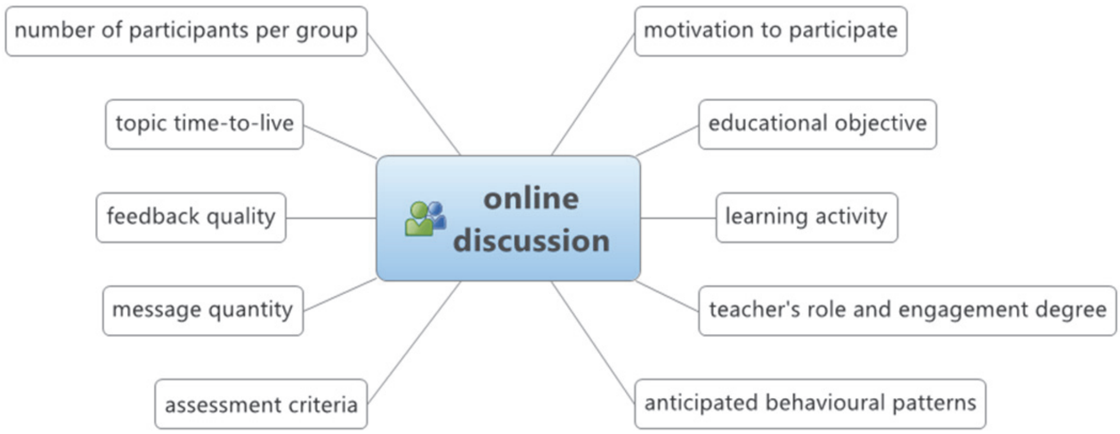

Figure 1: Factors influencing the discussion forum's design and success.

In (Abawajy, Kim, 2011), the authors present a useful taxonomy that helps to understand features of various online discussions as well as the related strengths and shortcomings. They classify online discussion forums as follows:

- auxiliary forums,
- hybrid forums,
- embedded forums.

The auxiliary forum represents optional, open, self-directed, unstructured discussion in which the learner-to-learner interaction prevails. The teacher responds to students' posts from time to time, in order to keep the discussion threads lively and relevant or to support students with learning difficulties. In programming courses, our students are active in online forums dedicated to homework assignments. These forums are appreciated especially by novice programmers, who seek for help from their more advanced colleagues.

In the hybrid model, online discussion is an integral part of the face-to-face classroom scenario. The online forum is used to enhance or to mediate the collaborative learning activity. The participation is compulsory and assessed. Topics and deadlines are set by the lecturer. In programming courses, we use such online forums quite frequently, for short warm ups (at the beginning of lab sessions), for team competitions/projects that last a longer period (from few days to few weeks) and for peer assessment of solutions.

The embedded forums are used in distance courses. In this case, the asynchronous online discussion replaces the face-to-face interaction so the active interventions of teachers are required and frequent. Students are obliged to contribute and their contributions are assessed. In distance programming courses, the embedded forums provide the platform for pursuing the same collaborative learning activities that we have listed above in relation to the hybrid model. But the amount of posts that need to be read, replied to and evaluated is much higher and the quality of the feedback is more important.

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Behavioural patterns

Discussion itself requires a pattern of call and response, with turn-taking and listening being as important as contributing thoughts to the dialogue. Students who are silent during the lesson may perform better on assessments than their extrovert, more communicative classmates. In asynchronous online discussions, the act of reading is the equivalent of listening. In (Dennen, 2008), the behavioural pattern of lurking is introduced. A lurker learner is the one, who observes situation without contributing actively in any other noticeable way. Dennen (2008) presents her research study focused on non-posting/lurking participation behaviour of students involved in online discussion forums. Students who preferred posting messages rather than reading, often with motivation to meet the course requirements as quickly as possible, were unlikely to feel like the discussion was a meaningful learning activity. The lurking students tended to indicate that the discussion activity was worthwhile. They were more interested in reading messages in order to find a model and point of entry into the conversation or review the contributions posted earlier.

We also believe that lurking has the potential of being beneficial learning activity that should be taken into account when preparing online discussions.

Implementation issues

The online discussions launched for educational reasons are typical for e-learning courses. It is convenient and recommended to use a learning management system. In case of not having this possibility, the LMS could be surrogated by any social network that supports the concept of separated user groups.

We have been using the LMS Moodle’s Forum activity in our e-learning courses for many years. This activity module implements five types of forums to choose from, each of them can be customized by additional settings (Moodle.org, 2012). Table 1 maps the general intent of the proposed learning activity to the appropriate forum type. We can define permission for students to assess contributions and use various rating scales and evaluation rules. Multiple discussions can run simultaneously in separated groups of arbitrary number of participants; subscription to forum can be made mandatory; number of a user’s contributions can be limited; deadlines can be set; different display options can be applied etc.

A transcript of the discussion is automatically archived and accessible online, so the researchers can use it for further analysis immediately. The posts can be exported when needed. Thanks to the Moodle logging system that records the active as well as the passive actions performed in online forums, we have another source of interesting input data to learn from.

Table 1: Moodle’s Forum activity in subjects concerned with programming.

General intent	Specific requirements	Suitable forum
To build a friendly learning community	Everybody sets topics, posts contributions and replies to others	Standard forum for general use
To promote active learning	Everybody has the same chance to express her/his ideas without being influenced or constrained by previous „speakers“	Question and answer forum
	Every member of a group should contribute to common goal set by the teacher	Single simple discussion
To manage the peer assessment activity	Everybody can present her/his original solution/project and waits for classmates’ ratings and comments	Each person posts one discussion Standard forum displayed in a blog-like format

Online discussion focused on functional programming: a case study

This case study shows how a well-designed online discussion forum can encourage students' activity, motivation, and other social-constructivist attributes of their learning. We worked within the context of a computer programming course. In such courses, problem-solving and hands-on assignments are typical learning activities. In online forums, students are asked to post their solutions written in a formal programming language. The source code is usually explained by inline comments or in a short additional paragraph. To increase the readability of sample source codes, students are instructed to pay attention also to formatting issues.

Objectives

The main goal of our study is to design a learning activity that would be:

- mediated by online discussion forum,
- suitable for computer programming course,
- engaging (increasing students' motivation and learning activity),
- and collaborative (encouraging social interactions in the learning process).

Scenario

Our research was set up during the winter semester of the academic year 2011-2012 with two groups of 13 and 20 students, who attended the course on functional programming. The course is a part of the applied informatics study programme. Students were tasked with solving 8 programming problems by applying standard higher order functions in Haskell programming language. Assignments of all problems were published through the online forum. Students were asked to suggest their own solutions as well as to study the solutions of others. Students' solutions were evaluated and graded by the teacher as follows:

- 3 points for the first correct solution (in each of two groups),
- 2 points for further correct solutions,
- 1 point for partially correct solutions,
- 0 point for incorrect solutions,
- no grade for contributions without any solution.

The learning activity was implemented as the Moodle's Question and Answer discussion forum. In this kind of forums, you must first post your answer in order to see other responses. This feature allows equal opportunity for answering the question among all students. The answers are independent, thus they may recur in discussion.

The learning activity was carried out in two phases. In the 1st phase, participation was compulsory. Students were working during the seminar for 1.5 hour. The discussion was synchronous. The teacher evaluated or commented students' contributions immediately after their submitting. After the classroom activity, students could continue discussions at home; the teacher continuously evaluated their solutions. The 2nd voluntary phase of the learning activity lasted for 1 month.

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Data analysis and observations

Figure 2 shows the time progress of the activity expressed in number of total logs per day. The most logs (915) were recorded during the classroom part of the learning activity (2 seminars on November 15th). Remaining 694 logs were distributed throughout the one month time period of the 2nd phase. As the participation in the 2nd phase was voluntary and the assessment of the participation in the forum did not influence the final assessment, we evaluate students' participation in the activity as a result of the high intrinsic motivation to learn.

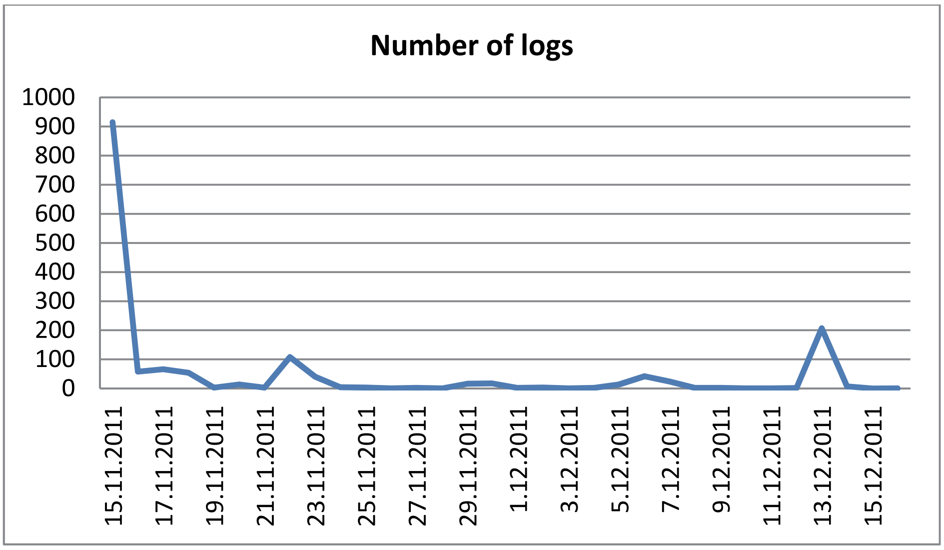

Figure 2: Time progress of the activity – the number of logs

More detailed analysis of logs resulted in identifying 4 specific types of students' behaviour during the activity. Table 2 contains the characteristics and percentage of these behavioural patterns: poster, lurking poster, lurker, and passive participant.

Table 2: Behavioural patterns observed during the learning activity

A	poster 67 %	posters' participation in discussion is active, their postings always contain solutions
B	lurking poster 12 %	lurking posters contribute solutions to the discussion as well as join discussion without any solution
C	lurker 12 %	lurkers monitor discussion without any visible creative contribution
D	passive participant 9 %	passive participants do not join any discussion at all

Our further observations refer to the behaviour and the performance of students in four groups. Diagrams in figures 3, 4, and 5 demonstrate minimum, maximum, and average values of the quantities monitored in each group.

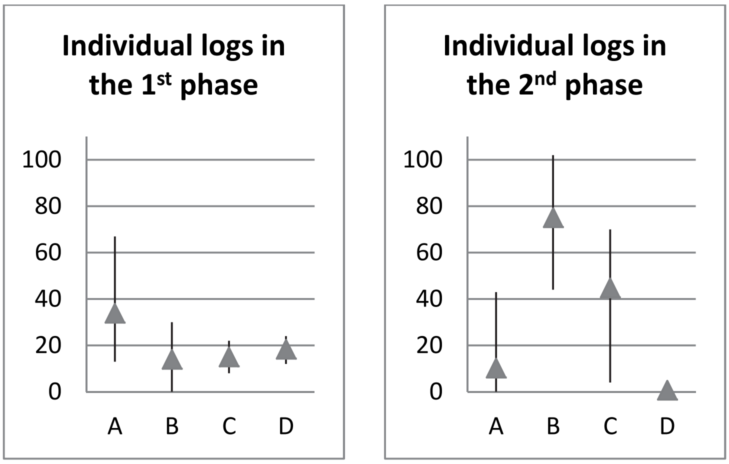

Figure 3: The number of individual logs in both phases of the activity

Diagrams of figure 3 compare students' activity in two phases of discussion. Posters (A) had the highest number of logs in the 1st phase; the rest three student groups generated similar number of logs. In the B group, 2 students did not participate in the classroom activity that's why the minimum value is 0. The order of individual logs in the 2nd phase differs from the previous case. The number of posters' logs (A) decreased. Posters reached good assessment during the classroom activity, for that reason, we suppose, they were less motivated to continue the discussion at home. The activity of lurking students (B, C) increased in the 2nd phase significantly. They were less successful in solving assigned problems than students from the A group and so they tried to solve the problems at home. Students from D group got passive in the 2nd phase of the activity.

Further, we were interested in type of students' activity. We filtered the active logs: postings with solution, lurkings (postings without any solution), and discussion views after initial posting.

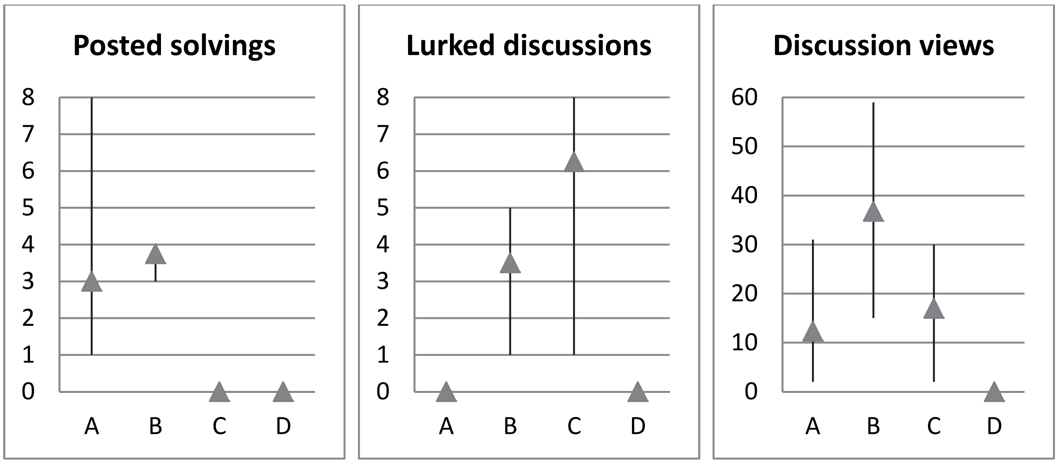

Figure 4: The number of active logs of individual students (postings, lurkings, and views)

The first two diagrams in figure 4 show that the highest engagement in discussion appeared in B group. The total number of joined discussions (posted plus lurked) is 7.25, in average, so students belonging to this behavioural pattern joined nearly all 8 discussions. Students tagged as the D group stayed out of discussion. Their total number of logs from figure 3 represents readings of the assignments without any active contribution.

We were also interested in students' activity after their initial postings. The number of individual logs involving discussions that were joined is shown in the third diagram in figure 4. These logs represent student's interest in others' solutions. Passive monitoring of the discussion predominated in this type of logs. Active discussion about others' postings was rare.

Students' score achieved during the activity is shown in figure 5. Total points in the first diagram depend on the number of solved problems (figure 4). Total score includes also bonus points (for first correct solutions), which all have been granted to posters (A group). The relative successfulness in solving of the assigned problems excluding bonus points is shown in the next diagram. The maximal dispersion of the values in A and B group indicates the high heterogeneity of groups as regards students' performance. However, considering the average relative score and granted bonus points, we evaluate posters' performance as the best. Participants from the C and D groups got zero score.

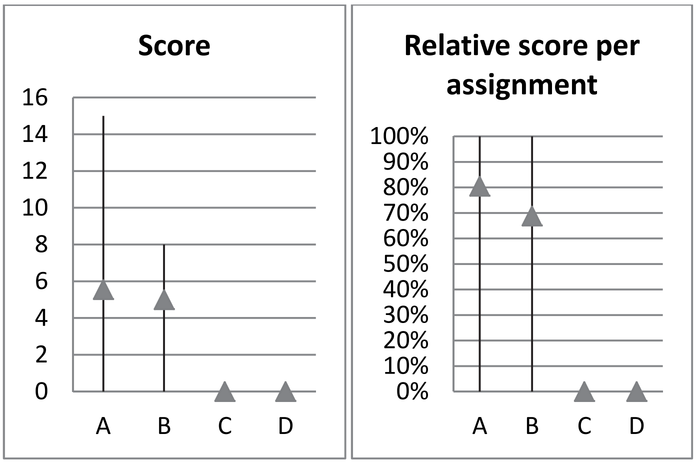

Figure 5: Achieved score – total points and relative score per assignment

Findings

By implementation through the online discussion forum, we have reached high level of students' activity. 91% of students (groups A, B, and C) took part in the forum actively without extrinsic motivation like grades. 79% of students (groups A and B) have solved at least one of the 8 initial programming problems (3.11 problems of average).

We have observed several types of social interactions in the online environment. Although students worked on individual basis, the online discussion forum provided stimulating social context for their activity. Students competed who would solve the problem first and get the bonus point; they competed who would achieve the highest score; they compared their solutions with others; they learned from others' discussion in the role of lurker. Although the term "lurker" often carries negative connotations, we consider the lurking behaviour as contribution to student's learning experience.

Conclusion

The presented study was aimed at designing a constructivist learning activity based on competitive collaboration through online discussion forum that would be suitable for courses on computer programming. We examined the suggested learning activity by analysing students' visible as well as their „invisible" participation in the online discussion. It is likely, that students who behaved as lurking posters or lurkers benefited from reading the posts of others significantly. When using an online forum for discussions, all the ideas and solutions of the community are saved into a common digital repository. This fact enables and could motivate students to return to those assignments they have struggled with during the traditional face-to-face lessons. The competitive character of the learning activity is likely to be satisfying for ambitious students who are quick and do not have difficulties with the curriculum. We found the problem-based online discussions to be an effective tool for promoting active learning as well as for applying the individual approach. However, the success of the online discussion depends mainly on the well-structured content set by the teacher and her/his level of commitment to the community of students.

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Smart Environments for Smart Learning

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Abstract

Smart environments for learning, as one of the results of intensive research in the area of Ambient Intelligence (AmI), can be naturally considered to be a new degree in the evolution of computer enhanced learning. The challenging exploitation of smart environments for learning together with new technologies and approaches as ubiquitous learning, mobile learning, etc. could be naturally named the smart learning. The purpose of the paper is to map the recent state of the art in the area of ubiquitous and context aware learning (smart learning) in a special type of smart environments, restricted on the case of smart workplaces. On the basis of our ongoing research we wish to present a view on the recent research of smart workplaces enhanced by advanced smart learning possibilities. The results are related to some recent activities in the area of smart offices and other intelligent workplaces. We shall focus here on smart learning possibilities enabled by the recent research results in the smart workplaces area.

Keywords

Computers and education. Ubiquitous computing. Artificial intelligence. Adaptive hypermedia. User interfaces.

Introduction

Smart environments for learning, as a result of intensive research in the area of *Ambient Intelligence* (*AmI*), deserve also attention of the large community oriented on e-learning and technology enhanced learning. Smart environments could be naturally considered to be a new degree of computer enhanced learning, with a considerable number of new facilities. Related to this, the area of *Ambient Intelligence* can be studied from several perspectives. As Bureš, Čech and Mls (2009) pointed out, besides its technological perspective, social perspective, or ethical perspective, we can also identify an educational perspective of *Ambient Intelligence*. The educational perspective deals with problems and challenges related to proper education in relevant *AmI* areas

Besides other intensively investigated and developed applications we may consider *Ambient Intelligence* also being a suitable technology for developing intelligent workplaces of various types.

An intelligent workplace can be, among its other features, helpful in managing knowledge which can be usefully needed by the users working in the workplace. Such knowledge can be used not only for solving various problems requiring some expert knowledge to be properly solved, but also for learning related knowledge at the workplace when creating decisions or looking for solutions of difficult tasks.

In the paper we intend to map the recent state of the art in the area of smart environments oriented on learning. On the basis of our on-going research we wish to present a view on the research of smart environments, related to some recent activities in the area of smart offices and other intelligent workplaces. We shall focus on smart learning possibilities enabled by the recent results of smart workplaces area research.

Problem formulation

Smart offices and other workplaces

Today different appliances have successfully become integrated to our daily life surroundings to such an extent that we use them without consciously thinking about them. Computing devices have transformed during last period of about 50 years from big mainframes to small chips that can be embedded in a variety of places. This has allowed various industries to silently distribute computing devices all around us, often without us even noticing, both in public spaces and in our more private surroundings. According to (Augusto, Nakashima and Aghajan, 2010), these computing devices will have to be coordinated by intelligent systems that integrate the resources available to provide an intelligent environment. This confluence of topics has led to the introduction of the area of *Ambient Intelligence* as a digital environment that proactively, but sensibly, supports people in their daily lives. All we have in the definition, that is

- digital technology,
- proactive but sensible support of people's activities,
- support of daily lives of people,

can be also utilized for further contemplations about supporting people in their working environments by recent *AmI* technologies.

According to (Cook, Augusto and Jakkula, 2009) the idea of *Ambient Intelligence* is not new, but what is new is that we can now seriously think about it as a reality and as a discipline with a unique set of contributions. The basic idea behind *AmI* is that by enriching an environment with technology (e.g., sensors and devices interconnected through a network), a system can be built such that acts as an *"electronic butler"*, which senses features of the users and their environment, then reasons about the accumulated data, and finally selects actions to take that will benefit the users in the environment. Therefore the features that are expected in *AmI* technologies have to be sensitive, responsive, adaptive, transparent, ubiquitous, and intelligent, as it is stressed by Cook, Augusto and Jakkula (2009).

One of most interesting and useful applications of *AmI* seems to be *Smart Offices* and *Smart Decision Rooms* (Ramos, Marreiros, Santos and Freitas, 2010). As mentioned already in various papers, decision making is one of the noblest activities of the human being. The topics as smart offices and intelligent meeting rooms are well studied and they intend to support the decision making activity, however, they have received a new perspective from the *AmI* concept. This concept enables a different way to look at traditional offices and decision rooms, where it is expected that these environments support their inhabitants on a smart way, promoting an easy management, efficient actions and, most importantly, to support the creation and selection of the most advantageous decisions.

Le Gal (2005) defines a smart office as an environment that is able to help its inhabitants to perform everyday tasks by automating some of them and making the communication between user and machine simpler and effective.

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A bit broader definition of smart offices can be found in (Marsá-Maestre, de la Hoz, Alarcos and Velasco, 2006). They characterize smart office as an environment that is able to adapt itself to the user needs, release the users from routine tasks they should perform, to change the environment to suit to their preferences and to access services available at each moment by customized interfaces. Smart offices handle several devices that support everyday tasks. They may anticipate user intentions, doing tasks on his behalf, facilitating other tasks, etc.

Freitas, Marreiros and Ramos (2007) pointed out, that the aim today is to develop systems that support distributed and asynchronous meetings, naturally allowing a ubiquitous use that can add flexibility to the global organizational environment of today. Such orientation in software development was followed by the design and building of rooms with specific hardware and software that could empower the decisions makers' actions, supporting them with knowledge and driving their attention to the problem and avoiding their minds from wandering on needless issues. This kind of rooms is commonly named as *Intelligent Meeting Rooms* (*IMR*), and can be considered as a sub domain of Smart Rooms for the workplace context. The goal of *Intelligent Meeting Rooms* is to support multi-person interactions in the environment in real time, but also they can be considered as a system that is able to remember the past, enabling review of past events and the reuse of past information in an intuitive, efficient and intelligent way. *IMR* should also support the decision making process considering the emotional factors of the intervenient participants, as well as the argumentation process. These ideas are in a more detail elaborated in (Freitas, Marreiros and Ramos, 2007). However, the *IMR* concept can directly lead to an intelligent support of smart learning.

Smart learning

The context aware and ubiquitous learning as being naturally close to the educational perspective of *AmI* as well as to the idea of smart learning environments, was defined and studied by several authors. Winters, Walker and Rousos (2005) pointed out that ubiquitous computing has tremendous potential for framing learning, particularly in informal and socially constructed contexts. To reach this potential it is necessary for the current desktop-focus development of technology in education to be challenged through the design, development and testing of new ubiquitous prototypes for learning.

Based on (Yang, Okamoto and Tseng, 2009), context-aware and ubiquitous learning is a computer supported learning paradigm for identifying learners' surrounding context and social situation to provide integrated, interoperable, pervasive, and seamless learning experiences. The objective of context-aware and ubiquitous learning is to enhance *Web-based learning* a step further from learning at anytime and anywhere to learning enabled at the right time and the right place using right resources and right collaborators. Alternatively, according to (Hwang, Yang, Tsai and Yang, 2009) context-aware ubiquitous learning is an innovative approach that integrates wireless, mobile, and context-awareness technologies to detect the situation of learners in the real world and provide adaptive support or guidance accordingly.

Yang, Okamoto and Tseng (2008) summarize the characteristics of context-aware and ubiquitous learning in the following eight aspects: mobility, location awareness, interoperability, seamlessness, situation awareness, social awareness, adaptability, and pervasiveness. More detailed descriptions of these aspects are as follows:

- *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.

On the other hand, Bomsdorf (2005) considered ubiquitous learning as the next step in performing e-learning and by some authors it was expected to lead to an educational paradigm shift, or to new ways of learning. The potential of ubiquitous learning results from the enhanced possibilities of accessing learning content and computer-supported collaborative learning environments at the right time, at the right place, and in the right form. Furthermore, and this is close to the ideas of *AmI* presented by ISTAG (Ducatel et al., 2001), it enables seamless combination of virtual environments and physical spaces. Ubiquitous computing leads to ubiquitous learning that allows embedding of individual learning activities into everyday life. As it was already stressed, the fundamental issue in a ubiquitous learning environment is how to provide learners with the right material at the right time in the right way. Context aware adaptation is therefore indispensable to all kinds of learning activities in ubiquitous learning environments.

In addition to the context-aware ubiquitous learning characteristics by Yang, Okamoto and Tseng (2008) mentioned earlier in this chapter, Hwang, Tsai and Yang (2008) formulated the potential criteria of a context-aware ubiquitous learning environment as follows:

- it is context-aware; that is, the learner's situation or the situation of the real-world environment in which the learner is located can be sensed, implying that the system is able to conduct the learning activities in the real world.
- it is able to offer more adaptive supports to the learners by taking into account their learning behaviours and contexts in both the cyber world and the real world.
- it can actively provide personalized supports or hints to the learners in the right way, in the right place, and at the right time, based on the personal and environmental contexts in the real world, as well as the profile and learning portfolio of the learner.
- it enables seamless learning from place to place within the predefined area.
- it is able to adapt the subject content to meet the functions of various mobile devices.

As it is pointed out in (Hwang, Yang, Tsai and Yang, 2009), researchers have different views of the term *"ubiquitous learning"* till now. A popular view is *"anywhere and anytime learning"*, which is a very broad-sense definition of ubiquitous learning. With this definition, any learning environment that allows students to access learning content in any location at any time can be called a ubiquitous learning environment, no matter whether wireless communications or mobile devices are employed or not. From this viewpoint, the mobile learning environment which allows students to access learning content via mobile devices with wireless communications is a special case of the broad-sense definition of ubiquitous learning. However, if we took into account the ISTAG scenario *Annette and Solomon in the Ambient for Social Learning* (Ducatel et al., 2001) that could serve as an ideal

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case for a smart learning environment, which was undoubtedly context-aware as well as ubiquitous at the same time, the popular view of *"anywhere and anytime learning"* should be considered as impractically broad. According to ElBishouty, Ogata, Rahman and Yano (2010), the challenge in the information-rich world is not to provide information at anytime and at anywhere but to say the right thing at the right time in the right way to the right person.

This approach is supported also by Yang (2006) stating that a ubiquitous learning environment provides an interoperable, pervasive, and seamless learning architecture to connect, integrate, and share three major dimensions of learning resources: learning collaborators, learning contents, and learning services. Therefore ubiquitous learning is characterized by providing intuitive ways for identifying right learning collaborators, right learning contents and right learning services in the right place at the right time.

The main characteristics of ubiquitous learning are permanency, accessibility, immediacy, interactivity, and situating of instructional activities. The ubiquitous environment should be personalized according to the learner's situation. Personalization is defined in (ElBishouty, Ogata, Rahman and Yano, 2010) as the way in which information and services can be tailored in a specific way to match the unique and specific needs of an individual user. While a learner is doing learning task or activity, she usually looks for some knowledge. In a ubiquitous learning environment, it is very difficult for a learner to know who has this knowledge even though they are at the same place. In this case, the learner needs to be aware of the other learners' interests that match his request (ElBishouty, Ogata, Rahman and Yano, 2010).

There are only a few studies that have attempted to induce the educational affordances of context-aware ubiquitous learning environment. Liu and Chu (2009) devoted attention to the problem of what educational affordances can be provided by a context-aware ubiquitous learning environment. They proposed a system named *EULER* that can provide eight educational affordances: knowledge construction, apply, synthesis, evaluation, interactivity, collaborative learning, game-based learning, and context-aware learning. Moreover, they stressed that ubiquitous learning provides context-aware information and self-learning opportunities for learners. Therefore, it not only enables students to achieve learning goals anytime and anywhere, it is also cultivating their ability to explore new knowledge and solve problems. This should be considered to be one of most important characteristics of ubiquitous learning.

Interesting ideas about learning in smart environments can be found in (Winters, Walker and Rousos, 2005). According to it, learning is no longer viewed only as a form of delivered instruction, undertaken within the confines of traditional educational environments. It is now understood as a social process that happens at a time and place of the learner's choosing, continuing throughout one's life. It is collaborative, evolving and informed by a process of self-paced development.

Winters, Walker and Rousos (2005) define a smart environment as any space where ubiquitous technology informs the learning process in an unobtrusive, social or collaborative manner. Thus a smart environment can be an 'aware' room or building, capable of understanding something about the context of its inhabitants or workers; it can be a digitally enhanced outdoor space – park, cityscape or rural environment; or it can be the environment created when peoples' meetings or interactions are augmented by wearable devices. These ideas are very close to that of original Scenario 4: *Annette and Solomon in the Ambient for Social Learning* from the well known ISTAG Report (Ducatel et al., 2001).

Possible solutions

There is already a number of interesting applications and other results in the area of smart workplaces that tackle various important problems necessary for further development of this important field. We try to mention some of them in this chapter.

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 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 (Tučník, 2010) and (Tučník and Mikulecký, 2010) are focused on decision making of agents in multi-agent environments, with a special accent on multi-agent based modeling of smart environments. The ongoing 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 behavior 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. Rondzhin and Budkov (2009) describe a development of an intelligent meeting room as a distributed system with the network of intelligent agents (software modules), actuator devices, multimedia equipment and audio-visual sensors. The main aim of the room is providing of meeting or lecture participants with required services based on analysis of the current situation. Awareness of the room about spatial position of the participants, their activities, role in the current event, their preferences helps to predict the intentions and needs of participants. Context modeling, context reasoning, knowledge sharing are stayed the most important challenges of the ambient intelligent design of this kind of rooms.

One of challenging applications is without any doubts any *AmI* application bringing new ideas and approaches into educational process at every level of education. Educational environment certainly is a rather specific workplace deserving a special attention and focus. One of these applications is the *Smart Classroom* project (Shi, Qin, Suo and Xiao, 2010). It aims to build a real-time interactive classroom with tele-education experience by bringing pervasive computing technologies into traditional distance learning. The goal of *Smart Classroom* project is to narrow the gap between the teacher's experience in tele-education and that in the traditional classroom education, by means of integrating these two currently separated education environments together. The used approach was to move the user interface of a real-time tele-education system from the desktop into the 3D space of an augmented classroom so that in this classroom the teacher could interact with the remote students with multiple natural modalities just like interacting with the local students.

There is a number of interesting attempts to propose ubiquitous learning environments of the type discussed in previous chapters. For instance, a wireless communication based network called *GroupNet* is proposed in (Chen, Kinshuk, Wei and Yang, 2008). It is a *Group Area Network* that is proposed on the basis of P2P wireless network connection to fit with this type of mobile scenario. *GroupNet* consists of a set of interconnecting handheld devices with wireless access, carried by a group of people within proximity.

GroupNet works with wireless modules of the handheld devices to achieve the best of ubiquitous networking. Ubiquitous networks enable secure access to data from everywhere on multiple devices to achieve the ubiquitous learning environment. The ubiquitous learning environment can connect, integrate and share learning resources in the right place at the right time by an interoperable, pervasive and seamless learning architecture. P2P networking used in *GroupNet* is one approach of creating ubiquitous networks for supporting ubiquitous learning.

Another interesting proposal of intelligent learning environments was published 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.

ElBishouty, Ogata, Rahman and Yano (2010) presented a model of personalized collaborative ubiquitous learning environment in order to support learners doing learning tasks or activities. It utilizes RFID tags to detect the surrounding physical objects and provides personalized recommendations based on the detected objects. It provides the learner with social knowledge awareness map for the peer helpers. The map visualizes the learners' surrounding environmental objects, peer helpers and the strength of the relation in the social network perspective. The learner can contact, interact, and collaborate with the peer helpers to address the learning goal.

Another example of a different approach towards intelligent learning environments can be found in (Winters, Walker and Rousos, 2005). They defined an intelligent environment as any space where ubiquitous technology informs the learning process in an unobtrusive, social or collaborative manner. In their paper, two ubiquitous devices for use in such an environment were presented: the

Experience Recorder and the *iBand*. The *Experience Recorder* is an embedded system that records the paths travelled by users – i.e. trails – in a particular place, for example at a museum or trade fair. It then recreates this visit in digital form, for example as a personalised website, enhanced for learning. The *iBand* is a wearable bracelet-like device that exchanges information about its users and their relationships during a handshake. Winters, Walker and Rousos (2005) stressed that the challenge of ubiquitous computing was to design and build systems for augmenting human capabilities rather than to replace them. In the context of learning, any ubiquitous computing tool cannot be viewed as deskilling the user. It must encourage skills development in a manner in which the learner is comfortable and engaged with. We cannot agree more.

The last example of a smart environment is the system *ISABEL* described in (Garruzzo, Rosaci and Sarné, 2007). The *ISABEL* is a new 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 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 problems and works mentioned above are just a collection of some applications and approaches which are somehow interesting and important for our further research direction. The collection certainly is not complete and a lot of other important problems could be extracted from the literature. However, we hope that some inspiration for focusing research work can be found here. We think that at least the importance of the area for common practice has been exhibited.

Conclusion

Quoting Weiser (1991), "*the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it".* As a matter of fact, smart learning at smart workplaces could be a good example of such a technology.

Bureš and Čech (2007) argue that the achievement of ambient intelligence postulates an adequate shift in thinking. The shift in thinking concerns also managerial work. The paper therefore presents on field experience on how to test the meaningfulness of teaching systems thinking for managers and increasing thus the level of acceptance of new technologies.

One of our earlier papers (Mikulecký, 2007) pointed out that managers, in order to be able of producing the best possible strategic decisions, should have the right information in the right time. However, without having the appropriate knowledge the production of good decisions would not be easy, if not impossible. It is, therefore, quite sensible to think about such a managerial workplace, where the manager would have the best possible working conditions in various meanings of this formulation.

A more general overview of the *AmI* possibilities in education brings our recently published book chapter (Mikulecký, Olševičová, Bureš and Mls, 2011).

The ISTAG scenario *Annette and Solomon* (Ducatel et al., 2001) was considered in the time of its origin as a long term future. However, we presented a lot of examples and arguments in favour of the idea, that the scenario can be nowadays implemented, as the relevant technology has matured enough. So, smart learning can be today used at smart workplaces as their integrate part.

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Morse Telegraph Alphabet and Cryptology as a Method of System Approach in Computer Science Education

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Abstract

The system approach is one of the education methods which can be widely applied in any subjects. The author has found this method as suitable for training of practical skill of computer science education. Application of system approach in computer science education develops logical thinking and correct understanding of using of computers in human life. Connection of Morse telegraph alphabet and cryptology has been chosen for the presentation of the system approach, modeling and simulation in this paper. The huge advantage of cryptology, which is a part of the curriculum in computer science, is that it enables the building of the system approach as well as interdisciplinary relations between such subjects as mother tongue, foreign languages, mathematics, history and geography, which is absolutely needed for prospective teacher of informatics. The use of the algorithm development and programming in the cryptoanalysis of the Morse telegraph alphabet cipher is specifically presented in the paper.

Keywords

Privacy. Security. Cryptology. Morse Code. Problem Solving. Heuristic methods.

Introduction

Teaching of the computer science education should develop all theoretical knowledge and practical skills reached in theoretical informatics subjects from education point of view. The system approach seems to be one of the most suitable methods to reach this goal.

Firstly, we briefly introduce the system approach methodology especially used in the education and then this methodology will be supplied by case study, based on e.g. (Milková, 2011; Hubálovský, Milková, Pražák, 2010).

The research investigation should confirm the hypothesis, that system approach implemented to computer science education positively influenced development of the cognition of the student about their role as teacher. What seem to be also important that the students – prospective teacher pass their knowledge about system thinking to their pupil, which is absolutely important in correct understanding of the real objects and real processes. With the term system approach are very closely connected the terms modeling and simulation. Similar research investigation can be found e.g. in (Hubálovský, 2011; Šedivý, Hubálovský, 2011)

System approach, modeling and simulation

System approach

System approach is closely related to the concept of system. Under the system, rather a systemic approach, however, can be understood also abstract issues like learning style. For a system approach is generally considered such way of solving the problems, where phenomena and processes are studied comprehensively in their internal and external contexts (Wilson, 2001). System approach in pedagogy means formulation, understanding and solutions of the studied problem under the consideration that the corresponding processes, events and phenomena that objectively exist in the world and which are transformed into the model learning situations.

In connection with the concepts of system and system approach is necessary to mention the other term that is commonly used in pedagogy – interdisciplinarity. This concept can be understood e.g. based on (Checklan and Poulter, 2006) as a method of linking and active cooperation between different sciences in order to achieve integrated and synergistic results in theoretical and practical professional activities, science and research.

Although the interdisciplinary approach in the context of learning process is frequently discussed, the concept of system approach in educational practice is not sufficiently specific and widely implemented (Checklan and Poulter, 2006). Unfortunately, this fact also applies to study computer science education, which in practical terms without system and multidisciplinary approach cannot be realized.

Modeling and simulation

Modeling and simulation are methods that are often used in professional and scientific practice in many fields of human activity.

The main goal of modeling and simulation is not only describing the content, structure and behavior of the real system representing a part of the reality but also describing the processes.

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 – see e.g. (Hubálovský, 2010; Šedivý, 2011).

The simulation model is usually represented by executable computer program. To create high quality computer simulation, it is important to create well done conceptual model of the process. The system approach one of the methods giving the rules for conceptual model and computer simulation creation.

Multidisciplinary approach

Another important benefit associated with the modeling and simulation of real processes is a multidisciplinary approach, without which the identification of the real processes using conceptual and simulation model and cannot be realized. This is also emphasized in this paper – (Hubálovský, Šedivý, 2010).

Multidisciplinary approach generally means that specialized disciplines are applied in a study of real process. These disciplines provide partial analysis of the process. These mono-disciplinary analyses are integrated to overall solution by integrating the solver who has basic multi-disciplines knowledge – see e.g. (Šedivý, 2011).

In the following text the application of the system approach will be presented in identification of the Morse telegraph alphabet and cryptology process.

Case study

American **Samuel Finley Morse** (1791 - 1872) worked out his proposal of the telegraph in practically usable form 175 years ago, then in 1837. It was after a lawsuit with the American physicist **Joseph Henry** (1797-1878), inventor of the electromagnetic relay, the same year it entered the patenting. Along with telegraph alphabet suggested by Morse that while still been modified several times, but the basic principle - alternating short and long pulses - telegraphic dots and dashes - has been preserved till present. It is interesting that in the same year **Charles Wheatstone** (1802 - 1875) and Sir **William Fothergill Cooke** (1806 - 1879) patented electromagnetic telegraph based on an entirely different principle.

Electromagnetic telegraphs and in particular good practice to use Morse's telegraph began to develop rapidly in the second half of the nineteenth century telegraph services began to be widely available to the public. Public Service, which had to text messages transmitted by several people approach (employments of the telegraph office on the sending and the receiving station) but did not provide in a foolproof guarantee the confidentiality of the message content from third parties. It was such an unpleasant for businessmen, for whom confidential information may represent a competitive advantage, but also necessary for the lover who, when their relationship revealed disclosure of a society scandal. That comes with the development of telegraphy social demand for cryptographic systems that are easy to use and yet sufficiently encrypted to protect confidentiality.

For example polyalphabetic substitution described by an English admiral and meteorologist (known for its wind force scale) Sir **Francis Beaufort** (1774 - 1857) popularized his brother, a table of encryption known as tabula recta sold along with instructions and recommendations for creating passwords for six pence by 1857. The amount designated by the versatile British scientist **Charles Wheatstone** (1802 - 1875) suggested in 1854 a new type of bigram substitution, which is somewhat wrongly called Playfair's cipher, according to his great friend and promoter of this cipher. His name was **Lyon Playfair** (1818 - 1898) and it was well-known scientist and member of British Parliament, who succeeded because of his political influence to promote the use of ciphers in Britain for diplomatic and military purposes.

Since the nineteenth century it probably becomes a custom to divide encrypted messages to groups of five letters. The average length of words in the English language is oscillated (by type of text) about 4.5 letter and telegraph companies traditionally charge sending message by the number of words (or number of groups in the ciphertext), not by the number of letters. Soon, they refused to accept encrypted telegram, which would include more than a five-character groups.

Methods of encrypting by Morse alphabeth

Samuel Finley Morse certainly did not anticipate that its invention indirectly affect the development of cryptology, the less that his telegraph alphabet will become an interesting tool for type doubling substitutions, which convert plaintext into Morse code is the first step, serving to create middletext. Middletext uses three-character alphabet (dot, dash, slash), with the termination letter, composed of dots and dashes. Slash is used to separate letters, and two slashes are used to separated two words. Slash is also usually added at the beginning of the middletext. The next operation is division of the text into groups of two characters in the cipher called **Morbit** or three characters in the cipher **Fractionated Morse**. If the number of characters was not even in the case

Morbit cipher, we'll add a slash at the end of the middle text, analogously for the middletext of Fractionated Morse cipher slashes to specify that the number of characters, from which it is composed is divisible by three. Finally, in the case Morbit cipher replaces each pair of characters, depending on the conversion table. If we lined up alphabetically character pairs (dot < dash <slash) and sort the numbers assigned to them by size in the normal way (1 < 2 < 3 <... < 9), we get the following table:

Table 1: Conversion table with digits in the normal order

..	**.-**	**./**	**-.**	**--**	**-/**	**/.**	**/-**	**//**
1	2	3	4	5	6	7	8	9

Of course, that in fact we use numbers to assign a different permutation of digits. Digits is not ordered by size but by a suitably chosen numerical password. If we choose as a password eg date of birth of Samuel Finley Morse, a 27. 4. 1791, then to the bottom line of the table write gear in sequence 2, 7, 4, 1, then the digit 9 (seven we can't enter a second time, as well as one at the end of the year of birth) and they write the remaining numbers, already sorted by size, ie gradually 3, 5, 6 and 8. Conversion table will look like this:

Table 2: Conversion table with digits ordered by password

..	**.-**	**./**	**-.**	**--**	**-/**	**/.**	**/-**	**//**
2	7	4	1	9	3	5	6	8

Analogously, we proceed in the case of cipher Fractionated Morse, with the difference that the middletext divided into triplets of characters convert according to the table, which corresponds to 26 international alphabet letters. Number of possible triplets is total $3^3 = 27$, but because it can't occur three consecutive slashes in middle text, it just comes to us. Let's see how it would look conversion table with alphabetically sorted letters, although even here, in practice we use permutations of the password:

Table 3: Conversion table with letters in the alphabetical order

...	**..-**	**../**	**.-.**	**.--**	**.-/**	**./.**	**./-**	**.//**
A	B	C	D	E	F	G	H	I

-..	**-.-**	**-./**	**--.**	**---**	**--/**	**-/.**	**-/-**	**-//**
J	K	L	M	N	O	P	Q	R

/..	**/.-**	**/./**	**/-.**	**/--**	**/-/**	**//.**	**//-**	**///**
S	T	U	V	W	X	Y	Z	+

Let the whole procedure encryption on a short example. It will be the first report, broadcast by Samuel Finley Morse at May 24th 1844 through the first line of his telegraph from Washington to Baltimore: „What hath God wrought“. For cipher Morbit was used the above password - date of birth, for cipher Fractionated Morse arranged alphabetically leave conversion table.

Plaintext: WHAT HATH GOD WROUGHT

Middletext: **/.--/..../.-/-//..../.-/-/....//--./---/-..//.--/.-./---/..-/--./..../-/**

Ciphertext 1: 59524 76822 53322 89493 14595 16957 61524 3

Ciphertext 2: TPATX SCFPA ZLNVI ETHOB WGAX

From this brief example, we see that the number of ciphertext characters (36 and 25 for Morbit and Fractionated Morse) is larger than the number of plaintext characters (18 letters). For Fractionated Morse cipher we can also compare the index of coincidence with plaintext, as both open and ciphertext are using the international alphabet with 26 letters. For this comparison, however, we use more text taken from book by HG Wells' The War of the Worlds, of course, the original English version. This text is about 266 thousand letters long and his index of coincidence is 0.0662. Cipher text obtained by fractionated Morse with any password has about 336 000 characters and the coincidence index is 0.0478. Recall that a random text with absolutely equal representation of all characters has coincidence index of 0.0385.

To decrypt the ciphertext with the password and the resulting conversion table is easy. Inverted conversion table and each digit in the case of Morbit cipher, or each letter in the case of Fractionated Morse cipher replace sequences of characters from the alphabet dot - dash - slash. So we get middletext entry representing the plaintext in Morse telegraph alphabet. It is decoded and plaintext written in the international alphabet letters is obtained. Is possible use script at web (Musílek, 2011) for encrypt and decrypt.

Discussion about deciphering of Morbit

More complex problem is deciphering the ciphertext, which we know that it is encrypted by system Morbit or Fractionated Morse cipher, but we don't know a password. We know that the cipher alphabet characters can arbitrarily permute in the conversion table and that the number of permutations of *n* elements is calculated as *n*!. For the 9 digits in the system Morbit we get a total of 9! = 362 880 possible keys, for 26 letters in the Fractionated Morse system we get a lot more, a total of 26! = 403 291 461 126 605 635 584 000 000 (403 quadrillion) possible keys. The question is whether and how it is possible to decipher the encrypted texts mentioned systems.

Morbit system has considerably smaller key space and is considered for the cipher that can be deciphered only with pencil and paper (American Cryptogram Association). However, the number 9! = 362 880 seems to be too large for us trying all possibilities. In fact, we can't assign individual digits (each character of cipher alphabet) to all possible couples from characters of the middletext alphabet. If we agree that middletext will always start with a slash, we have only two options for the first digit ciphertext: /. or /-. Conversely, if a slash at the beginning middletext omitted, there are six possibilities. Other estimates are based on the fact that each letter of the plaintext is coded into middletext in Morse Code using one to four characters, dot or dash, which is always followed by a slash. Ciphertext digits representing the combination with a slash may be close to one another, through one or a maximum through two digits. If characters are trough two digits, the first in the sequence must end with a slash and the other begins. In four-characters sequences cannot any sequence of dots and dashes emerge, because they are not expressing any of the 26 letters of the international alphabet. Specifically, the sequence:

..--	.-.-	---.	----

These sequences are sometimes used to write letters with umlaut (ü, ä, ö), or the letter ch. But this isn't an international alphabet letters and in Morbit encryption it isn't commonly used. If in the ciphertext occur the same two digits in a row, then this certainly can't be a digit or two characters .- or pair of characters -- because it would generate "forbidden" sequences .-.-, respectively ----. Similarly, another may be deduced, although slightly more complex rules. Let's take, but rather deciphering ciphertext, which was Morbit system generated, for example:

```
45189  83432  78517  37274  48956  46395  22392  55848  32495  67852
51231  77448  92137  14295  22396  72413  27543  27247  87448  92764
65351  42952  23474  48927  64653  75383  75229  52239  25584  83249
62332  52446  54134  83141  91233  14763  14292  72235  65
```

We know about the ciphertext that the system was Morbit, the first character of middletext is a slash and an plaintext was written in English. Furthermore, we have marked out the ciphertext pair of consecutive identical digits. If we use the above considerations, it has something we know about the first two digits of ciphertext. Digit 4 can only mean /. or /- and digit 5 can’t mean either .- or -- or the same character as the digit 4. As digit 5 the cipher text ends, we know that will mean either //, or ./, or -/. But if it were //, which represents the space between words, it would open the first word of the body of the letter E or the letter T itself, which is not probably. Thus, we will only consider the option ./, or -/. Mark what we already know in tabular form:

Table 4: Cipher Morbit deciphering matrix – non complete

	..	.-	./	-.	--	-/	/.	/-	//
1									
2		NO			NO				
3		NO			NO				
4	NO	NO	NO	NO	NO	NO			NO
5	NO	NO		NO	NO		NO	NO	NO
6									
7		NO			NO				
8									
9									

After the first replacement remains a recurring pair of digits (89 or 27) and some more groups (2239). From the location of the 89 pairs of characters we can estimate that either 8 or 9, or both, probably are representing a combination of numbers with a slash:

```
/../189   83/.32   78./17   3727/.   /.89./6   /.639./   22392
   ././8/.8   32/.9./   678./2   ./1231   77/././.8  92137
   1/.29./   22396 72/.13   27.//.3   272/.7 87/././.8  9276/.
   6./3./1   /.29./2   23/.7/.   /.8927  6/.6./3 7./383
   7./229   ./2239   2././8/.   832/.9   62332 ./2/././.6
   .//.13/.   831/.1   91233 1/.763   1/.2927223./   6./
```

We can try to start as an plaintext "I AM". Then 1 would have imagined .-, 8 /- and 9 -/. We got a partially decrypted text (we canceled the spaces between groups of digits):

```
/../.-/--//-3/.327/-./.-73727/././--/./6/.63-/./223-/2././/
-/./-32/.-/./67/-./2./.-23.-77/././--/2.-37.-/.2-/./223-/6
72/..-327.//.3272/.7/-7/././--/276/.6./3./.-/.2-/./223/.7/.
/./--/276/.6./37./3/-37./22-/./223-/2././/-/./-32/.-/62332
./2/./.6.//..-3/./-3.-/..--/.-233.-/.763.-/.2-/27223./6./
```

In this text, however, we see the "forbidden" sequence ..-, so we wandered into a blind alley. We start therefore from the beginning starting with other substitutions. What if the text started instead of the personal pronoun "I" by possessive pronoun "WE". So digit 4 would correspond to /-, digit 5 would be -/, 1 would be -. and 8 would be --. Then they had to answer nine // in order to finish the word "WE" and the resulting partially decrypted text would be:

```
/--/-.--//--3/-327---/-.73727/-/---//-/6/-63//-/223//2-/-/--/---32/-
//-/67---/2-/-.23-.77/-/---//2-.37-./-2//223//672/
--.327-//-3272/-7--7/-/---//276/-6-/3-/-./-2//-/223/-7/-/---// 276/-
6-/37-/3--37-/22//-/223//2-/-/--/---32/-//62332-/2/-/-6-//--.3/---3-
./--.//-.233-./-763-./-2//27223-/6-/
```

In this text, no "forbidden" sequences don’t see, so once again we return to our table, add to it to make a refund and considering how to proceed:

Table 5: Cipher Morbit deciphering matrix – nearly complete

	..	.-	./	-.	--	-/	/.	/-	//
1	NO	NO	NO	YES	NO	NO	NO	NO	NO
2		NO		NO	NO	NO		NO	NO
3		NO		NO	NO	NO		NO	NO
4	NO	NO	NO	NO	NO	NO	NO	YES	NO
5	NO	NO	NO	NO	NO	YES	NO	NO	NO
6				NO	NO	NO		NO	NO
7		NO		NO	NO	NO		NO	NO
8	NO	NO	NO	NO	YES	NO	NO	NO	NO
9	NO	NO	NO	NO	NO	NO	NO	NO	YES

The table clearly shows the value of the digit 6, that is .-. For the remaining digits 2, 3 and 7 are offered meanings .., ./ a /.. Trial - error we find that best matches the digit 3 is /. and substituting for 6 and 3, we go to the text:

```
/--/-.--//--/./-/.27---/-.7/.727/-/---//-/.-/-.-/.///22/.//
2-/-/--/---/.2/-//-/.-7---/2-/-.2/.-.77/-/---//2-./.7-./-2//-
/22/.//.-72/--./.27-//-/.272/-7--7/-/---//27.-/-.--//.-/-./-2//-
/22/./-7/-/---//27.-/-.--//.7-//.--/.7-/22//-/22/.//2-/-/--/---/.2/-
//.-2/./.2-/2/-/-.--//--././---/.-./--.//-.2/./.-./-7.-/.-./-
2//2722/.-/.--/
```

By reading this text, we get clear assignment of values to the last two digits. Number 2 is .. and number 7 ./. After substitution we get the complete decrypted middletext in Morse Code:

```
/--/-.--//--/./-/..../---/-..//../...//-/---//-/.-/-.-/.//
-/...././/..-/-/--/---/.../-//-/.-./---/..-/-.../.-.././/
-/---//..-./../-./-..//-/...././/.-./../--./..../-//          -
/..../../-./--.//-/---//.../.-/-.--//.-/-./-..//-/..../././-.//-/---
//.../.-/-.--//../-//.--/../-/....//-/...././/
..-/-/--/---/.../-//.-.././...-/../-/-.--//--././---/.-./--.// -
.../././.-./-./.-/.-./-..//.../..../.-/.--/
```

A simple decoding well known Morse telegraph alphabet, finally, open the original plaintext:

MY METHOD IS TO TAKE THE UTMOST TROUBLE TO FIND THE RIGHT THING TO SAY AND THEN TO SAY IT WITH THE UTMOST LEVITY

GEORG BERNARD SHAW

Research investigation

Let's return now to the issue of research in which we have investigated the influence of a systematic approach to development of students' skills to create a web application. The investigation was conducted among students of 3rd year of bachelor's degree in the subject of "Web technology". The aim of this subject is to acquaint students with the technology of static and dynamic Web markup languages like HTML, XML and XHTML, the rules of language of CSS and principles to various degrees using cascade and scripting language for client-side scripting (JavaScript) and server (PHP).

Characteristic of the first group of students was that in the previous semester the students study optional subject "Introduction to systems theory, modeling and simulation". The aim of the subject is to familiarize students with basic concepts of systems approach, modeling and simulation.

The second group of students the subject "Introduction to systems theory, modeling and simulation" has not studied.

Output of the work of students in the subject of "Web technology" is final web project, which must contain interactive sections and functionality.
Quantitative evaluation of web project was based on the percentage evaluation parameters. The evaluation parameters are listed in the table 6. 0% is completely wrong, 100% is quite correct.

Table 6: Research results

Parameter	1. group	2. group
Web architecture, web design	89	88
Using of graphics and pictures	92	94
Using of cascade language - CSS	85	75
Correctness of XHTML code	75	65
Correctness of using of CSS code	78	52
Correctness of using of JavaScript	82	65
Web hierarchy	68	59
Total result:	**81**	**71**

Discussion of the results

The above results indicates that students who completed the course "Introduction to systems theory, modeling and simulation" make less mistakes when creating their web project, than students without system approach knowledge / thinking. We can say that awareness of fundamental systems approach increases students' ability to create complex Web applications in which they make fewer mistakes. These students respect the basic rules and principles of Web programming.

The above research is the first of the anticipated researches. It is further assumed that the influence of a system approach in other subjects such as algorithms, programming, computer graphics, multimedia systems, etc. will be observed.

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Conclusion

There are various approaches how to provide learning of computer science education, how to introduce and develop basic theoretical and practical skills.

The paper offered one of the kinds of the possible teaching / learning strategies using the system approach. The system approach can be set as the default paradigm for a wide integration of this principle to computer science education. The paper emphasizes the fact that system approach is one of the suitable methods of using computer technology.

Solution of the Connection of Morse telegraph alphabet and cryptology has been chosen as one possible example of how to present the application of the system approach.

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Approach to Solving of Decrease in Disproportion Between Groups of Students

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Abstract

In this paper a problem of decrease in disproportion between part-time and full-time students is presented. It was solved by way of a virtual laboratory. The lab was created within the solution of the project named Virtualization. It represents the part of the decentralized program No. 3 The development of modern equipment and technology at the University of Pardubice in 2011, is sponsored by the Ministry of Education, Youth and Sports in the Czech Republic. The aim of the project Virtualization is to eliminate the disproportion of free access to licensed software between part-time and full-time students. Based on analysis of virtualization possibilities the solution has been implemented through Microsoft Terminal Server. A dedicated server with needed licensed software was installed. Students can connect this server and get remote desktop. Students can run installed software on the server's remote desktop as if it was on their private computers. Therefore students can solve specified problems anytime and anywhere, if the connection to the Internet is available. After a very short time of using the virtual laboratory we can say, that the students' skills in using the licensed software have been broadened as well as knowledge of part-time students.

Keywords

Education. Distance learning. Virtual private network. Virtual lab.

Introduction

Virtualization has become the real social phenomenon. However, using the word 'virtual' should be used carefully. For instance, Ivan M. Havel mentions: ' … The only problem – generally said – I can see is that mechanization, digitalization and virtualization of our life is coming quicker than it is salubrious.' (Cvek, 2005). In spite of this the word virtual has become ordinarily used in education, particularly in the field of distance learning (El-Bakry, Mastorakis, 2009) and e-learning (Doulgeri et al., 2006). Mentioned forms of education contribute to the development of the educated society, which meaning is confirmed in European (the i2010 strategy) and national documents. As we can see, it is a very important theme from the realized 3rd year of international scientific conference called Educated Society – Science and Education in the 21st century, which was organized by the University of Finance and Administration in Prague, the Academy of Sciences of the Czech Republic (CR) and the Masaryk University in Brno (10th March 2011). The conference was held under the auspices of the Prime Minister Petr Nečas and dealt with scientific and educational pieces of knowledge and their usage in drafting the higher education at present days.

In distance learning there are the constructs like virtual learning environment (Zounek, 2009), virtual lab (Casals-Torrens, Bosch-Tous, 2010; Drigas et al., 2005), virtual class (Drigas, Koukianakis, Glentzes, 2005; Květoň, 2005; Michailidis, Margounakis, Politis, 2005) or virtual University (Průcha, 2003). Virtual learning environment (online learning environment) is possible to define as a technology (hardware and software (SW)), which is used for online learning pursued out of the traditional classroom (Mason, Rennie, 2006 quoted in Zounek, 2009; p. 122). In case of virtual labs we meet the constructs such as: iLab (_iLab, 2011), online lab (_onlineLab, 2011), virtual lab (_virtualLab, 2011; _virtualLab, 2011a), web lab (_webLab, 2011), web virtual laboratory (Smutný, Farana, Smutný, 2005) etc.

The primary reason for realization of project Virtualization at the Faculty of Economics and Administration (FEA) was to make licensed software accessible for part-time students.

At FEA isn't any dedicated course to the virtualization. Basic principles of virtualization are discussed during lessons of Computer Networks (CNs) and Operating Systems. Students will meet practical usage of virtualization in lessons of CNs. In this course are virtual machines used as complete independent computers for teaching basics about settings of computer networks and network operating systems. These completely independent virtual computers are used at labs computers to avoid any harm or incorrect setting of hosting operating system of lab computer (students of another courses needs to have perfectly working lab computer, not some testing computer with wrong setting of operating system). For realization of virtual computers at student's labs computers are used Oracle VirtualBox. Due to this desktop virtualization every student has full access to its own virtualization environment and virtual computers. Virtual computers are used during whole semester, therefore students will learn every basic aspects of virtualization.

Within the study programme System Engineering and Informatics (bachelor's and master's degree) at FEA, full-time students process tasks in their seminars in the computer labs. These are assigned in different licensed SW, e.g. MATLAB. Part-time students have the same conditions for gaining the credit, so they process same or similar tasks. Within the part-time studies however, number of hours spent in the labs per term (usually 5 hours) cannot be compared to the number of hours spent there by full-time students (usually 28 hours).

The aim of the planned solution was to cancel the disproportion in access to the licensed SW between the full-time and part-time students and of course allow the part-time students full access to the used SW.

Problem formulation

There are many ways, how to allow students the access to the licensed SW, e.g. Figure 1. The left column shows the environment of the University (University), communication channel (Internet) and students' personal computers (Students). In the picture there are 3 possibilities of licensed SW distribution for the students. Most of the possible solutions are for the end user (student) very complicated and require certain network knowledge. For instance installation of the licensed SW directly to the student's computer is not possible, because the students themselves must after installing the SW also set the school license server. And this activity is not suitable for an ordinary educated computer user.

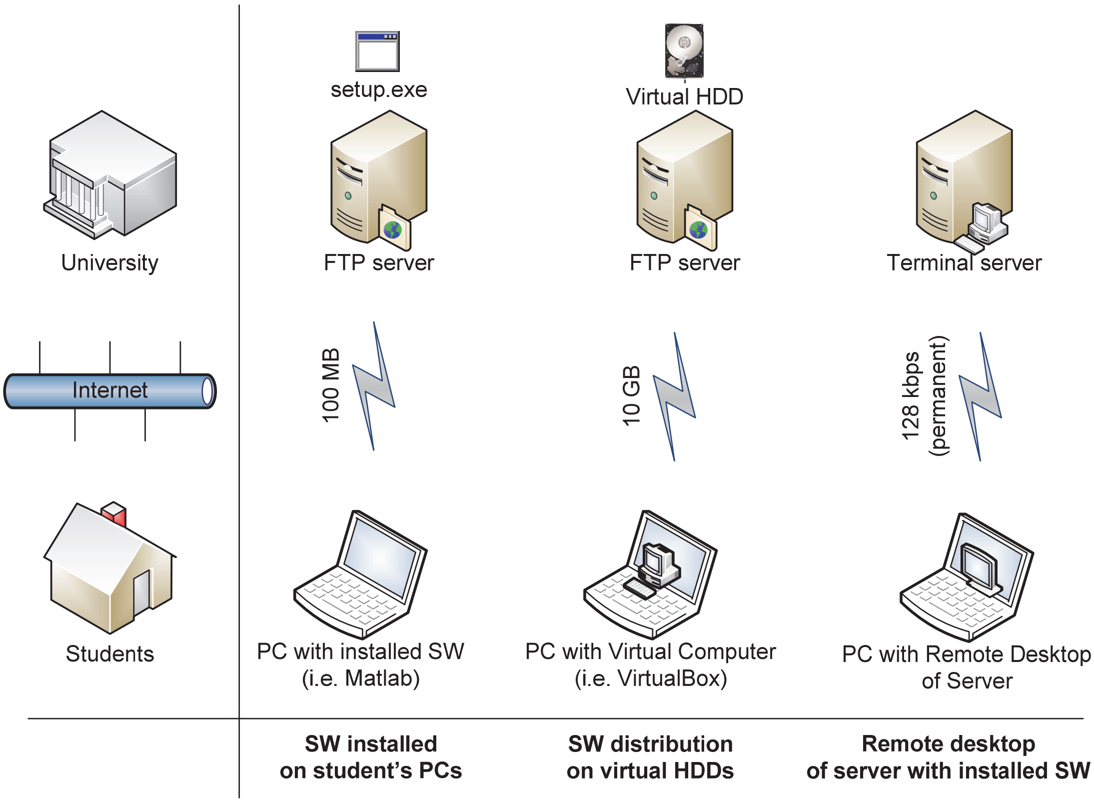

Figure 1: Possibilities of licensed SW distribution.

Another possible way is to provide students the installed SW on the virtual computer. Student would only download the image of virtual computer harddrive (Virtual HDD), which would be used for start of the virtual computer in common desktop virtualization environment, such as Windows Virtual PC (it is part of Windows 7), then also Sun VirtualBox or VMware Player (both solutions are accessible free of charge). Overall SW and needed settings for getting the licence from the university's licensed server would be the part of distributed virtual computer. Licence to operating system (OS) Windows for students is part of the program Microsoft Developer Network Academic Alliance (MSDN AA). One disadvantage is that there is a necessity to distribute a complete OS Windows, which usually means the usage of 5-10 GB of data. Another disadvantage is that there is nearly no possibility to update SW or OS remotely, or to change their settings. Distributed virtual computers would be completely under the end user manage, without the possibility of remote maintenance.

The last mentioned way is our planned solution, via Terminal server.

In the past we solved this problem via allowing licensed SW MATLAB by proposal and analysis of application in MATLAB Web Server (Galčík, 2008). MATLAB Web Server (Galčík, 2008; Hamar, P., Kropík, P., Šroubová, L., 2003) presents the possibility of the Internet communication between MATLAB and the user.

In application (Galčík, 2008) it is necessary: to set Apache HTTP server, create the input and output forms in HTML code and M-files examples in MATLAB, prevent making mistakes from the users' side (students). An example of application window is shown at Figure 2.

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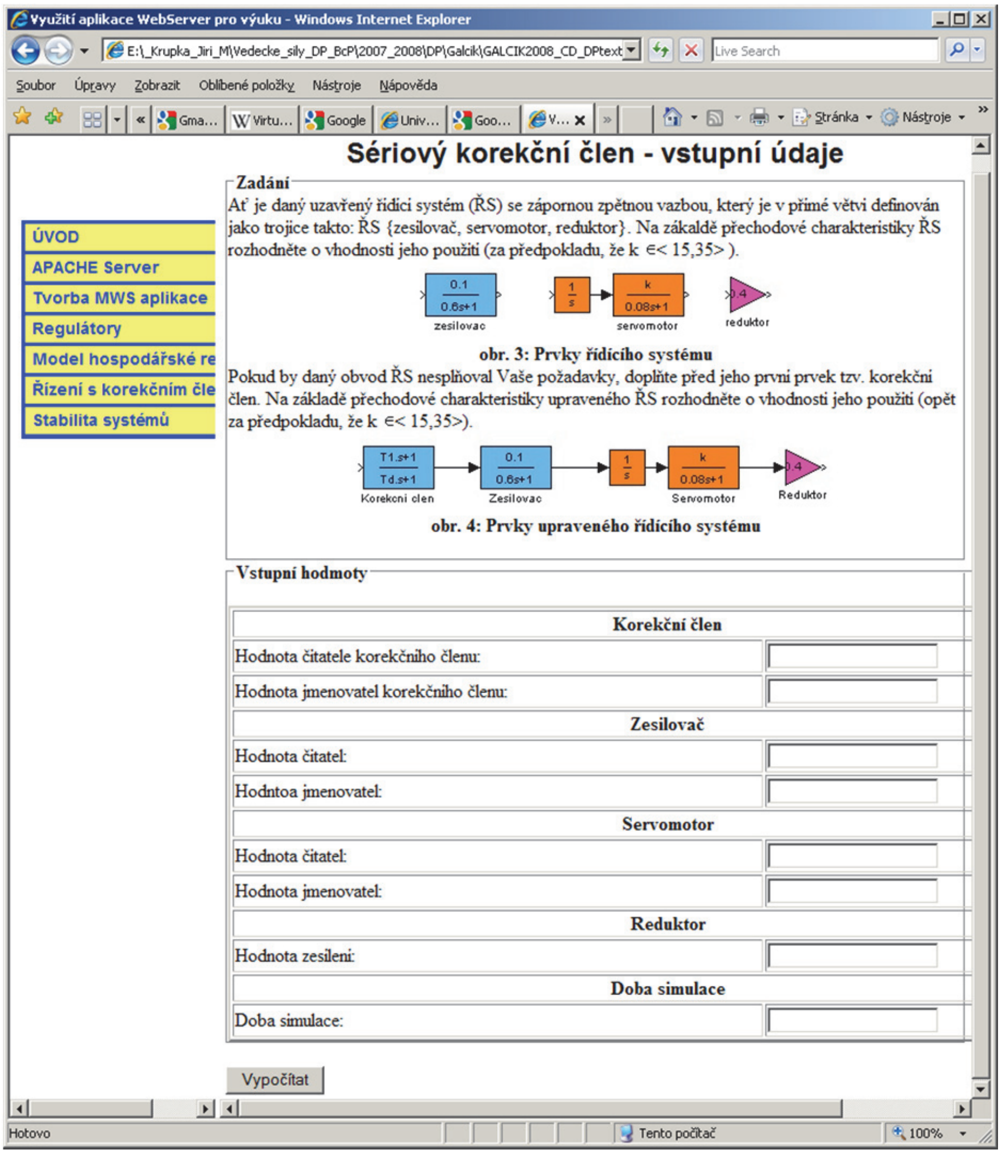

Figure 2: Solution using MATLAB Web Server.

The advantage is the remote access of the students to the licensed SW, but the disadvantage is a laborious proposal of HTML forms and M-files for solved examples made by the tutor. Another disadvantage for the students is that there is the possibility to solve the solely defined assignments and their solutions.

Proposal and solution testing

The most advantageous solution for testing was the terminal server at OS Windows Server 2008 R2. At this server there is a necessary SW used in the lessons installed. Now, there is MATLAB R2011b and Statistics 10 installed. Performance of the server is designed to 100 simultaneously working users.

Students have the possibility to connect easily to the remote desktop of the server. At the desktop there are the icons for the program start, which are installed at the server. After the program starts, the student can work on it without any limits as if the program was started directly at their computer.

For connection to this server, there is a simple program needed. It is either part of the student's OS or accessible free of charge. To the remote desktop of the server the students can connect from OS Windows (e.g. program Remote Desktop Connection, which is part of OS), from Linux OS (e.g. program rdesktop, which is either part of Linux or accessible to download) and it is possible to connect also from Mac OS (e.g. program Remote Desktop for Mac, which is part of the Microsoft Office set for Mac or is accessible to download free of charge). Thanks to the possibility of connection from nearly any desktop OS, it is also solve the problem with availability of needed SW for lessons to any OS, which student's use on their computers.

After starting program Remote Desktop Connection for connection to the server, the students only enter the server address (`fes-st01.upceucebny.cz`). They can also set, that they want to connect any of their disk drives or a printer to this server. At this disk drive the students can save the example assignment or source data. It is also possible to write into this disk drive, which means that the solution would not be stored only at the server. After connection it is necessary to log in to the server, which will be done via student's NetID and the password. The server is accessible for all the students and tutors of FEA at the University of Pardubice (UPCE).

There are no limits yet, e.g. access only for the students of the specific field or time limits, when the application in the server would be accessible only during the night or at the weekends. It is possible to access the server at any time from the University computer network. If the student is connected to the Internet out of the University network, the server would be accessible after log in to Virtual Private Network (VPN) of University. The students log in to the VPN also via their NetID. The client for the VPN connection is also accessible for all three above mentioned OS, i.e. Windows (Windows 2000, Windows XP, Windows Vista, Windows 7), Linux a Mac OS.

Figure 3 shows user's connection from home via VPN to the terminal server from the OS Windows XP via program Remote Desktop Connection. At the virtual desktop there is MATLAB running, where the simple example is shown. The window with the remote desktop is possible to maximize at the client's side (student's side), which means that the work on the virtual computer is not disturbed by double Start icon (at the local student's computer and the server's). The remote desktop can be widened over the whole screen provides nearly same comfort as if the students sit at their computers in the classroom.

Naturally to have the access to the remote desktop, within this project, the students' computers must be connected to the Internet. The minimal speed of the Internet connection is 128 kbps for work in the virtual lab. For a comfortable work with the virtual lab the optimal speed of the Internet connection is 512 to 1024 kbps. This requirement is accomplished by most of the commercially provided Internet connections in the CR.

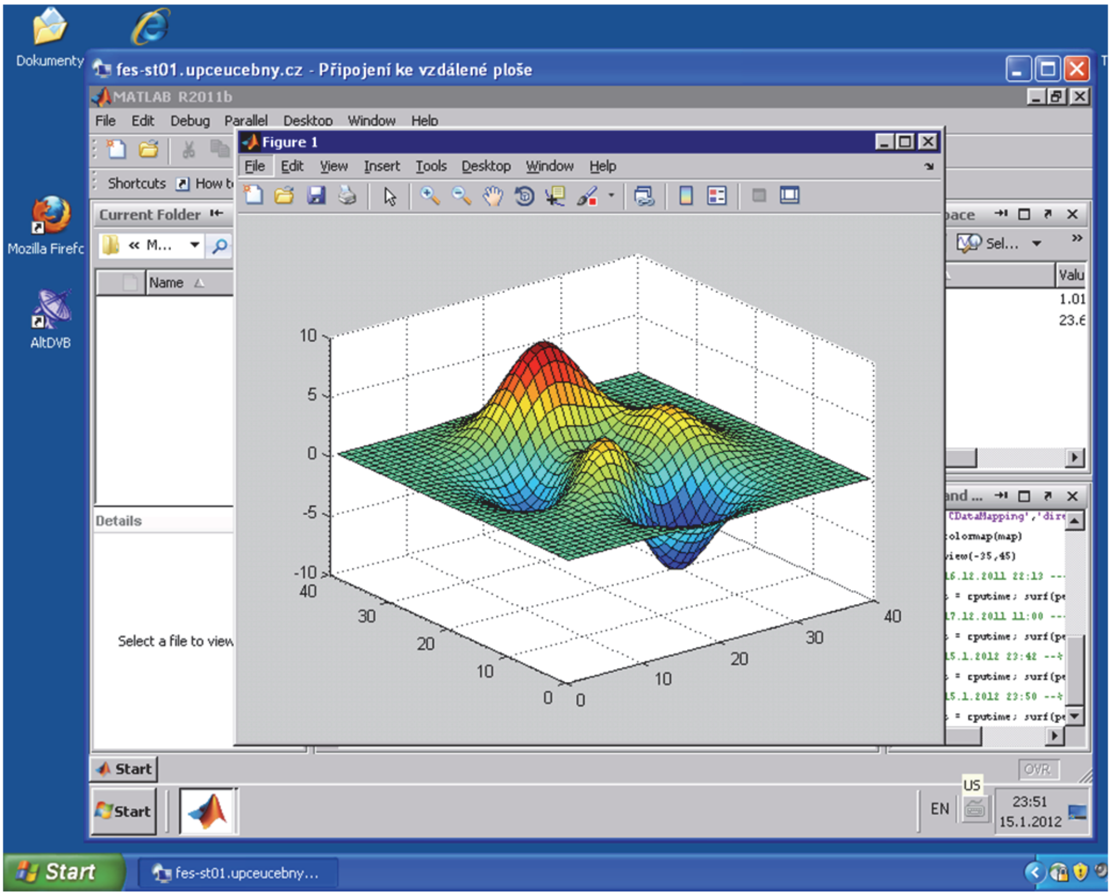

Figure 3: Remote desktop connection to virtual lab in Windows XP.

More important factor than the Internet connection is actually response time (between the students – computer games players called as a ping). The response time is neatly connected to the connection speed, but it is possible to have high speed Internet connections with very slow response time. The response time is the time, when the user gets the response to his request. It means when the user requires downloading a file from the Internet server, the response time is the time, when the actual download starts. Nowadays the Internet servers are very powerful and quick, so the most limited factor is just the quality of the line, which the user connects the Internet with. Considering the work with graphic user's environment of the OS, the interactivity of the environment is necessary (the graphic environment must react quickly to the user's requirements), the response time is a key parameter for the user friendly work with the remote desktop. The suitable response time is therefore 10 to 20 ms, maximum 50 ms, for the problem-free work with the remote desktop. Higher response time will be shown as slower response time of the remote OS to the user's actions (clicking the mouse etc.). The user then thinks, that the remote OS is slow and cannot manage the requests quickly enough; this can be compared to the work on the older and less powerful computer. There are no more serious failures and cut offs, when there is higher response time, only the comfort of using it is lower.

If the user's (student's) connection to the Internet was low-quality, there would be failures of the connectivity (mainly at the Wi-Fi network in the highly interferenced areas), this problem appears as so called image pixelation (very usual at television broadcasting in DVB standart), or by the frozen image. In case of a complete cut-off of the Internet connection, at the first frozen image appears, and then will be the disconnection of the remote desktop. However, at the server there will stay the running programs. If the student logs in to the server soon after the disconnection, the sessions will be recovered and all the programs will stay in the former state. Within the saving of the server resources and licences of the terminal server, the users' (students') disconnected sessions will be automatically closed after some time. This setting has proved to be the compromise between the used licences and server's performance on one side and the user's comfort on the second.

The server itself is run as a virtual computer (Novák, 2012) within VMware virtualization environment of the Information Centre (IC) of the UPCE. IC keeps this virtualization environment running, so after the end of this project there will not be any additional operating costs to keeping it running. Virtualization of this server brings many other advantages, such as e.g. very easy back-up of the whole device, which is possible to be done during its running state. Also very easy transfer of the virtual device to any other physical server (when there is a breakdown) and another advantage is that – in our purpose the most interesting one – its easy change of the virtual device performance. The change of the performance can be set dynamically (i.e. the higher load of the virtual device is the more resources of physical device is assigned), or the change can be done manually, if the server cannot operate requirements of all logged in users in a reasonable time. Currently 2 processor cores AMD Opteron 8220 and 48 GB of RAM memory are assigned to the virtual server.

Performance and memory of the virtual device was consulted with experts to MATLAB from the firm Humusoft and with experienced terminal server administrators. The experiences gained, while testing this solution at the low powerful servers and desktop computers, were also taken into consideration.

There are synthetic laboratory tests, how to test the load of the server, so called stress tests. All these tests are documented in detail and can be repeated, but only in the more or less similar conditions to the real. Due to the fact, that the simulation of the real environment of teaching is very difficult and the data gained by the synthetic tests would not be very relevant, the testing in real environment was proceeded. Testing was done during the lessons, when to the selected number of students was given an example assignment, which was then solved at the tested server. The load of the server really corresponded to the real conditions, which this server was designed for.

The results of the stress test of the server with the licensed SW needed for the lessons at the server are mentioned in the Table 1.

Table1: Results of stress test of the designed virtual lab.

Processor	CPU Cores	RAM	No. of Users	Result
AMD Opteron 8220	1	16 GB	30	Unusable slow
AMD Opteron 8220	2	48 GB	70	Quick responses

There were several tests done with different number of users and different configurations of the server. For instance server with 16 GB memory RAM and one assigned core processor AMD Opteron 8220 was already insufficient when 30 users work simultaneously. The most demanding test was done with 70 simultaneously working users in MATLAB and with server configuration: 48 GB memory RAM and both cores processors AMD Opteron 8220. The server persisted in this test and the work in MATLAB was fluent enough.

Other possibilities of development

Due to the server's stress testing during the lessons, information about the existence of the server has spread among the other students very quickly. Currently there are many students, who already use this server to process the assignments. The server is accessible for students of both forms of studies (i.e. full-time and part-time) therefore also students of full-time studies can try the work in the program, which are used during the seminars. Many students like this form of using the licensed SW from everywhere, and it resulted in requirements for the other programs used at the lessons to be installed to the server. The most required is the program ArcGIS, the program used at graphic information systems. ArcGIS is already included in the list of the other SW, which are being planned to install to the server.

Within the other development of the project the other licensed programs are also planned to be installed. Basically, the overall SW used for teaching could be installed there. The only problem is the lack of licences. Already installed SW uses the licences, which were bought within this project and are not used during the lessons. These licences are accessible 24 hours a day. The other SW licences are very often needed for teaching in the lessons, so they could not be provided during this time. It will be necessary to realize the solution, when the licences for these SW will be accessible at the terminal server only at the time apart from the school lessons.

Naturally, the other testing would have to be done, if the other SW does not overload the terminal server and if there was a necessity to make the higher performance and amount of memory RAM or disk space. In case of overusing the server resources, it would be necessary to use the unpopular limitation - FUP (Fair Use Policy).

Conclusion

The aim of proposed solution of the virtual laboratory, to make licensed SW needed for the lessons to the students accessible, was gained. All the students of the FEA UPCE have now programs MATLAB R2011b and Statistics 10 accessible at the terminal server. Via logging in to the server the student will get the remote desktop. At this desktop there are icons of each program, which are installed to the server. Starting the required program from the server, the student will get full access to the programs needed for their studies.

During the testing there were no problems appears. The terminal server is in full operation now. The students have a description and a simple manual how to connect to the server and how to process the assignments, projects and the sources for their thesis.

SW needed for connecting the terminal server (virtual laboratory) is commonly accessible for OS Windows, Linux and Mac OS and it is free of charge. The students can also set access to their selected disk drives, where it is possible to store the data and assigned tasks at their computers.

The terminal server is accessible directly from the University's network (direct connection), or anywhere from the Internet (it is necessary to log in to the University's VPN and then log in to the server itself).

The speed, performance and capacity of the server is rated sufficiently to the current requirements to the number of users, installed SW and also for the chosen OS including running services in this OS. In case of the lack of performance of the server in the future, it can be made upgrade easily thanks to the chosen virtualization technology. Just due to it, the results of the project are permanently sustainable also with the other development.

Improvement of learning, knowledge and practical skills has been evident from results of examinations, too. It is true; it was very short time in this semester (approximately two months) when it was made given software accessible to students. For all that better results have been demonstrable and improvement has been from 15% to 20% per subject by tutors.

Response of part-time students has mainly been very positive. They have found main contribution in improvement of learning, saving of time and finance. They had to report to school and to verify theoretical knowledge at practical assignments in computer labs during previous semester. In regard to their workload, it was very complicated and time consuming. Anyway it was complicated for tutors because they had to be at workplace at the weekends, too.

In the following time period it is supposed this way of learning (to give access to other software, except MATLAB, IBM SPSS Statistics and IBM SPSS Modeler) to part-time students in other subjects, too.

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The Role of Internet in Education

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Abstract

The rapid changing of life requires a support for continuous learning and ongoing creation of new ideas and skills. The life-long education is becoming a necessity in tomorrow's world. Thanks to Internet, the education process changed significantly in last two decades. E-learning becomes important source of knowledge for lifelong learners, as well as full-time students. The paper presents different definitions of e-learning, which are changing by development of technologies through the years. Although learning resources are often considered as key intellectual property in a competitive higher education world, more and more institutions and individuals are sharing their digital learning resources over the Internet openly and for free, as Open Educational Resources (OER). The concept of using the educational resources has changed significantly in last decade. The development led from free content that one can individually teach himself, to social learning, where users have the possibility of mutual communication and exchange of opinions. Linking databases of resources, which will allow the user to use the information adapted to his previous knowledge, is expected in the near future. The paper touches also the quality of educational materials and the problem which appears because a lot of the materials are pedagogically inadequately prepared. There are also several good practices of OER, ideas and existing initiatives presented.

Keywords

E-learning. Open Educational Resources. Web 2.0. Semantic Web.

Introduction

The access to higher education is becoming a necessary element in expanding economic prosperity and improving the quality of life. The problem of the growing global demand then we need to address for education, as S. John Daniel foresaw in 1996. Compounding this challenge of demand from college-age students is the fact that the world is changing at an ever-faster pace. Few of young people today will have a fixed, single career; instead, they are likely to follow a trajectory that encompasses multiple careers. As they move from career to career, much of what they will need to know will not be what they learned in school decades earlier. We are entering a world in which we all will have to acquire new knowledge and skills on an almost continuous basis.

It is unlikely that sufficient resources will be available to build enough new campuses to meet the growing global demand for higher education—at least not the sort of campuses that we have traditionally built for colleges and universities. Nor is it likely that the current methods of teaching and learning will suffice to prepare students for the lives that they will lead in the twenty-first century (Brown & Adler, 2008).

Fortunately, the Internet and Information and Communication Technologies have greatly expanded into the field of education in last two decades. The global adoption of new technologies into education provides an opportunity for modernising of study, the introduction of modern teaching methods, distance learning as a form of e-learning, and ultimately better prepare students for life in the twenty-first century.

Definition of e-learning

With the popularization of Internet, the demand of e-learning has greatly increased. (Chang et.al, 2009, Wirt et.al, 2004) The term e-learning has different meanings in different contexts (Nicholson, 2007). There are many definitions of e-learning, which are changing by development of technologies through the years. Rosenberg (2001) defined e-learning as 'the use of internet technologies to deliver a broad array of solutions that enhance knowledge and performance'. Masie (2008) similarly defined e-learning as 'the use of network technology to design, deliver, select, administer, and extend learning'. For an instructional designer, e-learning often means courses or learning materials directed at meeting an objective within the larger scope of program development. A corporate trainer may view e-learning as a combination of courses and knowledge management. Siemens (2004) defined 7 categories of e-learning:

1. Courses: organisations typically take existing educational materials, add various media, sequence the material and consider it "transferred" to the online environment.
2. Informal learning: "At work we learn more in the break room than in the classroom. We discover how to do our jobs through informal learning - observing others, asking the person in the next cubicle, calling the help desk, trial-and-error, and simply working with people in the know. Formal learning - classes and workshops and online events - is the source of only 10% to 20% of what we learn at work." (Cross, 2003)
3. Blended learning: is a combination of classroom (face-to-face) and online learning.
4. Online communities: allow people to stay current in their field through dialogue with other members of the same organization, or the larger global field.
5. Knowledge management: involves the process of identifying, indexing, and making available (in various formats) knowledge generated within the daily activities of an organization.
6. Networked learning: Communities typically form around a particular goal, concept or theme.
7. Work-based learning: attempt to inject learning content into the actual point of need. This style of learning can be seen in many computer applications.

Arguably, the most visible impact of the Internet on education to date has been the Open Educational Resources (OER) movement. Although learning resources are often considered as key intellectual property in a competitive higher education world, more and more institutions and individuals are sharing their digital learning resources over the Internet openly and for free, as Open Educational Resources.With reference to the OER movement, the William and Flora Hewlett Foundation justifies their investment in OER as follows: "At the heart of the movement toward OER is the simple and powerful idea that the world's knowledge is a public good and that technology in general and the Worldwide Web in particular provide an extraordinary opportunity for everyone to share, use, and re-use knowledge." (Brown & Adler, 2008). OER are the parts of that knowledge that comprise the fundamental components of education – content and tools for teaching, learning and research – actually all 7 categories of e-learning, defined by Siemens (2004), with open access.

What does OER mean?

There are different interpretations of Open Educational Resources (OER). For example, on the webpage of their OER survey, the OECD's Centre for Educational Research and Innovation (CERI) states that this would comprise "Open courseware and content; Open software tools; Open material for e-learning capacity building of faculty staff; Repositories of learning objects; Free educational courses" (Hylén, 2007).

According to Gesser (2007), OER have the following core attributes:

- that access to open content (including metadata) is provided free of charge for educational institutions, content services, and the end-users such as teachers, students and lifelong learners;
- that the content is liberally licensed for re-use in educational activities, favourably free from restrictions to modify, combine and repurpose the content; consequently, that the content should ideally be designed for easy re-use in that open content standards and formats are being employed;
- that for educational systems/tools software is used for which the source code is available (i.e. Open Source software) and that there are open Application Programming Interfaces (open APIs) and authorisations to re-use Web-based services as well as resources (e.g. for educational content RSS feeds).

The evolution of internet development for the educational needs

The very openness of OER is changing the relationships between educators, learners and content (resources) and is becoming a primary agent of change.

Free materials on the Web

The OER movement practically began in 2001 at MIT. The first e-materials, different Internet applications and online courses provided open knowledge to anyone (in March 2006, about two thirds of MIT professors had their courses online) (Dinevski, 2009).

Traditional e-learning systems and the first OER supported "one-way" communication and more individual studying. Teachers provided knowledge for learners, but they were unable to use a student's learning experiences to benefit the class as a whole. The learning style of open knowledge students was then centred on individual learning; the focus was on *what* he is learning, not on *how* he is learning.

Social learning with Web 2.0

Compelling evidence for the importance of social interaction to learning comes from the landmark study by Light R.J., of the Harvard Graduate School of Education, of students' college/university experience. Light discovered that one of the strongest determinants of students' success in higher education – more important than the details of their instructors' teaching styles – was their ability to form or participate in small study groups. Students, who studied in groups, even only once a week, were more engaged in their studies, were better prepared for class, and learned significantly more than students who worked on their own (Light, 2001).

Wang & Chiu developed a theoretical model to assess user satisfaction and loyalty intentions to an e-learning system using communication quality, information quality, system quality, and service quality. The empirical results show that communication quality, information quality, and service quality significantly and positively affect user satisfaction and loyalty intentions to use the e-learning system for sharing experience, communicating with others, and getting feedback. (Wang & Chiu 2011).

The findings that social learning and good communication are needed to improve learning outcomes led to the development of Web 2.0, allowing users the possibility of mutual communication and exchange of opinions.

Web 2.0 brings new opportunities for e-learning by associating with web applications that facilitate participatory information sharing, interoperability and user-centred design, and collaboration on the World Wide Web. A Web 2.0 site allows users to interact and collaborate with each other in a social media dialogue as creators of user-generated content in a virtual community. Examples of Web 2.0 include social networking sites, blogs, wikis, video sharing sites, hosted services, web applications...

It is argued that this represents a shift from a teacher-centric, systematic model of change in teaching practices as embodied in earlier ideas about LO to a learner-centric, systemic model of change as embodied in OER (Lane & McAndrew, 2010).

The vision of e-learning: Semantic Web or Web 3.0 will connect people and information

The Web is the world – everything and everyone in the world casts an "information shadow," an aura of data which, when captured and processed intelligently, offers extraordinary opportunity and mind bending implications (O'Reilly & Battelle, 2009).

The Semantic Web is regarded as an integrator across different content, information applications and systems. The future of e-education using Semantic Web is going to be like having a personal assistant who knows practically everything about the user and can access all the information on the Internet to answer any question. We can compare Web 3.0 to a giant database. While Web 2.0 uses the Internet to make connections between people, Web 3.0 will use the Internet to make connections with information. Linking databases of resources will allow the user to use the information, adapted to his previous knowledge. The Web opportunity is no longer growing arithmetically; it's growing exponentially. OER resources will gain essentially on the value of semantic-web, because it will be easier to use information in the correct context.

Quality of educational resources

Open content obviously has many authors, including professional authors, teachers and also learners is therefore subject to a constant improvement process. Open content quality control is in the hands of learners and teachers (and is conducted simultaneously with the learning process) instead of instructional experts.

Just a great volume of open content is not sufficient. It should support different teaching activities, different selection criteria, and be easily findable and adaptable. Although examples of successful OER utilisation are not isolated phenomena, there is a low level of awareness about existing OER. (Dichev & Dicheva, 2012).

Cazan and Indreica (2011) report that students are not satisfied with teaching and learning by distance. Their preference for distance learning is largely because of the flexibility of use of time and location and work commitment. We see the reason for this unsatisfaction in lack of communication and peer cooperation, which is typical for traditional e-learning systems.

It is obvious that the pedagogical model is not a key point in the OER as such. The discussion of OER has often been dominated by technical and management considerations rather than the perspectives of educational practitioners. To achieve the ambitious goals of the presented lifelong learning philosophy, didactics and pedagogy must be deeply involved into the practical solutions (Dinevski & Brodnik, 2005). This subject requires a wide and integral approach that exceeds the scope of this paper.

Lund University took part in three international benchmarking projects, related to the quality in e-learning. It shows that various aspects of accessibility, flexibility, interactiveness, personalization, and productivity should be embedded in all levels of management and services within the field of e-learning in higher education (Ossiannilsson & Landgren, 2012). Therefore, successful e-learning requires change from an organizational as well as a pedagogical perspective. Attracting experts with appropriate permanent financing of OER, the highest professional and educational quality would be guaranteed.

OER good practices

The OER movement started in 2001 when the Massachusetts Institute of Technology (MIT) announced Open Courseware, as free and open publication of the course materials for nearly all of MIT's courses. MIT Open Courseware has served as an important catalyst in the OER movement, and has provided the model for over 150 universities and educational organisations to openly publish over 13,000 courses and associated course materials. The majority of these courses follow the original model of collecting course materials and then publishing them openly. Course materials are arranged as they would be in a typical course, according to a syllabus with readings and lectures, and in some cases having associated video lectures and interactive exercises. (Muramatsu, 2011)

After 2001, the OER movement has an important tendency in universities all over the world (Johansen & Wiley, 2011, Klebl et.al., 2010, Wang, 2011).

While it is a fact that millions of documents can be found on the Internet using search engines like Google, there is no guarantee that a query will lead to trustable material on which high quality education can be built. Well managed learning object repositories that aggregate high quality content offer a solution to this problem. GLOBE (Global Learning Objects Brokering Exchange) is a one-stop-shop for learning resource broker organisations, each of them managing and/or federating one or more learning object repositories. GLOBE makes a suite of online services and tools available to its members for the exchange of learning resources, and is set up as a worldwide Open Community. The GLOBE initiative started in 2008, with a collaboration of 5 organisations. In the last 4 years, the number of collaborative organisations increased up to 13.

The number of non-course OER available increases rapidly as well. Rice's Connexions project currently hosts over 2.800 open learning objects available for mixing and matching into study units or full courses.

MERLOT offers almost 15.000 resources, European based ARIADNE offers links and federated searches in several networks and repositories. Textbook Revolution contains links to hundreds of freely available, copyright-clean textbooks. Freely accessible encyclopaedias like Wikipedia and Math World grow in size and quality. UNESCO/IIEP hosts a Wiki called "OER useful resources" listing several other portals, gateways and repositories. (Hylén, 2007).

Conclusion

The appearance of the Internet has changed the education significantly. Properly used information from the Internet, represent added value to the education.

Limiting the government's financial and human resources, consequently, has greatly increased the need to introduce new educational methods. E-learning has been in use for over a decade. During this time, both the advantages and disadvantages of using the Internet for learning have clearly demonstrated. In recent years, OER development has contributed to a higher quality and efficiency of e-learning.

The concept of using the educational resources has changed significantly. The development led from free content that one can individually teach himself, to social learning, where users have the possibility of mutual communication and exchange of opinions. Linking databases of resources, which will allow the user to use the information adapted to his previous knowledge, is expected in the near future. More about e-learning, its future and good practices will be presented in the book "E-learning Good Practices", which will be published both online and in printed edition in 2012.

There are many good practices scattered on the web, 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.

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Flexible E-learning: Online Courses Tailored to Student´s Needs

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Abstract

The paper deals with process of implementing the learning style theory in the field of e-learning. Since 2010 the three-year project "A flexible model of the ICT supported educational process reflecting individual learning styles" has been running at the Faculty of Informatics and Management, University of Hradec Kralove, Czech Republic. The main objective is to verify whether accommodating the individual learning style within the ICT-supported process of instruction results in increasing the level of student´s knowledge. The core part of the project is the analysis of various types of study materials which students of different learning styles consider to be suitable for their process of learning. The results are implemented in the learning strategy of the online course within which the flexible model is verified. For this purpose a software application was designed which generates the appropriate type of study materials and related learning activities. Thus the process of instruction is tailored to the discovered student´s needs.

Keywords

Learning styles. Learning combination inventory. E-learning. Tertiary education.

Introduction

The Czech educational system has undergone changes relating to the social development. New competences have been defined and reflected in the learning content, adequate teaching methods, organizational forms, ways of evaluation and new relations between elements participating in the educational process have been applied, curricula changed, the learner´s responsibility for his/her own education, creativeness and motivation supported, and economic aspects penetrated the whole system. These features have been slowly but steadily included into the new educational system. The information and communication technologies (ICT) have become standard and current approach to instruction is hardly to be imagined without computers.

It is generally agreed that people vary in the view upon the same problem; they do not do things and see the world in the same way as the others do. They differ in the way of perceiving a situation, evaluating it, judging consequences, making decisions. In spite of these differences, each person is clever and may be right in his/her own manner. Students should be aware of their learning styles, they should know what their strengths and weaknesses are, and should be provided with a variety of instructional methods and approaches to choose the most suitable ones (Šimonová et al, 2010a).

Learning styles in e-learning

Despite numerous authors dealt with the theory of learning styles and various solutions have been introduced, e.g. Felder, 1998, Coffield, 2007, Gregorc, 1979, Honey, 2011, Mitchell, 1994. Johnston presents another approach to this problem. Her concept "Unlocking the will to learn" (Johnston, 2006) arises from the hypothesis the traditional learning process is based on belief that all learning occurs as part of learner´s intelligence. The greater the intelligence, the more a child can learn. Johnston attracts attention to the verb *can*, as no one says *will* learn. When describing the whole process of learning, she uses the metaphor of a *combination lock* saying that cognition (processing), conation (performing) and affectation (developing) work as interlocking tumblers; when aligned they unlock an individual´s understanding of his/her learning combination. She designed an inventory for detecting individual learning styles, Learning Combination Inventory (LCI). It differs from other widely used inventories (designed by Kolb, Honey and Mumford etc.). It emphasizes not the product of learning, but the *process* of learning; it focuses on *how* to unlock and *what* unlocks the learner's motivation and ability to learn. The responses form the schema (pattern) that drives learner´s will to learn, and respondents are categorized into four groups as follows (Johnston, 2006):

- Sequential Processors (S), defined as the seekers of clear directions, practiced planners, thoroughly neat workers.
- Precise Processors (P), identified as the information specialists, info-details researches, answer specialists and report writers. It hides the original content of the Course Content page.
- Technical Processors (T), specified as the hands-on builders, independent private thinkers and reality seekers.
- Confluent Processors (C), described as those who march to a different drummer, creative imaginers and unique presenters.

Project description and method

The question is whether tailoring the process of instruction running within the LMS to student´s individual learning style results in significant increase of knowledge. To discover this is the main objective of the three-year research project currently running at the University of Hradec Kralove "A flexible model of the ICT supported educational process reflecting individual learning styles."

The process of problem-solving is structured into several phases:

First, to detect the student´s learning style by the Johnston´s LCI questionnaire. According to the scoring sheet, responses are matched to question in a special structure which finally provides total amount of points relating to each processor. The scale, extended from 7 to 35 points, is structured into three parts:

- I avoid this scheme (from 7 to 17 points).
- I use this as needed (from 18 to 25 points).
- I use this scheme first (from 26 to 35 points).

These characteristics are later applied in the process of tailoring the online course to individual student´s needs. The sample group consists of approximately 500 students of the University of Hradec Kralove enrolled in their first year in the 2011/12 academic year.

Second, to design an e-application (plug-in) supporting the flexible model of instruction within the LMS WebCT in order to match appropriate types of study materials and activities to individual student´s learning style pattern. To reach this objective, not only data on each student´s learning style are required but also single items of the Course Content and relating activities are classified according to the suitability to a certain style of learning, i.e. whether the material is appreciated (value 1), accepted (value 0) or rejected (value -1) by the student. The data are matched to the pattern and the course is tailored to the individual student´s preferences. The list of items is not completed; other type of materials and activities may appear resulting from the topic and/or special pattern of the learner. Above all, it is necessary to have in mind that the individual learning style is a *pattern combining four approaches* in some extent (Sequential-S, Precise-P, Technical-T, Confluent-C).

Third, to create the on-line e-course for the pedagogical experiment reflecting / ignoring learning styles in the LMS WebCT. The content focuses on library services, which is a topic students have to master before they start studying but they often have hardly any system of knowledge and skills in this field. The e-course "Library services – information competence and education" is structured into eight parts covering the crucial content, i.e. Basic terminology, Library services, Bibliographic quotations, Electronic sources, Bibliographic search services, Writing professional texts, Bachelor and diploma theses and Publishing ethics.

Fourth, to run the pedagogical experiment, collected data and statistically process and interpret them, and provide recommendations towards improving the whole process of instruction.

Before the first phase the project started, the *pre-research* was done which aimed at detecting whether student´s choice of a certain type of study materials and tools is influenced by the detected pattern. For this purpose a questionnaire consisting of nine questions was prepared where students defined their relation to following types of study materials: books and professional literature; electronic study texts; presentations; video-recorded lectures; animations; self-tests; hands-on tasks and examples other supportive materials, e.g. dictionary. Students were asked to define what type of study materials they prefer when preparing for lessons during the term and studying for exams. Single items were in the form of statements and evaluated by a five-degree scale (never- hardly any time-sometimes-almost always-always). The questionnaire was distributed to 107 students of the Faculty of Informatics and Management, University of Hradec Králové, in study programmes Applied Informatics and Information Management. Consequently mutual relations were researched among single patterns and preferred types of study materials. The received results prove that today´s students seldom work with printed sources. Only 1% of students almost always buy the recommended books, one third (33 %) does this sometimes and two thirds (66 %) do not buy books at all. This fact could be influenced by the price. Nevertheless, similar results appeared in question dealing with borrowing printed sources which are available in university library. Only 7% of students borrow books regularly, half of them (48 %) sometimes and 45 % never or hardly any time borrow the recommended books (Figure 1).

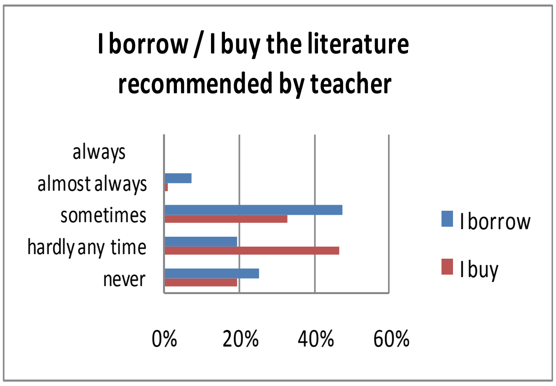

Figure 1: The use of printed textbooks.

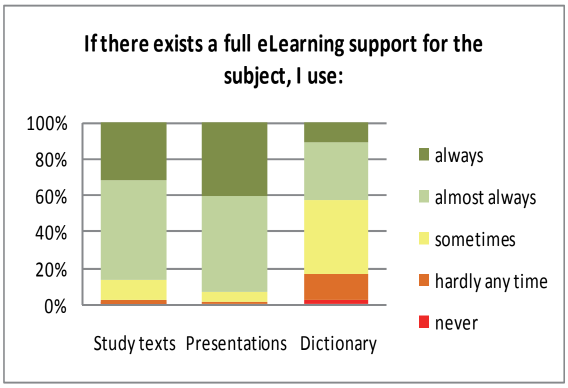

Figure 2: The use of electronic study texts, presentations and other supportive materials.

As following responses show, today´s students mostly prefer electronic study materials. In electronic courses various types of study materials are available, mostly in HTML format, PowerPoint presentations summarizing basic structure of the course, topic or subject, and some supportive tools, e.g. e-dictionary. Vast majority of students (87 %) always and almost always works with electronic study texts, 10 % use them sometimes. Nearly all students (93 %) always and almost always use presentations of the topics. Other types of study materials (e.g. dictionary) are used in a considerably little extent. 42 % of students always and almost always use them and another 41 % sometimes (Figure 2).

In some eLearning courses animations, video-recorded lectures or case studies are available which make some difficult parts of learning content easier to understand.

The research proves these materials are used less than presentations or study texts. Animations are more frequently used; more than half of students always and almost always uses them (53 %) if they are available. Video-recordings, which are more demanding to be prepared and can be found only in selected eLearning courses, are less popular among students. More than one third of students (38 %) never and hardly any time uses them, one third (33 %) sometimes and even fewer students (29 %) always and almost always work with them if they are available (Figure 3).

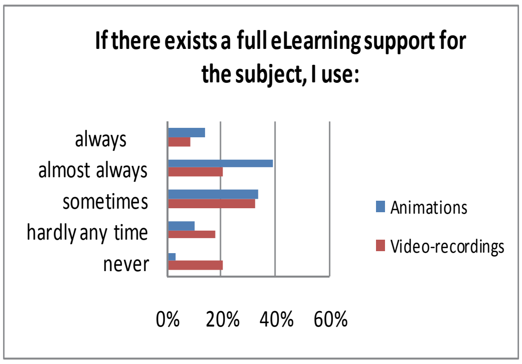

Figure 3: The use of animations and video-recorded lectures.

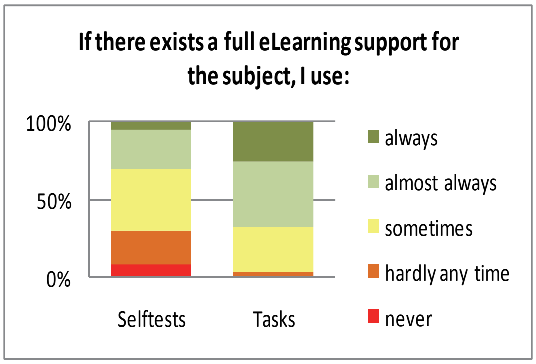

Figure 4: The use of self- tests and hands-on tasks.

Authors of eLearning courses include various feedback-providing tools, such as self-tests and numerous hands-on examples or tasks. Although these are to help students understand the problem, they are used less frequently than study texts and presentations. More than two thirds of students

(68 %) always and almost always use the provided examples. Self-tests are even less used. More than one fourth never and hardly any time uses them, 39 % sometimes and only fewer than one third (31 %) always and almost always work with them (Figure 4).

Research results

Totally 94 students of the Faculty of Informatics and Management participated in the entire research. As mentioned above, the student´s individual learning style was detected by the Learning Combibation Inventory (LCI) within the *first phase*. Data were processed for a single student. An example is presented in Figure 5.

	sequential	precise	technical	confluent
Student A	27	16	22	17
Student B	23	17	29	31
Student C	30	19	26	25
Student D	20	17	21	18
Student E	23	24	26	18
Student F	24	27	25	23

Figure 5: Example of LCI results

The value higher than 24 means student prefers the given pattern in his/her process of learning; the value between 18 -24 means this pattern is tolerated, accepted without problems; and the value lower than 18 means student rejects the given pattern.

Consequently, using the NCSS2007 statistic software, relations between single patterns and types of study materials were detected. The recommended value of the correlation is 0.15 min. Results are presented in Table 2.

Table 2: Correlations between types of study materials and patterns

	Sequential	Precise	Technical	Confluent
Books	0.11	0.27	0.05	0.11
Borrow books	-0.01	0.34	0.12	0.22
Electronic study text	0.12	0.11	-0.18	-0.17
Presentation	0.01	0.01	0.11	-0.10
Video	0.09	-0.03	0.20	-0.16
Animation	0.01	0.24	0.23	-0.02
Selftest	-0.04	0.11	0.12	-0.14
Examples	-0.11	0.00	-0.12	0.09
Dictionary	0.05	0.12	0.02	-0.04

According to the results, students preferring the *Sequential* Processor mostly use electronic study texts, books and professional literature, video-recorded lectures and presentations; they reject self-tests and other supportive materials, e.g. dictionaries.

Students preferring the *Precise* Processor work with books and professional literature, animations, examples, electronic study texts and other supportive materials, e.g. dictionary; they do not like video-recorded lectures.

Students preferring the *Technical* Processor often use animations and video-recorded lectures; they do not work with electronic study texts, other supportive materials, e.g. dictionaries and presentations.

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Students preferring the *Confluent* Processor prefer books and professional literature and self-tests; they do not use electronic study texts, video-recorded lectures, presentations and other supportive materials, e.g. dictionaries.

The Internet applications providing the electronic support of the process of instruction and organizing the materials according the types within the online course in LMS WebCT was designed within the *second phase* of the problem solving. The LMS provides numerous tools and the course is expected to suit most students despite it reflects the designer´s and tutor´s teaching style. But modern approaches enable to create interactive applications which react to user´s instructions. That is why the research team decided to apply a similar approach to individualization of eLearning courses.

The main idea is based on adding an application to running courses, which will arrange various types of study materials in order according to student´s individual preference. Before students start the work in a course, they will take the LCI. The received results are in the simple form, they are four figures meaning the sequential, precise, technical, confluent pattern, where -1 means reject, 0 means tolerated, 1 means preferred pattern. The application puts the study materials on the entry page in such order which reflects the individual learning style. The most appropriate materials are located on the top left position, the rejected materials on the lower place. Above all, the preferred types will by emphasized in colour and size of the pictograms. This approach requires form authors of study materials to evaluate each of them according to the same criteria as students were evaluated, i.e. the author matches each material to the type of learning style (pattern) it suits best using the figures -1, 0 and 1. Currently, a team of Ph.D. students is creating the application within the project of specific research “Application supporting the flexible model of the educational process”. The application will be used in the LMS WebCT. After piloting, it can be adjusted to using in other learning management systems.

The main objective of the e-application is to re-organize the introductory page of the e-course where the Course Content is presented to students. The criterion under which the e-application works is the student´s individual learning style. Single items of the Course Content, i.e. Study Materials, exercises, assignments, assessments, communication and other activities applied within the process of instruction, are presented in such order which accommodates student´s preferences. The LCI displays the final “pattern” which presents the combination of four approaches to processing information, i.e. it defines the Sequential, Precise, Technical and Confluent Processors. All items and tools of the course are accessible to each student but the plug-in arranges single items on the introductory page in such order which reflects the student´s individual learning style.

The whole plug-in is implemented in the JavaScript language and inserted in the e-course directly in the source form to the Heading of the introductory page. The plug-in is activated in the student´s browser at each access to the Course Content page, and it accomplishes following sequence of activities (Šabatová et al., 2010):

It hides the Expand button of the Course Content in Student view of the e-course so that the student is not able to access the Course Content tree; the entire tree is not adjusted to the student´s individual learning style and contains the numeric classification of various types of study materials and other activities and tools.

- It hides the original content of the Course Content page.
- Applying the AJAX inquiry it detects the student´s ID.
- Applying the AJAX inquiry it uploads data containing classification of single study materials according to their suitability to each learning style and the evaluation (i.e. pattern) of the logged-in student according to his/her user name.

- Applying the AJAX inquiry it uploads the tree of links to single types of study materials.
- Having evaluated each type of study materials, activities and tools to a single learning style, and detected the individual student´s learning style, it considers and counts the adequacy (appropriateness) of the item to the learning style within the topic.
- Finally, it re-organizes the Course Content page according to the provided data and displays a newly arranged page instead of the original one.
- If the process fails of any reason, the original Course Content page is displayed with caution an error appeared. In such a case the Error report is created in the browser, which is commonly hidden to the user.

The source code must be included in the Headings of the introductory page of the e-course (Designer view – Course Content – Edit Heading – HTML Creator: Plug-off, tick Use HTML, Insert the Plug-in code, Save). Single topics of the Course Content must be structured into folders - one folder for each topic containing links to single learning objects (i.e. various types of study materials). Each learning object in the folder is classified by four figures of the value of -1, 0, 1 which correspond to four types of processors (Sequential, Precise, Technical and Confluent) as follows:

- *minus one (-1)* means this type of study material, activity, assignment, communication etc. is rejected, i.e. does not match the given learning style;
- *zero (0)* is the middle value, i.e. the student neither appreciates, nor rejects, but accepts this type;
- *one (1)* means this type is appreciated and matches the given learning style.

The figures are presented at the beginning of the link to the object in the field of "User name of the link", e.g. in the form "(0, 1, -1, -1) Basic terminology".

The data should be taken from a spreadsheet, e.g. in MS Office Excel, in the CSV format, separated by semicolon. For the purpose of the Student view of the e-course the user name of each student is required to be included in the "studenti.csv" file. It is available within "My Grades" in Student view, presented in brackets on the first line, e.g. Demo Student 69259477001 (webct_demo_ 69259477001).

For running the plug-in appropriately each student is required to have the Internet access for the purpose of uploading the jQuery from the ajax.googleapis.com server.

The plug-in has been designed for the WebCT, version CE 6.0.3 (12.0.11.15), and considering the strong dependence on the concrete HTML page structure it is highly presumable the potential adaptation to another version will require additional modifications.

Due to the impossibility to adapt the WebCT source codes and absence of suitable API, it is necessary to implement the plug-in on the client side using JavaScript which modifies the content of the displayed page and uploads other necessary sources from the WebCT server using AJAX requirements. The data are received by parsing of the uploaded HTML pages. The implementation uses the jQuery of 1.4.2 version mainly for the manipulation with the page content (of the DOM model) and defining the AJAX requirements to receive additional data from the server.

Several limits of this solution have been discovered, e.g. the WebCT shortens file names in the Course Content tree, which the plug-in uses to receive links to learning objects, up to approx. 11 characters plus the length of the classification chain including brackets. That is why the file names in the newly generated Course Content page are shortened and filled with three dots. The problem can be solved by re-naming the links using the appropriate length (i.e. number of characters) or making a relatively complicated change in the plug-in code, which will result in the increase in higher frequency of inquiries on the server (the total number will correspond to the number of topics in the e-course).

An online e-course for the pedagogical experiment reflecting / non-reflecting learning styles was designed in the LMS WebCT within the *third phase* of project solving. The content focuses on library services, which is a topic students have to master before they start studying but they often have hardly any system of knowledge and skills in this field (Poulová et al., 2010).

The e-course "Library services – information competence and education" is structured into eight parts covering the crucial content, i.e. Basic terminology, Library services, Bibliographic quotations, Electronic sources, Bibliographic search services, Writing professional texts, Bachelor and diploma theses and Publishing ethics (Figure 6).

The study materials, exercises, assignments and all activities included in the course are provided to students in a wide scale of types so that each student can choose the appropriate ones which suit him/her best according to the individual style. Students´ process of study in the course is monitored, and the tracking and study results will prove to what extent the individual learning style is reflected.

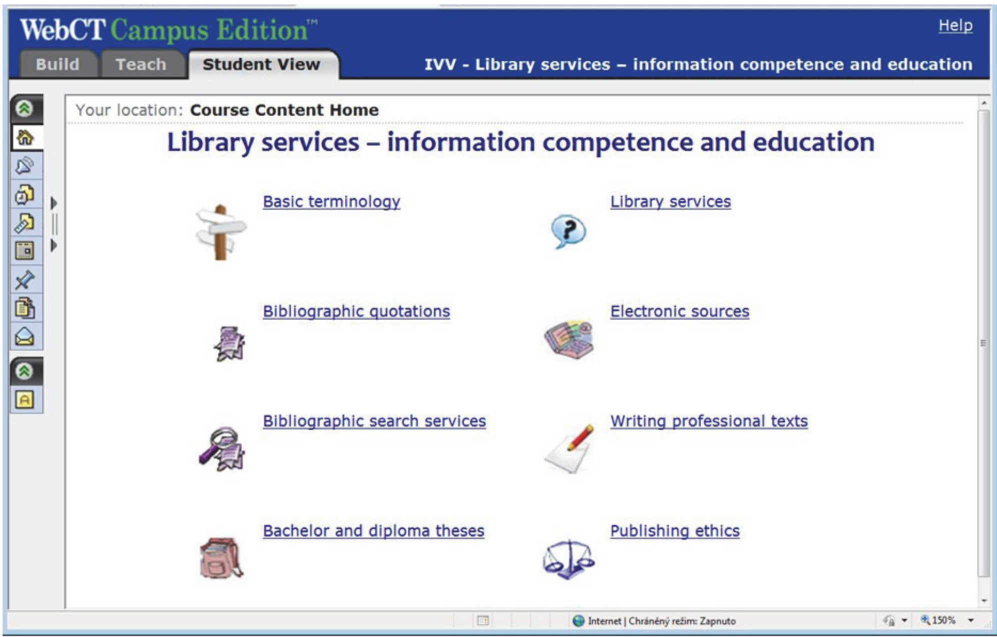

Figure 6: Library Services course home page

Finally, the pedagogical runs within the *fourth phase*. It is designed on the "pre-test – instruction – post-test structure. More than 600 respondents participated in the pre-test. Three approaches are applied to provide the process of instruction, following (1) the teacher´s style, (2) learner´s style where the content is tailored to the individual needs, i.e. generated by the plug-in, (3) providing all types of study materials to the learner and monitoring his/her choice which is then compared to expected preferences defined by the LCI. This phase is currently running – i.e. the pedagogical experiment was closed and the collected data are being processed. The results will prove, or not whether the individual approach in e-learning is able to contribute to the ICT-supported process of forming knowledge of university students.

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Conclusions

Current orientation of university education, which is changing under the influence of latest technology development and requirements of new key competences, can be researched from various, different points of view. The ICT supported education has been spreading because of growing popularity of digital technologies in general. Another reason is it enables easier and more complex realization of the process of instruction, offers the choice of place, time and pace for studying, allows an individual approach to students preferring a certain learning style. These are the key values important for the efficiency of the process. Material and technical requirements having been satisfied, strong attention must be paid to didactic aspects of instruction. To contribute to this process is the main objective of this research project.

From the results presented above it can be seen there is no definite solution. It is important for a student to be aware of his/her learning style, know what his/her strengths and weaknesses are and be provided a variety of instructional methods to choose the most suitable ones. In the days of fast technical and technological development, globalization, demand for further, lifelong education, the importance of education is increasing. These terms support the development of the whole system of education, which is often put into effect in a distance way being supported by ICT. Teachers' and students´ awareness of styles may help substantially in this process.

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Methods of Business Rules Harvesting in University Environment

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Abstract

Every university works according to principles which define business logic that controls all its processes and documents flow. However, lot of basic rules of business logic are hidden in companies' guidelines and directives, in informal techniques of teachers or office workers, person accountable for processes or other specialists. The aim of all university managers should be a replacement of this incoherent set of information by set of clear and unambiguous terms which describe the way the company is controlled from inside. This notion is a ground of control and administration of all university knowledge.

The rules of university logic are often transferred to application logic and implemented into a source code. Therefore, change of the business rule needs change of the code. This means compilation or replacement of the code. Adoption of new approach based on business rules would mean more effective possibilities in adjustment of the information systems to environment dynamics thanks to the change of the rules.

The article deals with methods of harvesting and subsequent structures of business rules for easier implementation them into information systems and for their management. The basis of business rules is at the same time the basis of business knowledge which can serve for varies purposes in all type of companies. The article deals also with relation business rules and business applications and especially it describes a method of harvesting and mining of rules from head of workers in university. The article emphasizes structure of formats of business rule and its reference to business applications implementation.

Keywords

Business modelling. Business process. Business architecture modelling. Business rule. Business rule repository. Information system. Information technology. UML business logic. Application logic. Information systems architecture.

Introduction

Universities can successfully manage their development and changes in relations with formalized support of business rules and processes and they can quickly adapt the internal processes, so that they can fulfil the changing needs. Suggested principle of management of business knowledge is in accord with information systems architecture oriented to services which offer simple adding of functions, users, support of new business models and classifying of solutions in a way that they can support all companies from small to large universities. It also unifies the standards and helps to ensure quality with help of centralized description of processes, rules and approaches and by sharing the recommended methods and expanding the administration of company concepts within the company units.

Suggested methodical approach to gaining, formalizing and administrating business rules will simplify respecting the business rules. Universities facing the countless regulation demands, which differentiate from country to country, can help to lower risks and responsibilities connected with managing the other universities, the public administration, department and several firms, to respect the directives and commands and initiatives of students and customers by consolidation and administration of processes and rules.

Materials and methods

According to (Marek, 2008), rules are one of the key documented business knowledge – it describes what the company knows about its desired behaviour and logic of decision-making. The concept of business rule defines all principles, techniques, restrictions and commands, which exist in the company and according to which the company works and is controlled. If we talk about a rule, we mean the business knowledge – knowhow of everyday processes in the company. Of course these rules are applied in information systems, data structures, algorithms and in user interface of the individual modules supporting real processes. However, many of the rules are not part of the software applications. In spite of this they must be expressed, kept, archived and controlled. The main advantage of this automated rule is that it cannot be broken. Therefore, there is no need to control it and develop special procedures which would find out such violation and would carry out relevant redress. Automated rule is accomplished when all the necessary data is available. Thanks to this there are no constrictions when the process is waiting for a specialist or authorized person to decide. Non-automated rule is verified in a different way; however it must be saved and formulated as well.

So far, there is no (or we do not know about any) mature and proved or widely tested and respected tool for controlling rules. We can name OCL language (Eriksson, Penker, 2000) which is used for expressing restrictions in object oriented models. It forms superstructure of UML language and enables to create in a better way some aspects of diagrams and UML elements by their specification. So far, the application of this language in information systems has not been sufficiently adopted, which is quite a pity. The problem might be quite a complicated syntax which is incomprehensible to company managers, owners and many of the users (Rábová, 2008).

In the proposed methodology, we have set up a term “business dictionary” which is not commonly used by the companies - universities. However, shared and correctly structured business dictionary is not used only for software implementation but also for explanation of the meaning of everything what is going on in the company. Under the terms of complex business architecture we save here all information which according to the definition is in accordance with the concept of business rule. We should stress that such dictionary contains mainly semantics of company employees and should support process models supplemented with business rules (Rábová, Hodinka, 2011).

Nowadays, in many universities there are employees from different divisions who have problems with communication, because they live in different semantic worlds. Therefore, well-controlled and correctly structured business dictionary could be the main thing in everyday company activities and is absolutely indispensable for process and rule control tool. We also think that it should be accessible and sufficiently interactive and supported by controls and correction possibilities (similarly as the spelling check in text editors).

Developing and controlling such a dictionary means including business knowledge from university teachers, employees and managers who perfectly command their job in the first place and gaining knowledge from established practice from some outer source or similar community in the second. Accomplishments, connected with the core of such business knowledge, are the basis for the business analysts.

In the next stage of our research, we are preparing automated support of the business dictionary, which is as important for effective company communication as is the integration of big sets of business rules and business processes. However, the main element is creating the database of rules with structure containing not only unambiguous identifier and description of the rule, but also its type, relation to the process, relation to the information system, responsible person and possibly connection to another rule. Before we can fill this rule database, we have to mine these rules from heads of experts, responsible officials, manager-seniors and from university documentations.

Methodological technique for gaining and structuring business knowledge is a very useful tool. The main idea of the presented material is its first processing, proposal of the process model, which consists of activities suitable for gaining rules for the purpose of their management and control. Model is made in the standard UML notation, we used activity diagram, object oriented developing diagram based on Petri Net Semantics (Arlow, Neustadt, 2007). Model is supplemented with text explaining the individual thoughts and techniques.

In (Rábová, 2010) the concentrating is focused on the format of business rules. Firstly, rules are separated into groups (Ross, 2006) according to whether they are rules expressing the main company terms and facts or rules expressing value calculation or rules containing condition or rules containing value calculation. Then, for each type of rules there are designed patterns for its formalization. These structures are formats which can be applied on nearly all rules in the company. Their main value lies in the fact that there can be gradually used in algorithm and they can be saved in the information system source code. The set of rules can then be put into database, furnished with attributes and controlled and managed outside the information system as it was said in (Rábová, 2008b).

Activity model diagram in the Figure 2 has classification in one of its parts and is therefore natural broadening of existing considerations of structuring and managing rules and it works on the previous publications (Rábová, 2006).

Business rules provide clear, authoritative insight into the essential concepts, techniques and tutorials. Analytics must go through the documentation about technology, methodology and standards and learn about the key areas of practical importance in university departments and get to know what’s happening in different situations. They must come prepared with the questions. Business rules should come from the head of computer experts, business people, office workers and also from the head of teachers. However, we cannot simply ask these people to come together and then multiply rules. We have to create and keep a comprehensive approach for gathering business rules from business experts using facilitated sessions. Discovering useful business rules is a form of “data mining”, which has proven capable of enormous returns in many fields and industries.

Results and discussion

Process model of business rule harvesting

The process model is presented here at two levels of abstraction. At the highest level, which is presented in the Figure 1, is shown one process of mining information. Its input are general, unstructured information and pieces of knowledge, results from workshops and discussions of company analyst with key employees, process owners or people responsible for it (rudiments of the future rules in the database). The output of this is then a business dictionary (homogenous set of rules with its attributes prescribed according to a suggested structure). The inseparable parts of this model are responsible roles of actors. These are company analyst and process owner, who take part in the model process, and the aim of the process, which is to create complex system of business rules. (Rábová, Hodinka, 2011)

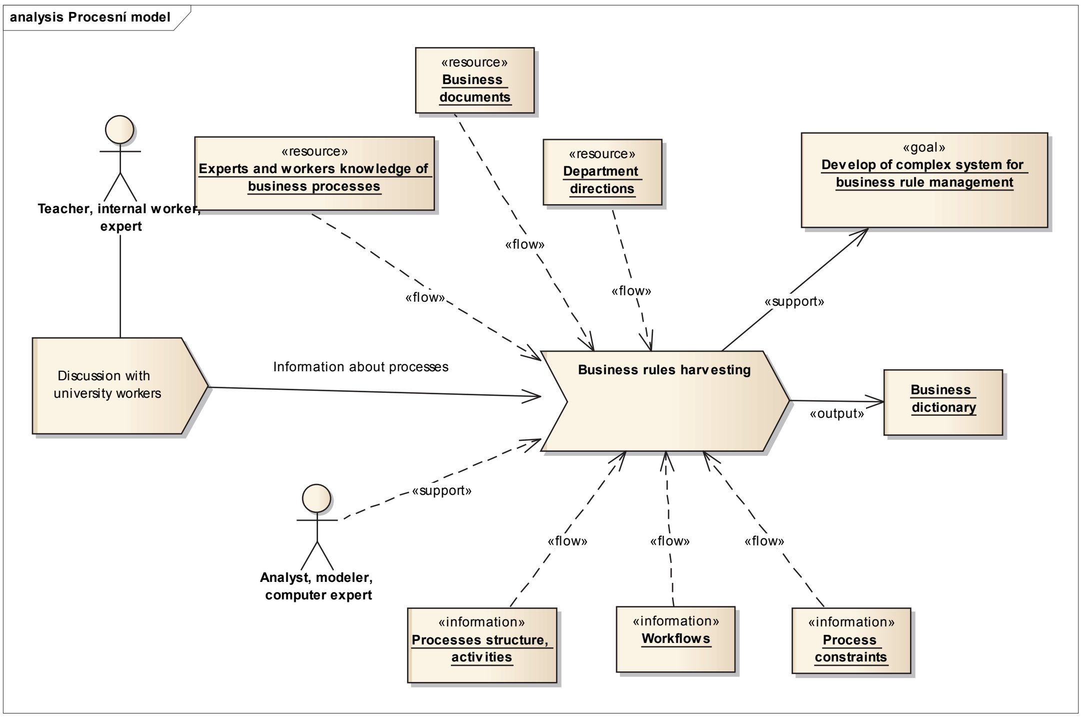

Figure 1: Process model at highest level of abstraction

Methodics of business rules harvesting

In the next Figure 2, this process is modelled with the help of activity diagram with lower level of abstraction. This diagram specifies in detail the sequence of activities which fill up the business dictionary with rules, knowledge, directives and regulations in structured form. After the start, analysis of basic information and business knowledge is carried out. This knowledge is saved in processes, control regulators and another company documents.

Modelling of business processes is part of this analysis. In the first version of methodology we deal neither with standards nor with techniques connected with process modelling. In (Rábová, 2008a) is presented a model of business architecture which is used as a model for gaining rules but neither control regulators nor company documents are regarded here. This model will be part of the methodology and will be applied in its final and complex version. Informally expressed rules will be made over to more formal form and analyst will compile their structure for saving, this means fact model.

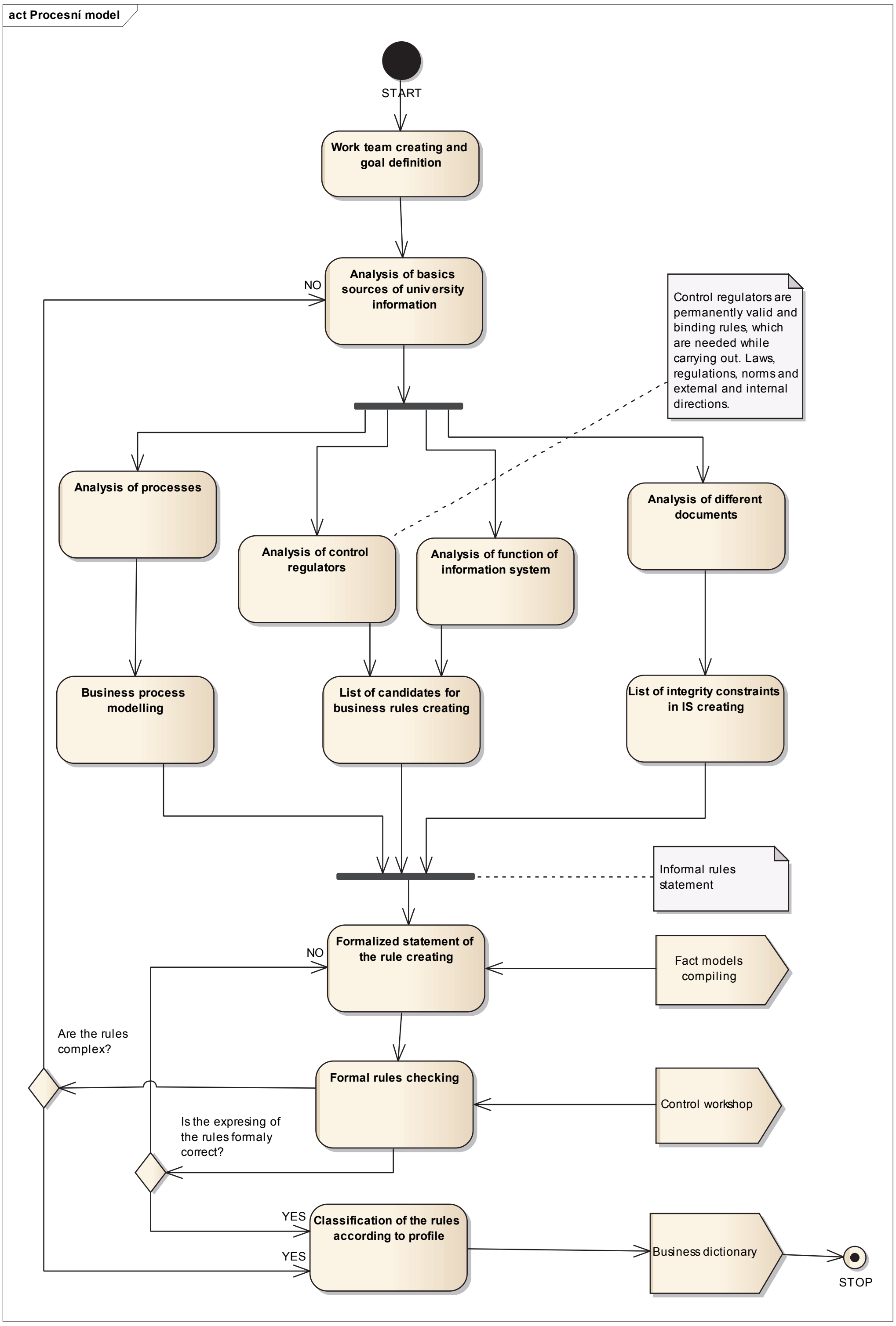

Figure 2: Process model at a lower level of abstraction

At workshop with the workers of processes, like users, teachers, administrative, not only the formal side of rephrased rules is discussed but also their semantic correctness and complexity. Only then is created the rules databases which can be, but does not have to be, automatically

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administered by software support. This new side in our methodology will be called business dictionary.

Methodology is gradually developed. In this report, we present sequence of recommended activities which are presented in well arranged model of single activities.

Let's replenish several methodological recommendations for systematization of rules which are not used in the process model in the Figure 2.

- Rule should be expressed complexly but as briefly as possible. Prescribed database structure is not part of this report.
- It is convenient to link the rule with some business aim, process or source.
- The rule can also be linked to risk if needed.

From the point of view of people interested in the process of gaining the data, we should take into account one more thought. While most of the workers from university area would welcome colloquial and informal way of expressing the rule, most of the programmers and implementators of software applications would prefer formal, exact and unambiguous expression, which could be immediately put into source code and according to them could be set up the configuration parameter for customizing information system. The person (translator) who should stand between IT specialist and company expert – implementator, could be company analyst. This is the scope of employment of the analysis discipline.

According to the communication with the user, the analyst develops the model of business subjects, objects and realities and develops a rule on an informal level. It works with pieces of text. This has the advantage of keeping the rule clear and comprehensible but also consistent. The transformation to the formal structure which leads in the closing stage to one or more implementations is also a human activity with possibilities of mistakes and inaccuracies. The way to develop more formal expression of the rule structure in a way that this expression would retain its simplicity and comprehensibility for the people in the company remains a problem. If we offer the analyst pre-defined set of patterns and structures, he could use them for generating equivalent text presentations. In spite of the fact that the shape for the analyst and the company is still in the form of a text, the whole control through the structure could be in the system. Then, it would be possible to think about generating the code from this structure.

The analyst is a mediator between university worker, an expert in his field, who knows all the techniques, conditions for transitions, descriptions of the states and items, calculations and so on and IT specialist whose task is to formally express the business rule. Anyway, human interpretation allows mistakes and inaccuracies. Therefore, the main condition should be that the company worker (manager or process owner) should have direct control over the definition and determination of the rule for this process.

The proposed methodology caters for this and actors taking part in his process are from the company (company analyst, process owner) (Rábová, Hodinka, 2011).

Summary

The article deals with the first version of proposed methodic for business rules mining and administration in university area. When universities enforce this new method and approach of business rules, can processes remain fixed, although legislative, business constraints and direction change. The processes will be only referencing at their rules. The rules are also independent from business persons as are teachers or office workers that rules control and enforce, so the rules are independent from change of organization person and competencies. In relation to business architecture we search the rule in vision, goals and resources, but especially in processes and functions and data of information systems.

Methodic in its complex version can make for gaining and retrieving of business knowledge and information about business activities, also for controlling of completeness and integrity in business rules file as well as for communication about them. It can support knowledge management and also information system development and customization.

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Towards Promoting Active learning in On-line Courses for Lecturers in Further Education: Experience and Observations

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Abstract

This paper presents a summary of experience with various methods promoting active learning. These methods were used in on-line courses of the two-year project Modern Lecturer – Modern and Effective Adult Education. In this project, which started in 2010 and was co-funded from the European Social Fund, the University of West Bohemia in Pilsen, developed ten tutor-led on-line courses. The courses were prepared with attention to detail and to pedagogical aspects, emphasizing effective and inspiring learning. Learners were encouraged to effectively use information and communication technology in their teaching practice in further education for adults. Continuous and final discussions and the evaluation of all ten courses have shown which methods and what conditions promoting active learning were well received by the target group.

Keywords

Life-long learning. On-line education. Educators training. On-line course. Feedback.

Introduction

Methodology of e-learning receives long-term attention at the University of West Bohemia in Pilsen. Effective promotion of active learning in asynchronous on-line courses is one of the key topics in this effort. This paper summarizes the experience and findings from the project Modern Lecturer – Modern and Effective Adult Education, which ran between 2010 and 2012 in the Ústí Region in the Czech Republic and which was co-funded from the European Social Fund. The project was managed by a private company. The University of West Bohemia took part in the project as a sub-contractor, developing ten on-line courses for lecturers in further education.

The following courses have been prepared:

1. Fundamentals of Distance Education
2. Principles of Effective Distance Education
3. Differences Between Distance and Face-to-Face Courses
4. E-learning in Distance Education
5. Working with LMS (Learning Management System) and Authoring Tools
6. Methodology of On-Line Education
7. Rules for Leading an On-Line Course

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8. Working with Interactive Whiteboard
9. Andragogy
10. Motivation in Adult Education

The project's target group is lecturers in further education. This includes both seasoned professionals with many years of experience and teachers who are still preparing for their career in this field.

Methods

Elaborate Pedagogical Framework of Courses

As the target group consisted of lecturers in adult education, an optimum mix of face-to-face and distance features had to be found. Careful consideration led to the choice of 3-6-week on-line courses with introductory and final face-to-face tutorials. The "Working with Interactive Whiteboard" course comprised an additional intermediate tutorial to meet learners' needs for developing specific practical skills in using basic functions of the board.

In the introductory tutorial the learners were informed about the schedule, content, and scope of the course and about the methods of study in the distance education module. In this session, the lecturer's/tutor's main aim was to motivate the learners to engage in the programme and introduce them to its framework. In addition, it was necessary to familiarise the learners with the on-line study and inform them about the requirements for successful completion of the course.

After the introductory tutorial, the learners worked on their own with the tutor's assistance. The distance learning course consisted of study materials, assignments, tests and discussions. Multimedia for individual courses were created in the ProAuthor authoring system and implemented in the Moodle LMS. In addition to an access to the on-line environment of the course, the learners received printed study materials and an off-line version of the course on CD in the form of a multimedia textbook.

The final face-to-face session was devoted to an evaluation of the course. The learners have presented their projects, which were the intended outcomes of the course. These projects were discussed with their authors and among the learners. The lecturers evaluated the projects and gave their professional and pedagogical comments. Successful learners received their certificates.

These on-line courses follow the pedagogical principles of developing on-line courses. The structure of the courses was well thought-out. The core of the courses was shifted from mere reading to active involvement of learners. Great emphasis was laid on formulating texts in a way, which would draw the reader into the course, and on the interactivity and continuous support for learner motivation. The on-line courses contain a number of stimuli for learner's self-reflection. They also lead the learners towards acquiring and evaluating practical experience with the contemporary on-line form of study. The course content is delivered in an increasingly demanding fashion: from fundamental information and definitions to practical guidelines and specific assignments related to teaching practice.

Pedagogical cornerstones:

- Basic principles of distance education (see Tab. 1)
- Constructivist nature of the course (see Tab. 2)

Table 1: Basic principles of distance education

Self-paced instruction	emphasis on learner's autonomy and activity (individual choice of the content and place to study), pedagogically well-prepared study materials
Individualisation	individual study plane, pace of study, learner-tutor communication, psychological support, motivation and remotivation
Interactivity	small amounts of course content, rapid feedback, a number of interactive features within and outside study articles
Deployment of technology	various techniques and means of presentation, use of senses, facilitating effective communication

Table 2: Constructivist nature of the course

Critical thinking	reflection of one's impression of various activities, formulation of recommendations for the course, detailed evaluation
Problem solving	problematic wording of some assignments and questions, "Try for yourself" activities before instruction
Substantiation	stimuli and topics for giving arguments in assignments, questions, tests and discussions in particular
Understanding	wording of assignments, tests and questions requiring actual application of knowledge, rather than just its reproduction
Cognitive flexibility (transfer)	deployment of experience from face-to-face instruction, stimulation for revising and refreshing previous topics
Reflection	one's own experience of the on-line form of study, stimuli for reflection and reasoning throughout the study
Sharing	topics for discussion inviting to share experience and knowledge, teamwork on group assignment

High-quality work of tutors – key element of success

A work by Reitmayerová, Broumová (2007) suggests that in every education process, a balance has to be struck between directive approach and spontaneity, between following a set goal and free will of individuals. This is why emphasis on high-quality work by the tutor in line with student-centred learning principles was laid in all courses. Fundamentals of tutor's role:

- positive and motivating approach
- individualized approach
- person-centred approach
- rapid (periodic) communication
- consistency, attention to detail, active involvement
- well-prepared feedback

The tutor provides answers to questions but initiates communication with learners, when needed. The tutor also contributes to main discussion and other discussions but, at the same time, leaves more space for learners. The course includes a number of tutor-led or tutor-evaluated activities. With regard to the target group, the individual text feedback on assignments is worded very carefully. The tutor evaluates the polls and prepares interim and final statistics to inform the learners about the developments in the course.

The following two efforts form important basis for planning the study and the activities:

1. Letting the learners experience and enjoy the on-line study

2. Letting the learners actually “study” and learn new things

These two aspects led to preparing courses that are demanding and require active approach on the side of the student. At the same time, the courses are user-friendly and effective. The courses are practically oriented in order to motivate learners to complete even the demanding assignments, to make the learners aware of the purpose of each activity in the course and to avoid feelings that any part of the course is “useless”.

In most courses, the students learn fundamentals of preparing high-quality distance learning courses. Authors have therefore made every effort to prepare courses in accordance with these very principles.

Methods promoting active learning

A great achievement of the developed courses was their capability to verify in practice how effective were innovations in the methodology of further education of educators. Each of the ten on-line courses was meticulously elaborated in terms of its pedagogical aspects in accordance with current e-learning trends in the Czech Republic and abroad. The courses also included specific inspiring features, which have not been common in education of educators in the Czech Republic.

The following overview presents the methods promoting active learning used in separate courses.

Course 1: Fundamentals of Distance Education

In this first course, it was very important to build a positive attitude towards on-line education. With this aim, the course was based on tutor's consistent support and individual approach to learners. Although containing simple on-line activities, the course was varied and included the experience of collaboration within student community (discussion forums and joint preparation of text in a wiki-based system).

Course 2: Principles of Effective Distance Education

This course emphasised high-quality work by the tutor and its perception by learners. It was based on commented experience of the on-line study and on sharing opinions among members of the study group. Features of this course that are innovative and less common in further education of adults included chat and its reflection and experiential learning integrated in the tutor-learner communication assignment.

Course 3: Differences between Distance and Face-to-Face Courses

This course was built around the concept of experiential learning and included a hands-on training, consisting in preparation learner's own on-line courses (according to their professional orientation). The course included literature search on the internet. Learners were required to find examples of distance learning course materials in their field prepared in the Czech Republic or abroad. The results were then shared through the wiki-based system.

Course 4: E-learning in Distance Education

The course focused on technical aspects of e-learning. Its practical training part involved creation of self-tests. It included a pedagogically interesting assessment activity: mutual assessment of assignments by learners.

Course 5: Working with LMS (Learning Management System) and Authoring Tools

This may be one of the most demanding courses in the "Modern Lecturer" project. Its outcomes were fragments of courses prepared by learners in the ProAuthor tool. The course was therefore oriented on experiential learning and continuous sharing of experience among learners.

Course 6: Methodology of On-Line Education

The key element of this course was an overview of current trends in on-line education. Besides a wiki-based system for sharing links to interesting on-line courses available on the internet, a shared interactive glossary was incorporated into the study plan.

Course 7: Rules for Leading an On-Line Course

The course was aimed at the role of a tutor in the specific environment of on-line education. It was based on learners' self-reflection and dealt in great detail with the issue of individual approach to on-line course students. The learners were encouraged to evaluate the course on a continuous basis and to provide reflections in relation to their own on-line projects they were preparing.

Course 8: Working with Interactive Whiteboard

The course was innovative in exploiting the entire range of multimedia materials and the scaffolding concept. Its students were instructed to share the materials they created and to provide positive motivation to each other.

Course 9: Andragogy

The course was thoroughly based on constructivist approach. Students were directed towards working with primary sources. The students made their own choice of documents and specialist texts on andragogy and shared commented summaries of key concepts of these sources. The course led to broad discussions of topics, which were only briefly mentioned in the course syllabus but the learners themselves expressed their interest in them (e.g. educating migrants, re-qualification courses and others).

Course 10: Motivation in Adult Education

The last course was the most interesting one in methodological terms. From the andragogical viewpoint, it was the most courageous endeavour as well, as it relied on consistent application of the Rogerian approach (person-centred learning). The course comprised several shared self-reflective exercises and a self-reflective group assignment. It also included mutual assessment of final assignments. The application of the Rogerian approach was made possible in the first place by the composition of the study group, which consisted of active and open learners with previous positive e-learning experience.

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Elaborate feedback

A broad range of tools was prepared for giving feedback and evaluation in the courses. Continuous encouragement of learners to reflect on course activities and on their own impressions led to very effective continuous evaluation in polls, during assignments and in classroom discussions.

An evaluation tool was incorporated into the final stage of each course. It was a questionnaire comprising evaluation through marks 1 – 5, as well as through comments.

Table 3: Final evaluation questionnaire

Subject	Mark	Text Evaluation
Administration and organization of study		
Pedagogical effectiveness of study		
Technical aspects of study		
Course materials		
Communication among all parties		
Overall rating:		

We find the combination of marks and text evaluation to be the most effective form of evaluation in adult education, chiefly because it does not trouble the learners and leads to high rates of completed evaluation questionnaires. This has been proven repeatedly in our courses since 2004.

Table 4: Final evaluation marks

Subject	1	2	3	4	5	6	7	8[1]	9	10
Administration	1,42	1,19	1,10	1,48	1,20	1,23	1,00	N/A	1,11	1,08
Ped. effectiveness	1,21	1,26	1,08	1,54	2,00	1,23	1,06	N/A	1,28	1,08
Technical aspects	1,47	1,24	1,15	1,40	1,20	1,20	1,00	N/A	1,25	1,17
Course materials	1,21	1,10	1,00	1,54	1,40	1,00	1,26	N/A	1,00	1,00
Communication	1,50	1,65	1,71	1,72	2,25	1,67	1,38	N/A	1,41	1,41
Overall rating:	1,29	1,10	1,05	1,33	1,60	1,07	1,09	N/A	1,06	1,08

The choice of marks reflects differences between learners, in a way that assessments of complex endeavours of students at school reflect differences between teachers. However, an important factor for objective evaluation of such questionnaires is the learners' need to explain the mark, whichever they chose. This is why this very simple questionnaire often yields very long comments from learners and, in general, much more information than complex structured questionnaires that are normally used in courses of this type.

Detailed evaluation comments from tutors were also collected for each course. In their evaluations, the tutors characterised the developments throughout the course and the peculiar features of working with the group of learners. In addition, they identified those features promoting active learning that were viewed favourably by the learners and those that were not received well, and their opinions on causes of such reception.

[1] Only qualitative evaluation is available for this course.

Results and discussion

Each course was evaluated by both learners and tutors. A total of 208 learner's evaluation questionnaires and 10 tutor's questionnaires were collected. Both learners' and tutors' evaluations suggest that learners appreciate the high pedagogical quality of all courses, seeing it as an added value of the project and are motivated to transfer the experience they acquired in the course to their own practice.

Tutors' evaluations, learners' comments and attendance statistics for course activities have shown the response to particular methods promoting active learning, as documented in Table 5.

Table 5: Responses to methods promoting active learning in the on-line courses

Methods Promoting Active Learning	
Good Acceptance	**Poor Acceptance**
Asynchronous discussion methods Shared texts – wiki-based system Experiential learning and reflections Mutual assessment among learners	On-line chat Contest Interactive glossary

It should be stressed that no activities received significantly negative response from the side of students – the distinction can only be made between activities, in which learners participated in large number and with enthusiasm and those, which had poor attendance. Naturally, some students have expressed their reservations about generally accepted methods as well, such as: *"Everyone took part in the communication with excitement but I do not feel that way".*

A great part of the success of the methods promoting active learning in this course was given by the enormous interest in this project in the Ústí Region. Learners in all ten courses were highly motivated and active throughout. Some learners attended several courses and formed a positively charged core of the group. Thanks to them it was possible to gradually add methods with higher requirements for their organization and learner activity. It was possible to expand self-reflection activities as well but we are aware that, for instance, the course Motivation in Adult Education was successful at the end of the project thanks to experienced learners, whereas its deployment at an early stage of the project would not be as much of a success.

Well-received features promoting active learning

Asynchronous discussion methods

Students most commended the discussions, the topics of which were related to their practical experience. It was found that the choice of the discussion topic is very important. Even in those courses, where most learners communicate frequently, a topic may arise, in which no one feels interested enough to comment. Such an unattractive initial contribution then receives no responses.

Discussions on concrete issues (press articles, comparative studies, controversial videos, etc.) inspire a great response. Discussions on topics, on which students from various backgrounds can comment from their viewpoints, are popular as well. These are even considered by learners as the most enriching ones.

Each course comprised thematic discussion forums, as well as a "Questions, Suggestions and Tips" forum for learners to discuss topics related to their needs. The latter was very popular in each course. Consequently the students acquired knowledge not only from course materials, the tutor and their own activity but also through exchange of experience with one another.

Shared texts - wiki-based system

Students had an opportunity to enter a contribution to discussion, as well as a shared comment or link. In the Moodle system, this is accomplished in the Wiki module. A proven procedure consisted in using just the first page of the module as the shared space, preparing an exact specification for the collaboration and drafting a sample contribution. Complex page structures were avoided in order to prevent any technical problems, which would discourage learners from using the wiki-based system. The shared space is excellent for presenting results of individual assignments. The learners jointly created overviews of methods, formats and techniques and drafted sets of recommendations. Where the use of wiki-based system is part of the course, it is advisable to make learners' participation mandatory.

Experiential learning and reflections

The learning by doing concept is well received by students, as it is oriented towards the use of acquired skills in practice. Courses focused on experience break the stereotype that practical skills cannot be acquired through on-line activity. Contrariwise, the individual training in practical skills with an on-line support has proven to be beneficial, as learners can set their own pace and practise the selected skills they need. This was confirmed particularly in the Working with the Interactive Whiteboard course. Learners initially felt they may need more hours in face-to-face session. However, in the end they found that the high-quality multimedia course comprising very illustrative videotutorials and experience-based plan of study gave them much more space for practising the skills than a face-to-face session.

In the on-line courses the learners were encouraged to acquired practical skills and reflect on them both individually and in groups. For lecturers in adult education, reflection in a group has enormous importance, as it helps to prevent generalising their subjective experience and conveys the diverse perception by various learners.

Mutual assessment among learners

The mutual assessment of assignments prepared by learners was used in two courses of the "Modern Lecturer" project. This activity was not mandatory and learners had the freedom to choose another assignment, which did not include mutual assessment. This assignment, however, has appealed to a number of students. The fact that in their evaluations learners tended to provide positive motivation to their colleagues was very interesting.

Organizing the mutual assessment among learners was complicated, as this project lacked the necessary technical background. For the purpose of mutual assessment of learners' work, it is recommended to use an adequate on-line application (e.g. the Workshop module in the latest versions of Moodle).

Poorly received features promoting active learning

On-line chat

On-line chat was used as non-mandatory activity in two courses. Very few learners took part in this activity. The most difficult problem in organizing a moderated chat session is matching the times when participants are available. In similar courses we developed for adult educators between 2004 and 2008, the interest in on-line chat was much greater. At that time, chat was quite unknown to many lecturers. This is not true any more. Educators do know chat sessions but their interest in participation is negligible.

Contest

A simple contest was included in the "Motivation in Adult Education" course to motivate and inspire learners' activity. Students were asked to find video sequences of best and poorest performances of lecturers in adult education on the internet. The contest was announced in the discussion forum and was not mandatory for successful completion of the course. No learner has taken part or commented on the contest, although the tutor repeatedly reminded the students of their opportunity to participate.

Interactive glossary

The Moodle LMS offers a function for building a glossary, the entries of which may be created and edited by learners. The interactive glossary was included in the "Methodology of On-Line Education" course. Creating an entry was not mandatory, which is why just a few active students took this opportunity. Tutor's reflection showed that one of the reasons for ignoring the glossary was learners' feeling of being overwhelmed by new terms and their unwillingness to deal with additional ones.

Experience from other types of courses developed by the University of West Bohemia confirms that effective use of the interactive glossary is conditioned on an attractive topic of the glossary and clear specifications for working with it.

Conclusion

Experience from abroad, as well as from the Czech Republic with education of lecturers inspired us to develop a unique modular system of courses. Their graduates are familiar with information and communication technologies and can use them purposefully in the field of adult education. The graduates also acquire sufficient amount of valuable practical experience in the position of on-line course students. The output of hands-on assignments can be used in practice immediately.

Our experience has shown that methods promoting active learning are beneficial, and even necessary, in adult education, and in our case in educators training. However, the wording of the assignments must be carefully considered, their usefulness for the topic of the course must be examined and the target group must be adequately prepared and set. High quality of tutor's work is necessary for these methods promoting active learning to bring the desired effect.

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E-learning and Quality: The Quality Evaluation Model for E-learning Courses

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Abstract

The paper introduces the quality evaluation model for e-learning courses that could be used in the e-learning implementation project. Authors shortly describe general issues of the e-learning quality. Subsequently, they pay more attention to the evaluation of the e-learning course quality itself. They analyse known virtual university development strategies and models and take them as a starting point in identification of important factors that are evitable for successful implementation of simplified quality rules to the e-learning course development and deployment process. Authors classify the identified factors to technological, developmental and educational ones. They perceive difference between general quality of e-learning issues and issues of quality of the particular e-learning course which represents the basic structural and content unit. They try to lay down e-learning course quality criteria for specific e-learning implementation project realized at their university. Finally authors propose some e-learning course quality evaluation criteria. Criteria are analysed from qualitative /quantitative and subjective/objective point of view. Authors define three milestones of the e-learning course evaluation as well as they introduce factors that reflect the effectives and fruitfulness of the e-learning course in term of the e-learning content, structure, learning effectiveness, students' activity, students' and teachers' satisfaction.

Keywords

Distance learning. Theory and models. Quality of e-learning.

Introduction

A virtual university has been described and defined in a variety of ways, which reflects the wide disagreement between specialists in establishing a unified definition. The virtual university can be defined as an institution of higher learning that has no confines, using technology to connect learners, instructors and administrators. Other authors have added that the virtual university provides education at time and distance that is convenient for the learner (Al-Shehiri, 2008).

The role of the virtual university is the same as the role of a classical one; however delivery methods of knowledge and transfer information are different from traditional delivery methods. A significant work in virtual universities development has been presented in many books and conference papers. Their results have flowed into the improvement of various virtual university development strategies and models (Guri-Rosenblit, 2001; Kahiigi, Ekenberg, Hansson, Tusubira, & Danielson, 2008; Moore et al., 2007; Yengin, Karahoca, Karahoca, & Uzunboylu, 2010). Al-Shehiri

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states that from models can be observed that the concept of the virtual university implies following common characteristics (Al-Shehiri, 2008):

- The use of a sophisticated ICT will have the major impact on the concept of the virtual university.
- The virtual university is not a traditional institution and it does not need to have an existing campus, offices, instructors and locus libraries. Instead, it has an electronic network which is capable of performing the same functions as a conventional university but in more democratic and flexible way.
- The emergence of the virtual university is derived from the urgent need to acquire knowledge and skills.
- Co-operation, collaboration and communication are significant elements of the virtual university.
- The mission of a virtual university is to increase educational opportunities, reaching widely dispersed learners who were barred from taking traditional university classes.
- The organizational structures of a virtual university can be represented in various models.

A headstone of the virtual university is an e-learning course. The e-learning course represents an elementary unit which attributes influence the quality of a whole. It is hard to say that one course is good or bad or if it rises or degrades the quality of the whole. This is why we have to form evaluation criteria for e-learning courses thus to define criteria for a quality evaluation.

The evaluation is the last phase in an e-course development process. This phase consist of a content rating by reviewers and a course assessment by students. Results of this evaluation phase where results are gathered by enquiring can be compared according to system logs from the learning management system.

Top-down implementation approach combined EES model

Many universities adopted a 'bottom-up' rather than a 'top-down' implementation approach. They tend to foreground the potential of the e-learning to enhance teaching and learning; and to foster a wide variety of learning outcomes. In addition, staff training is seen as essential to a successful e-learning but flexible support structures and mechanisms are seen as even more important. (MacKeogh & Fox, 2009).

Event though, we adopted a four-tier electronic educational system (EES) model in the above mentioned project (Cloete, 2001). The basic idea of this approach lies in initializing the implementation of e-learning solutions by the university or faculty management. This implementation should be in line with the *Long Term Vision of the Faculty Development*. A successful e-learning implementation strategy using top-down approach relies on five main elements: people, tools, training, processes and support (Moore et al., 2007).

One of the biggest advantages of implementation by top-down approach is the possibility to identify the whole process in advance and defining exact rules, procedures and responsibilities. The success of whole integration process depends on consistency of these rules and on clear delegation of responsibilities as well as definition of evaluation criteria. Based on (Drlik & Skalka, 2011) there are following starting points:

- The primary factor for an e-learning course evaluation is the result of reviewing of the scholastic correctness of the e-learning course. The comprehensive course must be appreciated better than the incomplete e-learning course.

- E-learning courses are different in content. It is necessary to evaluate the textual and multimedia extent of each e-learning course according to its purpose and aim.
- The number of active teachers in the course – The content of the course may be often created by several teachers. It is important to recognize the overall contribution of each of them.
- Teachers' activity and visibility in e-learning course environment represent important aspect of evaluation process. Creating of the e-learning course is only the first evaluative criterion. If a teacher is regularly visible in the course, moderates discussions and coordinates students' activities, he/she should be adequately motivated.
- The number of assigned students and their activities are closely associated with teachers' activities.
- The innovation of the e-learning course rests in the appropriate usage of new, traditional and unconventional methods that increase the overall quality of the educational process. The emphasis should be put on developing students' competitiveness and on the ability of the course designer and the instructor to exploit the technology efficiently, effectively, and at the right moment (Hvorecký, 2008).

E-learning and quality

A debate on quality is the debate about how the learning and the education should looks like in the future, about values and cultures, and it takes place on the basis of diverse experiences and convictions (Ehlers & Hilera, 2012). The survey of Ehlers (Ehlers, Pawlowski, & Wirth, 2006) which was realised on almost 250 European universities shows that 53% of them use some quality model for the e-learning. If we take a closer look at used quality models we can see that these models don't meet more exacting criteria, e.g. 24 universities do not make difference between the classical education and the e-learning one.

The evaluation of an e-learning quality process often begins by the definition of its structure and then by the implementation in the organization. This process is tightly interconnected to management model. Typical example is the five dimensions German view for a sustainable implementation (technical, didactic, economic, socio cultural and organisation) (Seufert & Euler, 2003).

Similar view can be found in work of Schönwald (Schönwald, 2003) who pay attention to Strategy and Management (Fig. 1).

Fig. 1 Dimension for a sustainable implementation of e-learning (Schönwald, 2003)

Masoumi and Lindström (Masoumi & Lindström, 2012) states that any framework or model for assuring and enhancing quality of education explicitly or implicitly should build on a set of theoretical premises, which however isn't met by many of current models. Based on comprehensive review of the practical knowledge (i.e. models, guidelines, benchmarks, etc.) they define that e-quality framework offers a structured set of factors and benchmarks as a tool for practical quality work with the e-learning in virtual institutions.

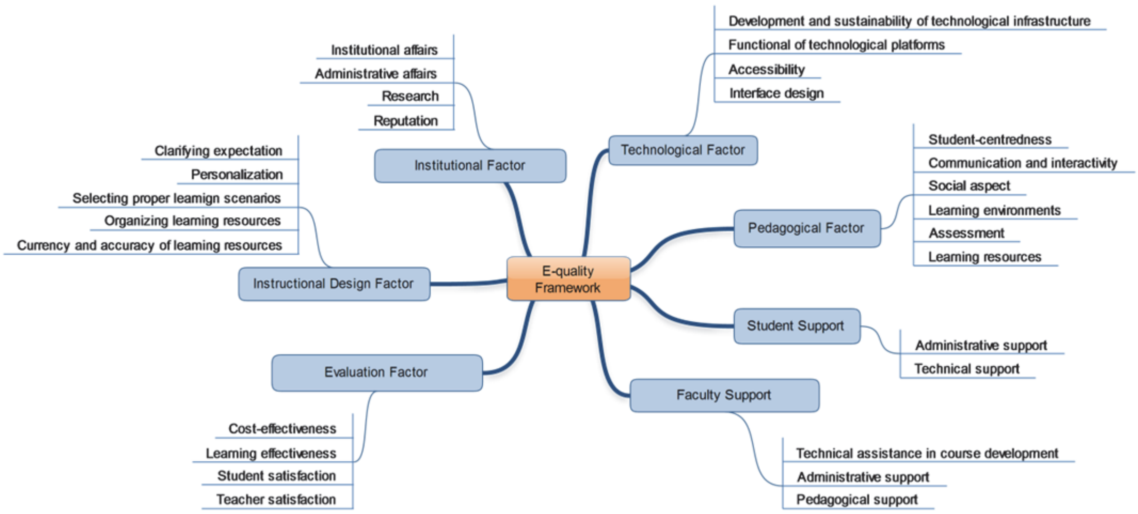

Fig. 2 E-quality framework (Masoumi & Lindström, 2012)

We think that the framework in the Figure 2 is generally applicable to evaluate all factors it describes but its real application or use carries significant personnel and time demands. If there is a variable ICT environment and the institution use lot of different technologies, learning management systems or even e-learning concepts it makes sense to watch all factors. If there is a homogenous environment we are able to eliminate some of these elements.

We can use a simplified model at the institution level which will provide a worth feedback for the institution management. Based on the current state at our university we can define the simplified model as follows:

- Technological factor has no importance nowadays. We are able to assure the 24/7 availability and usability for almost all systems.
- Institutional factor is like the technological one. Research and reputation are significant just in the case of recruiting new students, so these factors do not reflect the quality of the e-learning unit.
- Institutional design factor is the first important one which is related to usability and efficiency of a user interface. Institutions with an e-learning tradition deal with this problem by definition of principles which form the content-design template. This is the way how not to give a course creator space to "destroy" the course. Individual factor is the selection of proper learning scenarios and currency and accuracy of learning resources.
- Faculty support is partially related to the technological factor and it partially covers the field of a course creation. This group of factors plays main role if we want to measure the quality of the e-learning as whole and also in the e-university developing process. If we want to measure the quality of one particular unit then this factor is meaningless.
- Student support is in this case separated from the social aspect, which is part of the pedagogical factor, and is centrally assured. This central assurance means that it does not imply the quality of the e-learning unit.
- Evaluation factor can be divided into a subjective and an objective group. Subjective group consists of the students' satisfaction and teacher's satisfaction. The level of

satisfaction can be measured by questionnaires. Objective group is formed by learning effectiveness measurable tests or alternatively by the results classification. Cost-effectiveness is the combination of the financial burden at the teacher side and the financial benefit at the student side.

- Pedagogical factor is largely oriented to content, communication and used resources. It is the most important factor in our case.

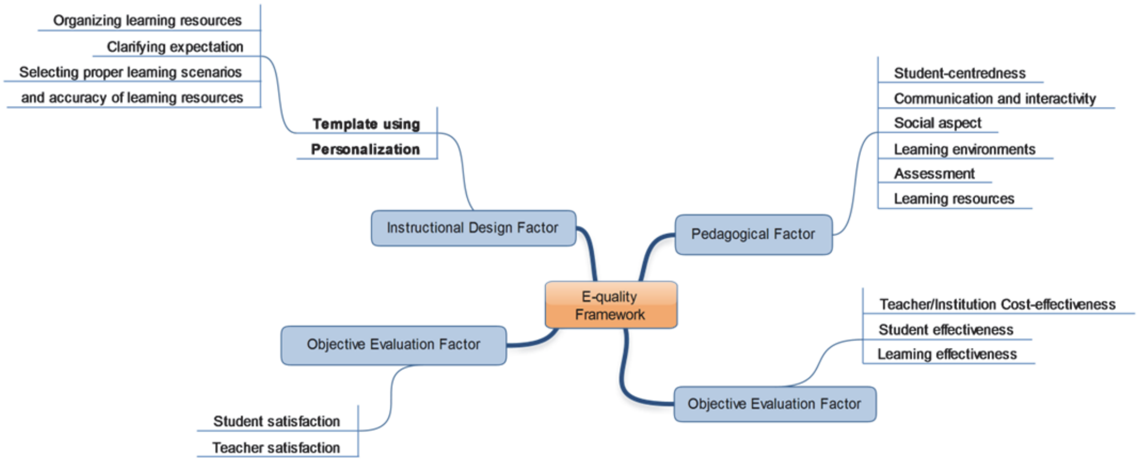

Fig. 3 Reduced e-quality framework

Similar groups can be found in work of Oztekin et al.(Oztekin, Kong, & Uysal, 2010) who however use feedback from questionnaires as the primary source. Basic aspects are defined as error prevention, visibility, flexibility, course management, interactivity, feedback and help, accessibility, consistency and functionality, assessment strategy, memorability, completeness, aesthetics and reducing redundancy.

Following above mentioned sources we can split watched factors into three groups:

- Technological factor monitors technological elements like hardware, software and administration.
- Development factor is oriented to the measurement of efficiency of tools which are used in the process of creation, development and update of e-learning content. It consists from the administration, the support of course creators, the system administration and the assistance for other system interconnections.
- Educational factor represents the content itself, various criteria for its evaluation including students and teacher satisfaction. This factor is the subject of our next study.

Measurement of the educational quality of an e-learning course

Each e-learning course has its content well-structured and thus we can imagine it as a database. Therefor it is not technically intensive to acquire huge amount of metadata from its parts. This is also the reason why modern learning management systems (LMS) contain some logging subsystem which collects all information about users' activity. Some LMS also offer tools for statistical processing of collected data.

Metadata and data acquired from logs offer the unlimited source of information for the investigation of user behaviour and a potential optimization of the content structure (Kapusta, Munk, & Turčáni, 2010). At the same time it can be used as the source for obtaining quantitative

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information about users and their behaviour (Munk & Drlík, 2011). According to (Hvorecký & Drlík, 2008) the common mistake of evaluation models is the mixing of qualitative and quantitative criteria without clear definition of differences. We think without be in contrary to Hvorecký's claim that we can obtain qualitative data based on the analysis of quantitative ones.

Conclusion

The evaluation process has two levels – the objective one, which is represented by measurable facts and the subjective one represented by questionnaires and feedback. One part of the subjective evaluation can be verified by objective sources. We have to mention that each course undergoes different phases of the development process, and not all evaluation criteria can be used during the whole lifecycle. We separate the evaluation process into three points that are represented by the specific stage of course development and usage:

- The completion of course creation - after the development process was finished but before its use in education.
- The end of the first educational cycle – after the education or the term ends.
- The end of other educational cycles.

Completion of course creation

The standard procedure after the completion of course creation is its evaluation as well as verification of the fulfilment of quantitative and qualitative (form and design) requirements. The evaluation phase guarantees that there will be no unsuitable e-learning courses in education process. Each course has to meet rules for the text range and the course structure defined by the template. Some parts of the course can be controlled automatically like the syllabus or literature other like the content have to be reviewed by the professional. The successful review is the necessary condition to run the course.

End of the first educational cycle

This step of evaluation is represented by factors reflecting the behaviour of teacher and students related to the content. These factors are as follows:

- Permanence – continuous education represents the continuity of information received by a student.
- Complexness – a student goes through all parts of the course content or more precisely through all mandatory parts.
- Activity – assignment submission, the level of participation in discussions, and participation in other collective activities.
- Successfulness – A student successfully completes the course if she/he passes all tests and assignments. It is recommended to use the final grading if it is missing in the course.
- Activity of teacher – means the teacher's response time for answering questions, solving problems or grading course activities.

All the mentioned factors can be quantified or expressed as the ratio of completed elements and all elements of the same type. This quantification may be fully automated.

After the end of educational cycle it is necessary to realise a final survey so we can obtain subjective information (Tab. 1). This survey has to focus on information that is not discoverable by tracking the student and teacher activity. We can assign them the relevance depending for example on the teacher results or on student's activity in the course.

Tab. 1 E-learning course evaluating criteria after the completion of course and after the end of the first educational cycle

		Subjective	Objective / Objectivity support
Completion of course creation	Qualitative	Content ▪ Review	
	Quantitative		Range ▪ Syllabus ▪ Content ▪ Tests ▪ Activities ▪ Planned discussions
End of the first educational cycle	Qualitative	Can be verified with a survey, but when there will be no future use of results than it is not needed.	▪ Permanence ▪ Complexness ▪ Activeness
		The assessment in the mean of learning effectiveness.	▪ Successfulness
		The assessment in the mean of students' satisfaction, teacher satisfaction, a pod.	▪ *How students with better grading rate the content?* ▪ *How students who study continuously rate the content??* ▪ *How all students rate the content?*
		Teacher's activity assessment	▪ Activity of teacher
		▪ Teacher's activity assessment with regard to the understandable answers	▪ *How students with better grading rate the teacher?*
	Quantitative		Range ▪ Syllabus ▪ Content ▪ Tests ▪ Activities ▪ Planned discussions

End of other educational cycles

This phase is similar to the end of the first educational cycle whereby two others elements raise:

- An appraisal of the realized changes in course content in case when the course creator is also the teacher of the course. This situation means that the content is often changed and we have to know the amount of this teacher's activity.
- The identification of changes in the list of resources, which have to assure that these resources are up-to-date. This information is just informative.

It is useful to store and compare the results of each cycle and identify proper and inappropriate changes based on this comparison.

Observed variables

The definition of observed variables in the e-learning course is just the beginning of the evaluation process. Even if sources of information are clear, it is necessary to define the form of final evaluation. We will use elements in Table 1 where each element will take the value from 1 to 100. This value will represent the successfulness in the given area:

- Range and Structure – represents the amount of the used content compared to the expected content. For the 13 weeks of term it can be hundred pages of text, five activities and five discussions for example.
- Learning effectiveness – final tests or final grading success rate compared to the best possible outcome.
- Student activity (permanence, complexness, activeness) – evaluation of the student behaviour. While these criteria are the combination of many factors, it is necessary to optimize their weights.
- Satisfaction of student and teacher – it is subjective aspect. It expresses the satisfaction with the content, learning management and with the teacher and it is often acquired by a survey.
- Teacher activity– it is easy to measure the teacher's activity but just in the case when there is also the activity from students. We can define processes in the way that the teacher will be responsible for students' motivation.
- Course creator activity – it is easy to define creator intervention based on the activities that are typical for content updating and editing. The problem can be the significance of these tasks (typo correcting vs. content updating). In case of major content changes it is possible to require another review.

Ideas presented in this paper are implemented into the institution education quality strategy software nowadays.

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Teachers' Competence in Using Information and Educational Internet Resources in the Education Process

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Abstract

This paper discusses teachers' levels of competence in the use of information and education Internet resources in the education process, which are very relevant for contemporary teachers. We can distinguish two main categories of activity: 1. Purposeful and effective use of information and educational Internet resources by users (learners and teachers). 2. Ability to create one's own didactic resources and develop an informational and educational environment: each main skill included in teacher competence comprises a number of sub-skills, presented in an ascending order: 1.1. Search activities on the basis of a thematic hierarchical directory; 1.2. Search activities using search programmes (software search engines); 1.3. Skills to evaluate sites for efficient use in the educational process; 1.4. Using the potential of information and educational Internet resources for the research activities of students in the learning process; 1.5. Skills in area of the objective and comprehensive assessment of a distance course. 2.1. Developing own educational environment in the form of thematic catalogue of the subject area or a personal web-site; 2.2. Training and assisting students in developing their own information and educational resources on the basis of Internet technologies; 2.3. Participation in the development of an educational portal (school, region, etc.). Use of educational portal resources; 2.4. Development and conducting of distance learning courses using a Content Learning Management System (CLMS MOODLE, Claroline, ATutor, Dokeos, etc.); 2.5. Use of all (or most) Web 2.0 services for development of one's own information and education environment. The author also describes examples and methodological bases for the implementation of these skills into practice at school.

Keywords

Internet. Information and education environment. Internet resources. Levels of teacher competence. CMS. CLMS. Connectivism.

Introduction

Possible applications of information and educational Internet resources in the learning process are varied in both form and content and have great educational and developmental potential. Although in recent years, according to statistical data, almost 100% of schools have been provided with Internet connection the number of teachers who use the Internet in their classrooms has changed disproportionately, rising only slightly. Additionally, if we analyze the actual use of the

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Internet and in particular, Internet resources, we can see that not all possibilities of its use are being fully realized and the stated objectives are not being met. It is important to consider the activities that are appropriate to implement research, using the pedagogical potential of information and educational Internet resources.

Summing up the study into various approaches in using ICT tools in learning activities, it is appropriate to distinguish ten directions corresponding to the levels of teacher competence in using information and educational Internet resources (by ascending order of skill level).

But on the other hand, in order for the teacher to grow professionally, and with her/him, IT competence in the use of information and communication technologies, particularly Internet technology in the learning process, the teacher must be aware of all the variety of opportunities to use Internet resources (Dashnist, 2003), (Smyrnova-Trybulska, 2007), as well as options for use of these technologies, depending on the technical, technological, educational, organizational possibilities and conditions of schools, students' skills, educational purposes, etc. We can distinguish two main categories of activity:

1. Purposeful and effective use of information and educational Internet resources by users (learners and teachers);
2. Ability to create one's own didactic resources and develop the informational and educational environment.

Below are presented the options of using information and educational Internet resources in the educational and cognitive activity and corresponding levels of teacher IT skills.

The use of information and educational internet resources by users (learners and teachers)

Search activities on the basis of thematic hierarchical directory

This activity allows the user to view educational and other resources and to look through topics and sites, specially structured in a hierarchical directory of general and thematic purpose, for example, general purpose sites, such as: www.onet.pl, www.o2.pl, www.interia.pl, www.meta.ua, www.yandex.ru, www.km.ru, math - http://www.e-zadania.pl/, http://www.megamatma.pl/, http://www.exponenta.ru/, http://www.bymath.net and others; physical - http://fizyka.org/, http://efizyka.win.pl/, http://www.fizika.ru/, http://optics.ifmo.ru, etc., chemical - http://www.interklasa.pl/portal/index/strony?mainSP= subjectpages&mainSRV=chemia&page=subjectpage&item=-1, http://www.edukator.pl/ portal-edukacyjny/chemia/238.html, www.chem.km.ru, www.college.ru/chemistry, etc., the site of astronomy - http://www.astronomia.pl/, http://astroflesz.pl/, http://www.crao.crimea.ua/ - the site of the Crimean Astrophysical Observatory, case, for example, developing children – www.interklasa.pl, www.profesor.pl, www.dzieci.pl, www.scholaris.pl, www.kinder.ru, www.children.edu-ua.net – children Web-site of "Children of Ukraine", etc., a site of international traditions and Kangaroo distributing games in Europe - www.mathkang.org, dictionaries and encyclopedias - www.wikipedia.org, http://encyklopedia.pwn.pl/, http://www.slovnyk.org, sites of libraries - www.bs.katowice.pl, http://library.org.ua, www.rsb.ru, etc., the sites of distance learning systems - www.moodle.org, www.dokeos.com, www.claroline.com and others. These websites are organized specifically to enable the user to find the necessary information on the subject area, or any subject.

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This kind of activity is recommended for novice users, who are required to only be familiar with addresses and only to be able to use browsers to reach a given website, as well as the folder "Favourites" for ready reference and to create their own database of Internet resources. The advantage of this kind of activity lies in the fact that websites with a generalized hierarchical structure contain a large number of links to various resources which in turn comprise other, supplementary information. The disadvantages of this type of data retrieval include abundance of material, non-essential in terms of specific learning tasks and distractions from the purpose of the users. On the other hand, the extent of information and educational environment and its vast resources require the ability to distinguish primary from secondary data and motivate direction and critical thinking.

Teachers' skills: Possession of techniques and methods for working with data and materials and the use of ICT and other technologies and resources (e.g., search for information in encyclopaedias (including online encyclopaedias), books, magazines, maintenance and suitable use).

Search activities using search programmes (software search engine)

Quite often, users do not have the addresses of Internet resources and therefore must have the necessary skills on their own to find the information they need on the Internet. In this connection, the next level of search (as well as the level of use) is to organize search by keyword, expression, and also with the use of advanced search. Here, the necessity of making the ability to properly make a search request, selecting the right keywords, the number and quality of which depends on the nature and location of the request. Use of advanced search, described in each search programme („advanced search"), to reduce data redundancy, resulting from the search is a very important aspect in finding the required information. Students should be taught to regularly and systematically use it in order to avoid the viewing of hundreds and thousands of unnecessary pages.

The more keywords are entered into the search box as criteria, the more likely it is that the search will be reasonable and relevant web resource will be found among the first hits. These skills need to be strengthened not only on science subjects lessons, but also during all other lessons. For example, to find information about the Nobel Prize for Marie Curie-Skłodowska in 1911 need to type a few keywords or by a sign "+" or "or": Noblists+Marie Curie-Skłodowska+1911. Or to use Find articles options and text fields: „with all of the words", with the exact phrase, with at least one of the words, without the words, where my words occur; Author: Return articles written by, Publication: Return articles published In; Date: Return articles published between, Collections options, and others (http://scholar.google.com/advanced_scholar_search).

Teachers should regularly use the Internet to achieve a variety of professional goals and to strengthen their skills constantly in search of necessary information in practice.

Skills to evaluate sites for efficient use in the educational process

Assessing the quality of information services appearing on the Internet is very difficult because the evaluation criteria are constantly changing and rating elements are selected on an individual basis. That which has value for one user may be unnecessary for another. Therefore, if we want to assess the information found on the Internet, we should remember that some general rules have been adopted and they are worth knowing and using. Why should we assess the quality of the information as it appears on the web? Because (Bednarek-Michalska, 2002):

- The quality of supplied or abstracted information has an effect on the status and level of education and public awareness.

- As the amount of messages and data on the Internet grows, its evaluation and selection is essential.
- The future will be linked to information and new technologies and the skill to evaluate the quality of information will be necessary in any profession.
- Quality is a category that is more and more often being referred to in all areas of life, not only in connection with information.

As far as information evaluation is concerned, it is similar to the evaluation of information transmitted in the traditional form. Especially if we take into account the evaluation of content. The differences lie in the form of expression of the content and form is mainly a result of Web hypertext system for sharing information. It also has a significant effect on the quality of information. The use of modern information technology has completely changed the availability of information, the way it is updated, aesthetic features and processing capabilities.

If we analyze and evaluate an educational website, we obviously pay attention also to the reliability, current status, interactivity, provision of links and other feedback. Until recently, when we talked about the Internet and the possibilities it provides for the transmission and the availability of news, often we were excited by the flow rate of the documents, the amount of data, variety of formats, graphics capabilities, tools, search tools, but we did not reflect so much on the quality of data the Internet has to offer. Now, after several years, seeing the problem of data redundancy, we begin to more frequently analyze quality. There is growing literature on this subject, which discusses in detail the criteria for evaluating electronic information. The proprietary proposal to evaluate a website for use in the educational process has been developed by the author of the article and is available in distance courses on the faculty e-learning platform http://el2.us.edu.pl/weinoe.

Using the potential of information and educational Internet resources for the research activities of students in the learning process

On the basis of exploring the potential of distributed information resources teachers can use this potential directly in research tasks in their subject area. By getting students to implement research projects with the use of information and educational resources of the Internet as online and off-line classroom and homework assignments, they can be specifically addressed to the specific resources to explore the necessary information on organization and conduct of research, the study methodology of the experiment, the viewing experience, etc.

For example, it can be applied in on-line Virtual Labs - an innovative method of education, applied at various educational levels. On the http://www.laboratoria.wsl.com.pl/, http://www.laboratoria.wsl.com.pl/index.php?go=laboratorium-mag there are available all the necessary materials to conduct workshops and laboratory work in the field of Logistics, Freight Forwarding, Warehousing in secondary schools. Virtual Physics Laboratory - WLF is a set of simulated experiments in physics, partly developed within the European project VccSSe and Warsaw University of Technology and Development Program (PRPW), which can be regarded as materials that support the teaching of physics in secondary schools and at universities, as well as supplementary materials to the physics laboratory and the Department of Physics, PW (http://wlf.if.pw.edu.pl/).

The aim of the Virtual Laboratory for Artificial Intelligence is to provide the basics and applications of artificial intelligence using web technologies (web pages). Available materials illustrate the principles of neural networks and can; be used as aids to the objects in this area, including the time course of computer science in secondary school (http://galaxy.agh.edu.pl/~vlsi/ai/)

Further examples. Using a resource http://nyelabs.org, you can get a list of detailed descriptions of experiments and demonstrations that can be done at home. In addition to the usual content of a textbook on astronomy through the resources of the web page of the Center for Space Research NASA (www.nasa.gov), you can view regularly updated photos and video clips, filmed during the flights and expeditions of spacecraft and satellites to the surfaces of planets, distant galaxies etc. This is a very important and useful tool because information on space quickly lose their current status. The information and educational resources called „Ask the scientists" (http://www.jpl.nasa.gov) allows you to provide feedback in the studies of different space phenomena and find a competent scientific opinion on the subject of interest in astronomy and astrophysics, etc. (Dashnits, 2003)

Such projects can be simply and efficiently implemented on the basis of the potential use of multimedia teaching opportunities through which this information is delivered. The data collected in the teaching and search process and research work should be used to supplement the information and educational resources on specific subjects on school websites (links, articles, photos, videos, commentaries, etc.).

The complexity of this activity lies in the fact that the use of some of the described resources requires a teacher to have special scientific background and the skills to adapt resources to students' needs and to produce explanatory material.

An advance type of the aforementioned competences can include joint research with other partners (classes, schools, etc.) based on Internet technologies and information and education resources of the subject areas.

When organizing and conducting joint research with other partners, in addition to work with information and educational Internet resources the subject-area the teacher needs to have: communication and organizational skills to find a partner on the project, plan and organize students to work together to hold a general discussion forum (to be a moderator), managing the results obtained jointly, to choose the best form for submission and publication (presentation, web page, video, etc.).

The source of the organization of this kind of activity can be the following resource: Global SchoolNet (http://www.globalschoolnet.org/index.html), which allows to make suitable choices of the existing areas of research and submit one's r ideas and find partners who want to take part in the implementation. Global SchoolNet's mission is to support 21st century learning and improve academic performance through content-driven collaboration. It engages educators and students in meaningful e-learning projects worldwide to develop science, math, literacy and communication skills, foster teamwork, civic responsibility and collaboration, encourage workforce preparedness and create multi-cultural understanding. It also prepares youth for full participation as productive and compassionate citizens in an increasing global economy. Founded in 1984, GSN is a 501(c)3 non-profit education organization (http://www.globalschoolnet.org/index.html).

Similarly, you can use other similar resources (www.mcrel.org, www.epals.com, etc.)

The advantages of this type of activity include the synergies of educational nature, including the formation of a sense of tolerance, acceptance and understanding of other cultures through working with people of different cultures, creed, languages, traditions, etc. Students can see the similarities and differences of the learning process and learning process of their partners, which enhances mutual understanding and ensures the effectiveness of joint activities, and fosters a sense of belonging to the global information society.

The disadvantage of this type of activity is the result of reduced control over the learning organization as compared to a similar project within the same class. In addition, joint work is complicated by the characteristics of participants in the learning environment, time zones differences for the organization of interactions in real time, language differences, traditions, mentality, etc. The teacher should possess skills and experience in effective and successful coordination of similar students' activities.

Skills in area the objective and comprehensive assessment of a distance course

The use of e-learning platform and distance courses distributed by other educational institutions becomes one of the important components of the methods used by the teacher who uses, for example, a specific course to support the teaching of his subject, a course for talented students, or as a course advisory etc.

That is why it is so advisable for every teacher to have competences in comprehensive, objective evaluation of eLearning courses, prior to their wide deployment in the educational process, in order to assess how valuable it is and whether it meets the expectations of effective use in the teaching-learning process.

In order to comprehensively evaluate the usefulness of a distance course offered over the Internet, one needs to use a set of specific standards by which the course can be judged. For this purpose, a number of reliable objective criteria can be used. For example, the criteria described in (Smyrnova-Trybulska, 2009) are recommended to be considered when developing and evaluating distance courses.

Developing own informational and educational environment

Developing own educational environment in the form of thematic catalogue of the subject area or a personal web-site

The level of complexity of this activity is not different to the previous one, but it requires of teachers additional knowledge and skills in the creation of Web pages. Technically, the easiest way is to create text pages via an ordinary Word editor and save them as HTML-documents. Thematic catalogues should be structured by topics of the relevant subject area, there should be a short commentary on the content, supplemented with presentations and examples of use. Because school websites, as defined and formulated according to requirements and principles of its creation, are an open resource, building of such these pages is not particularly difficult.

An additional advantage is the ability to reduce search time students need to study the resources and, therefore, effective use of resources during the lesson. In addition, it allows the teacher to simultaneously improve her/his skills and provide students with important information for the study of the topic. In order to publish such a resource on the Internet, one needs to use, for example, a publicly accessible server, for example www.republika.pl, www.narod.ru or other. The subjects and nature of projects may be various: thematic, personal page, group project, etc. An important modern tool for the creation of thematic catalogues or databases of knowledge is the Wiki. As an example of creating such a resource we can recommend using http://wiki.lo5.bielsko.pl/index.php/Strona_g%C5%82%C3% B3wna, http://staff.edu.pl/wirtual_lab/000001-strona-g----wna.html, other. It should be emphasized that thus created the resources of must be checked periodically for accuracy of links and updated as new resources from a given subject area.

Virtual Chemical Laboratory Project was initiated in February 2010 as part of the fifth edition of the Warsaw educational initiatives. The author of this project is Ms Beata Ostrowska, a chemistry teacher at the Group of Secondary Schoolsat Wiśniowa Street 56 in Warsaw. The project was open to all willing students of the school. The aim was to create a database of school teaching materials for teaching chemistry, which will benefit students and teachers of the School on Wiśniowa. Students of forms 2TC, 1lc, 1TB, 1ld, 3TA, 3TB and 2lc were particularly involved in the project activities. The project website presents the results of their work in the form of own-made movies, multimedia presentations and computational programs. http://staff.edu.pl/wirtual_lab/000001-strona-g----wna.html.

Another example of a database of chemistry teaching materials in the form of a virtual laboratory: http://www.chemia.pk.edu.pl/wydzial/info/c1/mcho/wlab/#. On each virtual table there are additional materials for the lectures. We recommend that you read them gradually and thoroughly. They will prove helpful in acquiring knowledge and skills (and even when it comes to examinations.You can find here various additional texts (written in Polish or English). There are also interactive drawings, diagrams and animation - virtual experiments. They illustrate the phenomena mentioned during lectures, so you may want to experiment, but also read descriptions prepared for them. (http://www.chemia.pk.edu.pl/ wydzial/info/c1/mcho/wlab/#)

Training and assisting students in developing their own information and educational resources on the basis of Internet technologies

One such form of activity is the participation in an international organization called Think Quest (www.thinkquest.org), which has declared as its goal the creation of an information and educational Internet resources by international groups of students, exhibiting specific national characteristics of the education completed by each individual student group member.

A necessary condition for participation in the activities of this organization is the presence of an international team of students and teachers-trainers. Next the team, through telecommunication means, selects a topic of research associated with in-depth study of a scientific topic (or multiple topics), designs its information and educational resources, and publishes them on the site. All stages of the resource, as well as communication between the participants are carried out over the Internet. This form allows one to establish closer ties between teachers and students in the learning process that aims to create a resource from the results of the study of selected topics. This changes the role of the teacher, who acts as a consultant and organizer of the research activities of students. In addition, teacher-coaches exchange ideas to improve their strategic activities to achieve the objectives and obtain the necessary results. Parallel to this, students who acquire skills in technology of web page design in turn can become teachers' consultants, which increases their self-esteem and sense of worth.

Creation of information and educational resources on the Internet requires from the participants (including the teachers) the allocation of great deal of their time, even at the expense of extracurricular time. But the effect and satisfaction from the work done usually pays for the time spent, because students more deeply "immersed" in the subject taught, and teachers have the opportunity to acquire more thoroughly the technology to create web-pages.

Effective use can also be made of such technologies as Web 2.0. such as Wikis, Blogging, Microblogging, Podcasting, Videocasting (Hyper Cam, Adobe Captivate, etc.) that can be accessed on the level of school website.

The important category of the teacher skills is the coordination of the development of Web Quest (WebQuest) by students. Web Quest is the information and educational resource on the Web, serving educational purposes on a particular subject, which satisfies the requirements for educational facilities (www.webquest.org)

A WebQuest is an inquiry-oriented lesson format in which most or all the information that learners work with comes from the web. The model was developed by Bernie Dodge at San Diego State University in February, 1995 with early input from SDSU/Pacific Bell Fellow Tom March, the Educational Technology staff at San Diego Unified School District, and waves of participants each summer at the Teach the Teachers Consortium (http://webquest.org/index.php). This is a separate type of activity that is designed for teachers who are interested in developing an information and educational environment for their courses in the form of information and educational resources and who have the competence in the field of independent webpage design. The teacher develops a scenario of all possible variants of use of future resources, gives the student (or group of students) a list of tasks to do, a list of essential information and educational resources, the requirements for skills and knowledge that students should acquire while working in the information and educational environment, the criteria for evaluation of their activities. Time limits for the completion of the tasks are set in advance, taking into account both in-class and extracurricular students' workload.

Work on the Web Quest requires from students to look deeper into the subject, which research activity also requires. They act as the organizers of the formation of knowledge among the future users of this resource. Students should be like higher rank researchers, analyzing the possible situations that may be faced by persons who will be working with this resource, comparing different points of view and positions, combining different versions of data, methods of presentation, assessing different situations.

Obviously, the creation of a good teacher resource requires a lot of time and skills to structure the data that best meet those educational goals and objectives for the sake of which the resource was conceived and created. Not all teachers (and especially students) are capable of accomplishing this task. It is also quite a task to select the material and its content and scope. This activity activates and integrates all the knowledge and skills acquired and formed at the previous levels of use of Internet technologies. More detailed concept of web-quests, and examples of projects are presented in the author's distance course "Project-based learning and training in co-operation" on the distance learning platform http://el2.us.edu.pl/weinoe and on the web-sites: http://webquest.furgol.org/, http://www.ii.uni.wroc.pl/~eko/webquest/, http://artplastyk.republika.pl/portrety.htm, http://doradca.oeiizk.waw.pl/wqlista.htm, other.

Participation in the development of an educational portal (school, region, etc.). Use of educational portal resources

The development of thematic portals until recently was a very complex task and required developers to have advanced programming knowledge in the field of software development for web sites. Free software developers were first to realize these deficiencies, so they embarked on Creating Free Software content management systems (Content Management System) in short called CMS. A CMS should be understood as a platform allowing the user to build on their own information service or an Internet portal based on the pre-developed modules. The most well-known and popular CMSs include: Drupal, Joomla, Wordpress, Mambo and others. The Apache PHP Nuke is still used although it has lost some of its popularity. Depending on the specific type of CMS, the number of modules is different, but in all CMSs the following tools are always available: news, FAQ, Download, Links, Search, Surveys, and many others. To this list one can add other modules downloaded from the Internet or developed by oneself. Each module can be disabled at any time, or its availability will be limited to selected users. Blocks are elements of web pages that are displayed in the form of an independent frame. Modules are examples of such blocks (Smyrnova-Trybulska, 2012). Today, access to various IT systems to support the content management – Content management System (CMS) (including Open Source such as Drupal, Joomla!, WordPress, etc.), the use of which does not require advanced programming skills, yet they provide a wide range of different functions and capabilities of their use, for example, can be placed on the portal server educational resources (news, articles, notes, papers, didactic multimedia materials and other projects, including possible to copy on your computer (download)), create a catalogued Internet resource links to support the theme, a discussion forum, chat, create a glossary of terms, concepts (general and thematic), a vote (poll) on the topic of interest and much more. To participate in the development of this interesting and useful resource, you can bring the entire class of students or schools, but especially teachers, each of whom can oversee the information and educational resources and services to interact and communicate (Chat, Forum, an internal messaging system, etc.) users of the portal on your subject. An example might be sites http://erudyta.weinoe.us.edu.pl, www.interklasa.pl, www.profesor.pl, etc. The positive side of using this method is teachers' and students' familiarity with useful and modern multi-purpose tools as these systems are available, as well as the possibility of creating an educational portal of school or region that presents the achievements of the institution or region, as well as links to the most interesting and useful Internet resources.

For example, more and more Polish schools are using CMS for developing their school web-sites:

- http://www.zs4.wroc.pl/joomla/index.php, http://www.zs2-gostynin.edu.pl/index.php?option=com_frontpage&Itemid=1, http://www.gim1.cieszyn.pl/, http://www.sp1.mielec.pl/ index.php?option=com_frontpage&Itemid=1, other (CMS Joomla!);
- http://www.us.edu.pl, http://www.weinoe.us.edu.pl, http://krolowka.com/, other (CMS Drupal)
- http://www.szkola-liderow.pl/index.php, http://www.akcjadobrapolskaszkola.com/art/, other (CMS WordPress)

Development and conducting of distance learning courses using Content Learning Management System (CLMS MOODLE, Claroline, ATutor, Dokeos, etc.)

Today, various IT systems are available for for planning, organizing, and supporting distance learning (including Open Source: MOODLE, Claroline, Atutor, Dokeos, etc.). Their use does not require teachers (tutors) and users to have expertise in programming. These systems also provide a wide range of different functional characteristics, such as the ability to develop and deploy the system in distance learning courses that allow one to support virtually all stages of learning: planning, training, reinforcement, repetition, routine and final control, different types of interactions (as in synchronous or asynchronous mode), the means for discussion: forum, seminar, administration of the learning process (log (activity), evaluation, statistics, reports, etc.), the possibility of representing feedback and opinions about the course, both from the students and the teacher (the questionnaire, the voting (polling), questionnaire, etc.). It is important to emphasize that all of these systems are constantly developed and improved, for example, the system MOODLE now includes over 35 modules and their number is constantly growing. At the same time the functions of existing modules are being expanded too.

All teachers in a given school or region can be encouraged to participate in the creation and development of UP, each of them h can develop courses in their subjects. An example might be such sites as http://www.2lo.vdl.pl/moodle/, http://gim2mielec.kei.pl/moodle/, http://el2.us.edu.pl/weinoe, etc. The positive side of this activity is, on the one hand, familiarity of teachers and students with modern multi-functional and useful tools in form of the above systems, distance learning, and on the other hand, the possibility of creating a the school's or region's platform of distance learning, which will provide the possibility of conducting classes in the remote mode for different categories of users.

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Use all (or most) Web 2.0 services for development of one's own information and education environment

The highest and most advanced level is the one which integrates all the above described skills, simultaneously taking into account the implementation of the connectivism theory as a theory most adequately designed for the challenges of the digital age. Connectivism is a new theory (concept) of human learning. Its author is George Siemens, who described his theory as early as 2005 in a document entitled Connectivism: *A Learning Theory for the Digital Age*. According to him, learning is a process that is not under complete control of the learner and teacher. We do not have to have everything in our heads. The knowledge we have does not have to reside inside us it can be in areas outside of us (for example, organized resources, or databases), and it is our connecting to these resources that starts the learning process. The very act of connecting to (for education) is more important than what we currently know. The Connectivism theory assumes that we make decisions on the basis of a specific resource of information, which is constantly changing. New pieces of information are constantly input into this resource. The key skill is to distinguish what is relevant and what is not. Equally important is to realize at which moment in time the new information significantly changes the basis on which a given decision was made. In other words, "to know how" (know-how) or "to know what" (know-what) is replaced by "to know where" (know-where), because this is the key leading to the required body of knowledge. It becomes a meta-principle effective learning, as important as knowledge resources, which we already have (Sawiński, 2010).

Learning and teaching in the digital age can be performed according to several important principles: Preparation of information resources, networking with them and processing them; Knowledge (better *educational information*) discovery and ability to find and to show; Critical thinking, perception of connections between nodes; Selection the content of learning, assessment of their significance and independent decision.

More principles of connectivism can be viewed on the thematic Web-site (http://en.wikipedia.org/wiki/Connectivism) and in the theory (Downs, 2008), (Siemens, 2005, 2007). The authors of connectivism theory describe in their works (Downs, 2008) new types of educational resources (available and newly created), new concept of access to them and other important categories regarding learning and teaching process.

Information. Information becomes free and ubiquitous; easily found via personalized semantic social networks; data becomes embedded into learning resources. Learning resources as a thing - book, learning object, pages, video, audio, etc. Learning resources as events – class, lecture, seminar, conferences meeting, lecture, lessons, etc. The first two models are *information-theoretic* and *medium-based* models: they stress content; they stress rules. Learning resource as a flow: stresses experience; stresses learning recognition. What does personal learning look like? User generated content – personal, opinionated;

Interaction can be implemented across Games, Simulation, Training, Learning Objects. Games-based learning is becoming widely accepted; games and simulation are becoming more and more realistic; new tools and kits to help people program their own work. *Network of interaction* can be implemented across different services, such as Messenger programme (Skype, Yahoo messenger, Gadu-Gadu, etc.), Adobe Connect, Big Blue Button, etc., Forum, Social Network, other. Possible of implementation of the new kind of immersive learning (after natural integration of the constructivism, connectivism and other pedagogical theories). New roles – for the student, for teacher, for the rest of us – as teachers of Web of user generated content: Wikipedia (e.g. http://Wikipedia.org). Learning can be seen as a network phenomenon. There are different web-tools for creating environment for students and teachers: Second Life, WordPress, Diigo, other. But first we choose Learning Approach step by step: Strategy – Methods – Technology (http://apsblog.com/site/learning-architecture/learning-approaches (source, IBM))

Co-location changes. Learning and teaching is not going on only in traditional laboratory, classroom (Coaching, Mentoring, Interaction, Play, Creation), but also in virtual laboratories. Some good examples are described above. With such services as *Second Life, Adobe Connect, Elluminate,* etc. it is the possible to conduct effective cooperation and application of the Collaboration method (across: Conferencing, Meeting, Conversation, Co-creation, Teaming, Network). Collaboration is becoming more and more mobile; facilities for recording and capturing are also becoming available.

Simultaneously, some problems and issues are still arising (Downs, 2008) during the implementation of the connectivism theory and in the use of Internet services and resources in education such as too much information. There is the need for critical evaluation and verification of retrieved (found) information; too many resources to scan, new sources; localization, personalization, relevance. With the introduction of this type of educational activity, teachers should also pay special attention to critical thinking (critical evaluation of Web materials by students) and compliance with copyright laws.

Conclusion

This paper discusses teachers' levels of competence in the use of information and education Internet resources in the education process, which are very relevant for contemporary teachers. The author also describes examples and methodological bases for the implementation of these skills into practice at school. In the near future teachers will be tested in the use of information and education internet resources in teaching and learning. In the near future the next stage of research will be carried out to review the current level of teachers competences in using and education of information internet resources in the education process. Also, as part of the research, distance courses are being developed, available on the faculty distance learning platform (http://el2.us.edu.pl/weinoe) work is also continuing on developing postgraduate programs in the WEiNOE Faculty, the aim of which is to raise teachers' competence in the Silesian region in this respect.

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On Individually Adapted ICT Applications in Computer-supported University Instruction

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Abstract

The paper presents the research results reached within the project dealing with the teaching and learning process reflecting individual learning styles. In the first phase the respondents´ ways of processing information were detected by the Johnston's Learning Combination Inventory. Then, resulting from the learning style theory and the concept Bloom's digital taxonomy and collaboration, the IT application was designed generating appropriate types of study materials, assignments, testing methods and related activities towards tailoring the learning to student's needs. Finally, this process applying both the computer-assisted and computer-managed approach to instruction was piloted and the collected results are provided in the form of didactic recommendations. These are structured according to types of information processors and analyzed from the learner's and teacher's point of view. The recommended learner's approach focuses on both appreciated and frustrating activities, while teachers are provided with advice on how to run the process of instruction without been frustrating to learners.

Keywords

Tertiary education. Computer-assisted instruction. Computer-managed instruction. IT applications.

Introduction

Since 2010 the three-year project "A flexible model of the ICT-supported educational process reflecting individual learning styles" has been running at the Faculty of Informatics and Management, University of Hradec Kralove, Czech Republic. 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. Their approaches to learning, i.e. the learning styles, can be described from various points of view, e.g. as:

- preferences of one mode of adaptation to the others; but the preferences do not operate to the exclusion of other adaptive modes but vary from time to time and situation to situation (Kolb, 1981),

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- a set of cognitive, affective and psychological factors serving as relatively stable indicators of how a learner perceives, interacts and responds to the learning environment (Keefe, 1979, in Coffield et al., 2004),
- a description of attitudes and behaviour determining an individual's preferred way of learning (Honey&Mumford, 1992).

There is an important difference between the style and ability. According to Sternberg (1999) ability refers to *how well* someone is able to do something, while a style refers to *how someone likes* to do something. Therefore a style is *a preferred way of using abilities* which an individual has.

There exist various learning style models which were worked out by different researches at isolated places. Despite this there exists a conceptual overlap of distinct extent. Newcastle University Report on learning styles (Coffield et al., 2004) found 71 of them worth consideration. Coffield categorized them into 13 groups; five of them are generally considered major ones, and most of them resulted in the special tools for detecting the learning style:

- the model of constitutionally-based learning styles and preferences (Dunn, 2003);
- the model of the cognitive structure family resulted in the Cognitive Style Analysis (CSA) (Riding, Cheema, 1991),
- the model of the stable personality type which resulted in the Myers-Briggs Type Indicator (MBTI);
- the model of flexibly stable learning preferences, resulting in the Kolb's Learning Style Inventory (LSI) (Kolb, 1981), Honey-Mumford's Learning Style Questionnaire (LSQ) (Honey, Mumford, 2002), and the Richard Felder and Barbara Solomon's Index of Learning Styles (ILS) (Felder, 1996) ;
- the model of learning approaches and strategies which resulted in the Pack's Spy Ring History Test and the Smuggler's Test (Pask, 1976), and the Vermunt´s Inventory of Learning Styles (ILS) (Vermunt, 1996).

These are the basic learning style models. Another approach to detecting the student's learning style was applied within the above mentioned research project – the Learning Combination Inventory (LCI) designed by C. A. Johnston (1996).

Project description

Christine A. Johnston from the Rowan College of New Jersey has been dealing with the nurturing of real schools, students and educators through focusing on efficient communication, clear understanding of the learning process, and a commitment to the student-centred classroom for several decades. The traditional learning process is based on belief that all learning occurs as part of learner's intelligence. The greater the intelligence is, the more a child can learn. Johnston attracts attention to the verb can, as no one says will learn (Johnston, 1996). For decades, intelligence has been measured by examining a child's cognitive processes based on "information input – manipulation with information – information output" pattern, and the learner's level of cognition has been measured by the performance on standardized tests. Johnston started her own process of seeking how humans learn. She partly agrees with theories of Piaget, Jung, Skinner, cognitive psychologists etc., i.e. with the tripartite theory of the mind (feelings, thoughts, behaviour) which proves in cognition (i.e. the processing self), conation (i.e. the performing self) and affectation (i.e. the developing self). Then, another question appears, i.e. what motivates the learner to learn? For centuries, the will has been closely aligned with the concept of motivation, being described as the passion, the energy that moves individuals to actions. Current psychologists refer to the will as the drive to act that is uniquely individual. According to Assagioli (Johnston, 1996) “the will is a specific power which rises up within each of us to give the individual the inner energy to wrestle, cope with, and integrate the whole of our self.” To work efficiently, the will must be supported by the why-question. It can show the learner whether the learning content is relevant, meaningful and applicable to real life. In other words, learners want to discover the wholeness of learning, and it will spark their will to learn. And, the will is the degree to which the learner is prepared to invest in the learning process (Johnston, 1996).

To describe the whole process of learning, Johnston uses the metaphor of a combination lock saying that cognition (processing), conation (performing) and affectation (developing) work as interlocking tumblers; when aligned they unlock an individual’s understanding of his/her learning combination. The will lies in the centre of the model, and interaction is the key. She compares our learning behaviour to a patterned fabric, where the cognition, conation and affectation are the threads of various colours and quality. It depends on individual weaver (learner) how s/he combines them and what the final pattern is (Johnston, 1996).

For decades she has been collected feedback from learners from 6 to 22 years of age within the USA and abroad and finally designed the Learning Combination Inventory (LCI) consisting of 28 statements, responses to which are defined on the five-level Likert scale, and three open-answer questions: What makes learning frustrating for you? How would you like to show the teacher what you know? If you were the teacher, how would teach your students learn?

The responses are categorized into four describing the schema that drives their will to learn. They are as follows:

- Sequential Processors (S), defined as the seekers of clear directions, practiced planners, thoroughly neat workers.
- Precise Processors (P), indentified as the information specialists, info-details researches, answer specialists and report writers.
- Technical Processors (T), specified as the hands-on builders, independent private thinkers and reality seekers.
- Confluent Processors (C), described as those who march to a different drummer, creative imaginers and unique presenters.

Application generating the course content

The application (plug-in) supporting the flexible model of instruction within the LMS WebCT was designed to re-organize the introductory page of the e-course where the Course Content is presented. The criterion under which the application works is the student’s individual learning style. Single items of the Course Content, i.e. Study Materials, exercises, assignments, assessments, communication and other activities applied within the process of instruction, are evaluated from the point of appropriateness to it. Then, the plug-in selects those types which accommodate learner’s needs. To reach this objective, not only data on each student’s learning style are required but also single items of the Course Content and relating activities are classified according to the suitability to a certain style of learning, i.e. whether the material is appreciated, accepted or rejected by the student. Finally, single types of study materials and activities are matched to each student’s pattern and the course is tailored to the individual student’s needs. Results will be evaluated within the pedagogical experiment following the “pre-test – instruction – post-test“ structure. Respondents are divided in two research groups. The experimental group studies in the course where the application is implemented, the control group uses the traditional course without the application. All activities of each student in both groups are virtually monitored. Finally the study results of the tests will be statistically processed and evaluated.

Research results

In the first phase of the research four types of processors and three combinations were detected by the LCI within the sample group of 500 students of the University of Hradec Kralove. The structure of the group is displayed in table 1.

Table 1: Structure of the sample group.

Type of Processor	I use this first (%)	I use this as needed (%)
Sequential	37.9	1.5
Precise	7.6	1.5
Technical	31.8	3.0
Confluent	3.0	1.5
Sequential/Technical	15.2	-
Sequential/Precise	3.0	-
Technical/Precise	1.5	-

Responses to questions 1, 2, 3

In the second phase of the research the three questions (1 – 3) were analyzed independently from the 28 statements of the inventory. The collected responses cover a wide scale of answers. When preparing the research process we intended to display the whole scale of responses supported by statistic data, but finally we recognized the data proved neither significant, nor slight differences because the same or very similar responses were provided by most students. Below, the responses to the three questions are structured into groups according to the preferred type of processor. Those of low number of respondents are not included.

Sequential processors are frustrated if they do not understand the instructions, instructions are not clear, exact, complete, there is too much information to be processed, they cannot get (find) the required information, memorizing, not understanding is emphasized, writing is preferred to doing, study materials are not available in the electronic form, study materials must be searched from several sources, such learning content is required which they have mastered before, so they do not learn new things, the learning content is not clearly structured, the new knowledge is theoretical and cannot be applied in the real life, they are disturbed by noise, music, chaos, there is a low quality of light, or air, the teacher is not prepared well for the lesson, they are tired, lazy, short of time for studying. Eleven per cent of students declare there is nothing to frustrate them, as they are used to adjusting to the given conditions. Sequential processors would show what they have learned mostly in the form of written tests or essays, oral exams defending their opinions, without other students presented, in discussions with teacher who can immediately correct mistakes, in individual projects, practical examples and applications, in oral presentations.

Technical processors do not like if instructions are not clear so they are not sure what to do and how to continue, or the instructions restrict their activities and ideas, if they are disturbed from work being asked irrelevant questions, they are tired, there is noise and lack of time or motivation, the new knowledge is not useful for the real life, they cannot discover how things work, and why. Technical processors prefer individual long-time projects (the team work was not mentioned by students of any processor), they accept both oral and written exams, discussions of practical solutions with the teacher only, not been disturbed by other students.

Sequential/Technical processors do not feel comfortable if instructions are exact and complete, they understand them restrictive, they are frustrated if study materials are not well structured, or there is lack of them, they prefer the printed version to the electronic one, and if they are disturbed by the teacher or other students. Sequential/Technical processors emphasize the combination of tests followed by discussions, or possibility to take one topic from others which is close to their interests, solve it and present their opinion and results.

Precise processors would prefer the same ways of presenting their knowledge, i.e. written tests, oral exams, and practical doing. Precise processors hate if they do not receive enough information and have to search it by themselves, they do not understand the topic from the text in study materials, and cannot discuss the problem with the teacher immediately, they do not like the learning content which they cannot describe in their own way, they hate noisy environment and if instructions are not clear.

If they were teachers, the *all types of processors would have students learn* the most important topics only, which are closely related to real life, by doing. The traditional approach to instruction is accepted, i.e. theoretical explanations, examples, exercises, but strong emphasis is paid to the practical use of new knowledge. Role-playing, gaming, competitions, positive class environment, good mood, entertaining forms of work etc. are mostly proposed but not a student presented any concrete activity which s/he involved in the described categories.

Once these hardly expected data were collected, we should have in mind each type of processor understands the single item in the own way, i.e. in accordance to preferred ways of processing information. These days, when the implementation of information and communication technologies in the field of education has become standard, subsequently the reflection of this process appeared within the Bloom's taxonomy, which is understood to be the adequate method for defining educational objectives. The concept of the Bloom's Digital Taxonomy and Collaboration was introduced by A. Churches (2010). The author, teacher and ICT enthusiast from New Zealand, describes digital tools which he applies in his lessons. The most suitable ones, frequently used and appreciated by students, are presented below, being structured according to the six taxonomy levels of the Bloom's taxonomy. Special attention (and column) is devoted to the field of Communication which is understood a crucial competence penetrating all teaching/learning activities. Despite the Bloom's digital taxonomy of educational objectives was originally intended for the process of teaching/learning in general, i.e. for all subjects, numerous activities can be applied in the field of foreign language instruction. Churches emphasizes and recommends the activities displayed in figure 1 to teachers´ attention.

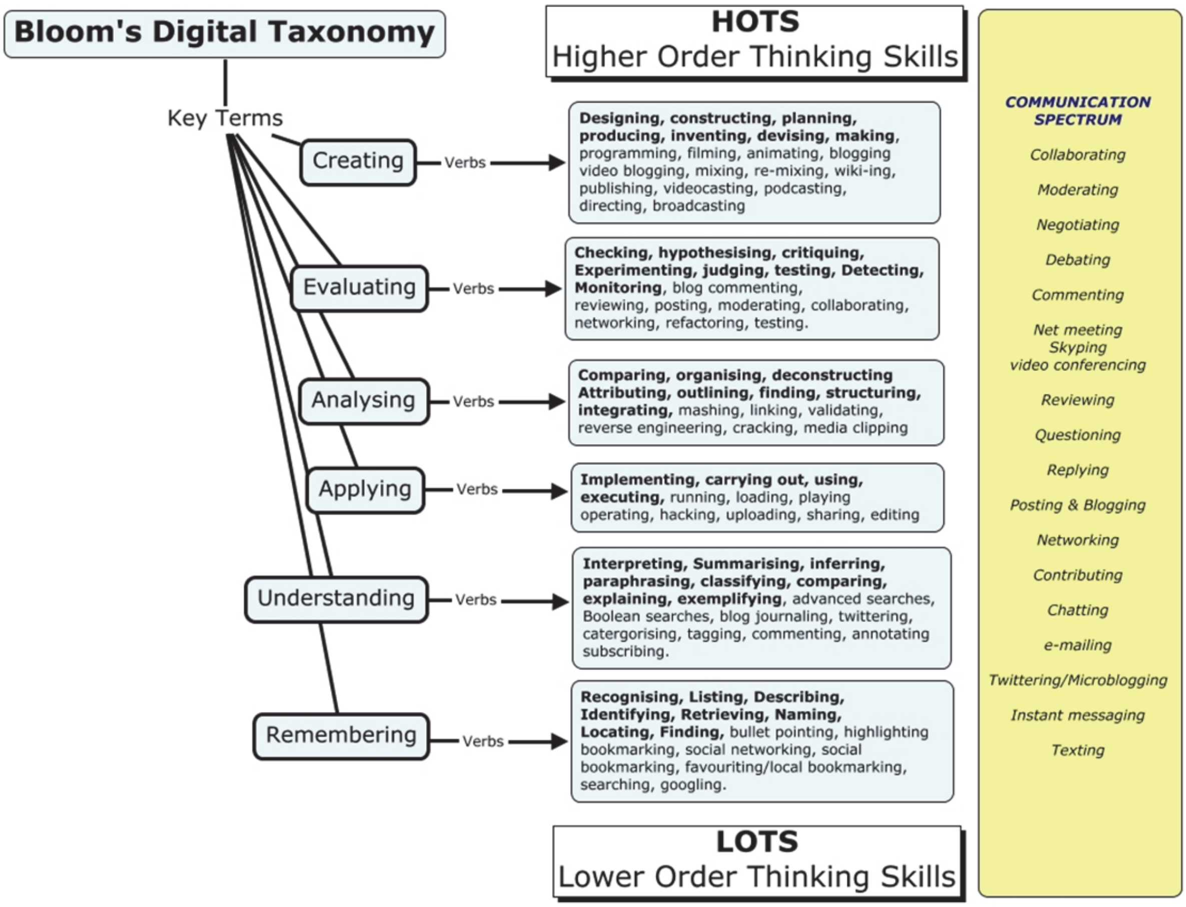

Figure 1: The concept of the Bloom's Digital Taxonomy and Collaboration.

The concept provides a wide range of ICT-supported activities which can be used by learners of all styles. Above all, in the extra column Churches provides the communication spectrum of activities from lower to higher levels: texting, instant messaging, e-mailing, chatting, networking, blogging, questioning, replying, reviewing, videoconferencing, skyping, net meeting, commenting, debating, moderating, collaborating etc. To sum up, Churches work gives educators an excellent framework to begin and/or assess their digital practices. We recognize that he differs from numerous teachers who tend to push the "search" concept, and provides strong support to networking, social bookmarking, blogging, and at the highest level to producing unique items to enhance the learning. The author highly appreciates Churches´ concept and considers it a wide didactic database of activities where every student of any learning style can accommodate his/her needs, the field of foreign languages included.

The following table (table 2) presents a list of single activities structured according to the type of processors and their combination as they were detected in the first phase of the research.

Table 2 Learning activities structured according to the detected types of processors.

	Sequencing	Precise	Technical	Confluent
APPREACIATES	-clear instruction, -verifying theory in practice, -much practicing and doing exercises in class, -memorizing correct answers, -planning, -mastering single items step-by-step -collecting, summarizing, classifying information -creating own system of storing and recalling information	-correct, precise, detailed information, -having all and full answers -collecting and analyzing information, asking questions -concentrating on searching own sources, verifies them	-technical, logical thinking, - hands-on activities, -autonomy, -having a tool to create, build, demonstrate what he knows, -having a challenging project, and solving it independently -thinking about practical use of information, eliminating those of no value -having his own way of processing information, analyzing the predefined information, applying trial-and-error approach	-possibility to apply own ideas, concepts, theories, -working with creative people having their own approach, -working in the relaxed way, -designing pieces of art -considering information from the unique point of view
FRUSTRATING	-instructions are not explained properly, -teacher changes instructions during the work	-there is lack of detailed information, lack of answers, corrected by teacher, so the student cannot use them for revision and memorizing	-taking notes is required, -hands-on activities are not required, -there is applied learning without doing	-being caught in teacher's style (concepts, methods, forms, approaches, …), - forced to work according to teacher's instructions, -he has an idea, but not allowed to apply it

The presented learning activities should be emphasized by recommendations in the following table and are provided to both teachers and learners (table 3). In the ICT-supported instruction the variety of didactic means, i.e. learning methods, organization forms, material didactic means, is wild enough to accommodate needs and requirements of learners of all types of processors (Karásková, Hartingerová, 2007).

Table 3 Didactic recommendations

	Teachers are expected to	Learners are expected to
SSEQUENTIAL	-make sure all instructions are clear and were explained step-by-step, -provide a model or example, - to repeat the instruction appears more times, -provide students enough time, -not to change instructions, -display the content structure of expected outcomes, -use numbering within the structure, procedure etc.	-not start work until they know what is expected from them, -set the main objective, and keep it, - divide each activity into three parts: beginning, middle and final one, then follow the procedure. -schedule their school day and after-school time to be able to finish the work which is expected from you, -plan everything (doing homework, spending leisure time, content, questions, key ideas), and only after the planning start the work, -have enough time to finish the activity and check your answers.
PRECISE	-make sure instruction provide detailed content, -provide references to other, more detailed sources, more detailed information on instructions, work etc., -provide students with detailed notes on everything what you say, -pay attention to both the providing information and finishing student's work.	-not trust their memory – put down, times, events, deadlines, -learn by practising answers to questions, using data and events, -apply elimination and deduction rather than guessing answers, -save their assignments and tests for future use, -put down their questions to teacher, as well as notes, -listen to other students´ questions to understand why some information is important and correlates to the structure.
TECHNICAL	-make sure the student understands the consequences if he does not follow the instructions, - perform the hands-on activities relating to the field, -let students learn in the hands-on way, apply problem-solving and immediate evaluation of the activities, -accept the trial-and-error approach, students will not take notes, and then they will need your advice and support to fulfil the expectation (i.e. assignment) in the paper form	-analyze how things work, what they consist of, -plan their school activities to have enough time for sports, -set the time for doing what you are most interested in, -keep your attention to the activity you are working on.
CONFLUENT	-accept students will not read instructions and follow them – help them understand when their independent work is desired or acceptable, and in what situations following the instructions is strictly required, -make sure students know that taking a risk in applying new approaches is appreciated, -understand that some students learn more by making mistakes, -discuss possible ways of doing activities and reaching targets, -detect some students will have the same problems for several times, -accept some students will have more ideas and consider more approaches, which may look like they are not able to finish the work and keep the deadline	-not get excited about mistakes, they are a step towards reaching the target, -find supporters of your ideas, -consider various approaches before they start work,. -be in contact with others to receive new ideas, and tailor them to your needs, - not waste time and start with the task even if they do not have all information, corrections can be made later on, -approach creatively to some small tasks – after doing that they will feel better in taking risks in important projects.

These activities should be applied in the process of instruction individually according to the student's learning style pattern. Within the above mentioned project the online course Library services was designed which is running on this principle, i.e. various types of activities are provided to the learners, and the offer is managed by the application described below.

Conclusion

Current orientation of university education, which is changing under the influence of latest technology development and new key competences, can be researched from various, different points of view. The ICT-supported instruction has been spreading because of growing popularity of digital technologies in general. Another reason is it enables easier and more complex realization of the process of instruction, offers the choice of place, time and pace for studying, allows an individual approach to students preferring a certain learning style. These are the key values important for the efficiency of the process. Material and technical requirements having been satisfied, strong attention must be paid to didactic aspects of instruction. To contribute to this process is the main objective of the project.

The partial results clearly show the Johnston's model really works, and how important it is to take into account the whole pattern which includes all the four types of processors in some extent. If the strongest one is applied only as the main criterion, as we did, no adequate, significantly different responses occur. We conclude there is no difference in the scale of students´ opinions under these conditions. To summarize the most frequent responses, students of all types of processors do not like to be disturbed from work, and being short of time, they would like to have entertaining environment at schools, select such ways of evaluating their knowledge which do not stress but motivate them to further study. The question is whether this is not the added value of the learning style application to the instruction. Gregorc (1984) proved that only students with very strong preferences do not study effectively when another style is required. On the other side, Felder (1996) says partial mismatching supports the development of new learning strategies. All the methods and forms, mentioned or recommended by students, are considered traditional ones these days, none of them is revolutionary, providing the immediate success in foreign language learning and teaching. If modern information and communication technologies are implemented in the process of instruction, requirements of various learning styles can be satisfied, both in foreign language learning/teaching and other subjects because of the wide range of tools provided.

From the results presented above it can be seen there is no definite solution. It is important for each student to be aware of his/her learning style, know what his/her strengths and weaknesses are and be provided a variety of instructional methods to choose the most suitable ones. In the days of fast technical and technological development, globalization, demand for further, lifelong education, the importance of education is increasing. These terms support the development of the whole system of education, which is often put into effect in a distance way being supported by ICT. Teachers´ and students´ awareness of styles may help substantially in this process.

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On Creating Animations in System Maple

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Abstract

In recent time using various application programs (e. g. Macromedia Flash), is very popular and usable in process of creating web pages. Macromedia Flash is determined for developing and creating the interactive graphic interfaces for web applications. The various types of animations are undoubtedly their inseparable component. This article deals with the animation as one of many graphical possibilities of the CAS system Maple. Our contribution introduces way for improving acquisition process of students in mathematics. Many pages were written on using Maple in calculus, mathematical analysis, linear algebra and algebra, see for example (Došlá, Plch, Sojka, 1999 and Plch, 2000). We are going to show some animations in Maple, which lead to better understanding and motivating students of mathematics.

Keywords

Animations. Curve, surface, solid, and object representations. Geometric algorithms, languages, and systems. Modeling packages.

Introduction

Maple is one of the famous systems for symbolic and numerical mathematics. The adjective numerical means that it can perform basic arithmetic operations like addition, subtraction, multiplication and division, but in contrast with traditional programming languages in which the numerical calculations are usually inaccurate, they almost always are represented by number with floating point operations, the mantissa has a limited number of digits, we can work with numbers with essentially arbitrary precision in Maple. Symbolic adjective emphasizes that the final aim of solving of a mathematical problem is to express the solution in explicit analytic form or find its symbolic approximation. Thus, calculations are carried out strictly in accordance with the rules of algebra. In the last fifty years great progress has been done in mathematics in theoretical foundations of symbolic and algebraic computation and algorithms. This led to constitution of a new global branch that is usually denoted by the English acronym CAS (Computer Algebra System), thus computer algebra systems. Such systems automate mathematical computations of all sorts. Many types of these systems have been developed. Their list can be found e. g. on the web at http://www.SymbolicNet.org/systems/. Notice that Maple, Mathematica and MATLAB belong among the most popular and used. There is more detail information in (Buchar, 1994, Plch, 2000).

Some facts about Maple

System Maple has been developing during the past 30 years together at several universities, the largest share of the work was done under the combined group of scientists called "Symbolic Computation Group" at the University of Waterloo in Canada and then in federal technical university ETH Zurich in Switzerland, where part of this group passed in 1990. Maple was commercialized and its further development is governed by a Canadian company Maplesoft Inc. based in Waterloo and 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 you to perform both symbolic and numerical calculations, show graphs of functions of one and two variables. We can involve all computations by some text and create hyperlinks (this closed block is named as "worksheet"). Maple worksheet created in this way saves files in its special format MW, which is stored in XML format. Files can be also exported to LaTeX, HTML, RTF and MathML, which is an extension of HTML for the presentation of mathematical texts on the web. Maple also allows automatic conversion of their commands and procedures in the programming languages C, Fortran 77 and Java. Maple is based on a programming language similar to Pascal fourth generation with many predefined functions and procedures. Maple involves many functions covering various parts of mathematics such as differential and integral calculus, linear algebra, algebraic equations, differential and difference equations, geometry, graph theory and logic. (Bernardin, 2011, Maplesoft, 2011)

The Maplesoft product suite includes beyond Maple the relatively new product named MapleSim. MapleSim is a physical modeling and simulation tool built on a foundation of symbolic computation technology. It efficiently handles all of the complex mathematics involved in the development of engineering models, including multi-domain systems, plant modeling, and control design. MapleSim reduces model development time from months to days while producing high-fidelity, high-performance models.

Using maple in educational process

It is clear that the role of technology and using specialized software in educational process is growing in recent time (Niess, 2006), but this is not just a feature of recent decades, what is nicely expressed in the following citation.

“Educators have a long history of using technology, from the abacus to the Internet, to enhance teaching and learning. The advent of the Internet has resulted in the creation of many educational web sites, both commercial and academic, targeting a wide variety of audiences. Some sites focus on students and parents, with interactive games and tutorials, while other sites are aimed at teachers, providing class activities, lesson plans and other pedagogical content.” (Kellar, 2003)

Teaching mathematics with the help of Maple has many challenges, for example it allowed decreasing funding, shortening student attention span, heavy demands on instructor time, increasing expectation for student results and difficulty acquiring support staff. Maple gives a lot of benefits for mathematics education. It creates an engaging lesson, interactive classroom environment, increases student comprehension, minimizes preparation time and facilitates corrections for teachers. Moreover, the significant upgrade of Maple, called Maple T.A., is an easy-to-use web-based system for creating tests and assignments, and automatically assessing of student responses and performance. Maple T.A. eliminates the headaches of traditional placement testing as it enables automatic grading, place students accurately, before they arrive to campus and placement before scheduling.

Selection of certain orders of Maple

In this section we describe the Maple commands that we need in the following sections.

The `seq` command constructs a sequence of some values. A typical calling sequence is `seq(f(i),i=m..n)`, which generates the sequence

$$f(m), f(m+1), \ldots, f(n). \tag{1}$$

For example command in the form `seq(n^2,n=5..10)` to create the sequence of six members in the form of the squares of natural numbers from 5 to 10.

Maple uses packages for better orientation in the sets of statements which relate to one type of problems. For example, if we want to use a set of commands for working with graphic objects, we need the package named **plots**.

The statement with is designed for opening Maple package to be available included statements at the interactive level. Maple offers a full programming language that allows you to write custom functions, procedures, and algorithms. Here is a structure of procedure in Maple (we named it as `ExampleProcedure`):

```
ExampleProcedure :=
      proc(...sequence of variables...)
  ...sequence of statements...
      end proc;
```

Maple graphic ability

A visual form of information is used very often, because graphic shape is intuitive, fast understandable and memorable. Visualization from the point of view tools of IT is understood as a set of tools for visual analysis (Plch, 2010). Let's focus on some graphics options in Maple. Firstly, we show how to draw the graph a function of one real variable, and function of two variables. The basic statement for creating of two-dimensional graphs is named **plot**. In its simplest variant, it is sufficient to specify a function whose graph is created, and interval of independent variable on which the graph is restricted (Maple automatically selects the scale on the both axis to be visible on the whole graph of functions in the specified interval). Similarly Maple uses statement **plot3d** to display the graph of a function of two independent variables. In its basic form we must always enter definition rule of the plotted function and a range of plotting on both axes of independent variables.

There are three different object types for plotting in the plane and space (if a z value is also supplied): curves, points and polygons. The **CURVES** structure defines a sequence of curves where each curve is made up of multiple line segments. Similarly the statement **POINTS** defines a set of points located in 2 or 3 space and **POLYGONS** structure defines multiple polygons. A useful statement is **COLOR**(RGB, ir, ig, ib), which we set the coloring of the used object (variable ir, ig, ib, must be from interval [0, 1], to indicate the intensity gradually red, green and blue). All these graphics commands must be entered as parameters in the statement **PLOT**. The default form of statement PLOT has output directed to a monitor, if we want to change the output to a certain file type, then we have to use the command **plotsetup** that has the format

```
plotsetup(typeOfFile,plotoutput=`FileName`,
            plotoptions=`AditionalOptions`);
```

Animations in Maple

In Maple, we can not only draw graphs, but also we can perform simple animation. The reader can find problematic of animations in many papers (Hubálovský, 2010, Magdin, 2010, Magdin, Turčáni, Vrábel, 2009, Tomanová, Cápay, 2010). It arises from a sequence of images. Images are in film terminology named frames, depending on some animated variables. This statement is named **animate** and it is part of package **plots**. Its input parameters are gradually the name of the procedure giving a graphic output, the input variable sand the intervals of values of animation variables. For example we can easily animate statements **plot** and **plot3d** for plotting graphs of functions that we show in the following examples.

Example 1.

Do animation of amplitude of quadrate of sine wave.

We will construct animation by the following way:

```
with(plots);
animate(plot,[sin(t)*sin(x)^2,x=-10..10],t=0..2*Pi);
```

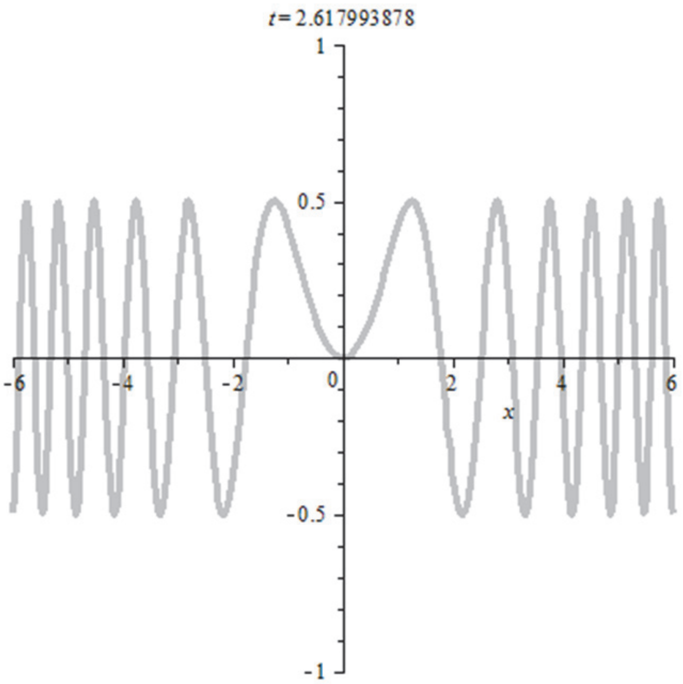

Figure 1: Animation of graph function of one variable

Example 2.

Do animation of a radius of a sphere.

We will construct animation by the following way

```
with(plots):
animate(plot3d,[[sin(t)*cos(u)*cos(p),
      sin(t)*sin(u)*cos(p),cos(t)*cos(p)],
      t=0..Pi, u=0..2*Pi], p=0..Pi);
```

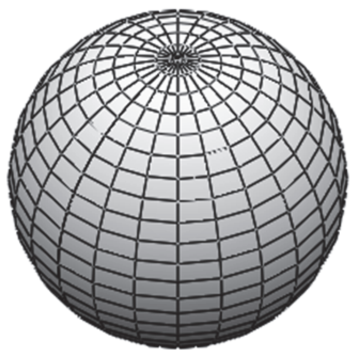

Figure 2: Animation of a radius of a sphere

Two concepts of teaching the theme of roulette in mathematics university level

In this subsection we will focus on the problem of construction of different types of roulette, thus a curve generated by a curve rolling on another curve. Usually, students of mathematics are learning on a construction of them in the subject which deals with planar geometry and problems connected with their areas and lengths that appear in mathematical analysis. The “rolling definitions” of these curves are relatively simple and understandable, but most of students have sizeable problems to imagine the final form of curve. Hence the possibility to prepare animation of formation of this curve is very useful tool in educational process generally and in the process of teaching of programing in software Maple specially. Now we will concentrate to programming of animations of two types of roulettes, namely astroid and epicycloid (we show which way the resulting animation can be saved as GIF file type too).

Example 3.

Do animation of an astroid, which is formed by the locus of a point, attached to a circle with radius *r/4*, that rolls on the inside of another circle with radius *r.* This curve has parametric equations

$$\begin{aligned} x &= r\cos^3 t, \\ y &= r\sin^3 t, \quad t \in [0,2\pi]. \end{aligned} \tag{2}$$

```
    astroid := proc(s)
    PLOT(
      # ROLLED INNER CIRCLE
    CURVES([ seq([3/4*cos(s)+1/4*cos(t/20.),
3/4*sin(s)+1/4*sin(t/20.)], t=0..128) ]),
      #  FIXED OUTER CIRCLE
```

```
        CURVES([ seq([cos(t/20.),sin(t/20.)],t=0..128) ],
COLOR(RGB,1,0,0)),
       # ASTROID
     CURVES([ seq([cos(t/20.)^3,sin(t/20.)^3], t=0..20*s) ]),
       # POINT DRAWING ASTROID
         POLYGONS([
seq([cos(s)^3+1/40*cos(t/20.),sin(s)^3+1/40*sin(t/20.) ],
t=0..128)], COLOR(RGB, 0,0,0))
          )
     end proc:

     plotsetup(gif,plotoutput=`c:\\plotAst.gif`,plotoptions=`portrait
,noborder`);
     animate(astroid,[t],t=0..2*Pi);
```

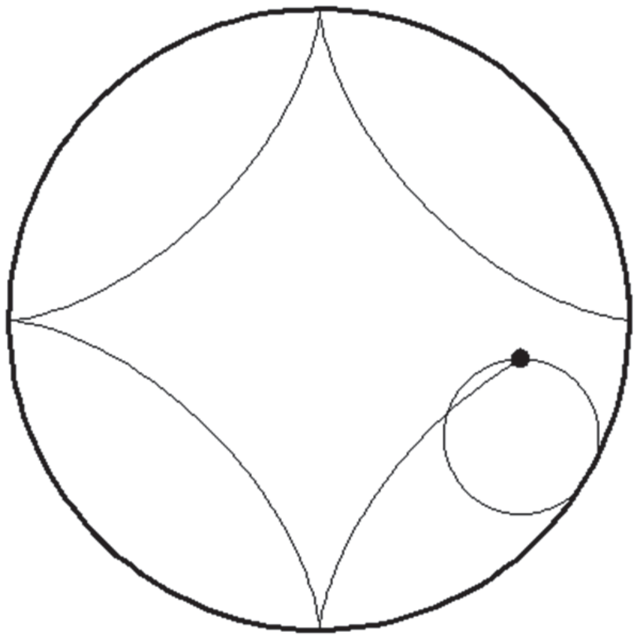

Figure 3: Animation of astroid

Example 4.

Do animation of an epicycloid, which is formed by the locus of a point, attached to a circle with radius *r*, that rolls on the outside of another circle with radius *R.* This curve has parametric equations

$$
\begin{aligned}
x &= (r+R)\cos t - r\cos\frac{r+R}{r}t, \\
y &= (r+R)\sin t - r\sin\frac{r+R}{r}t, \quad t\in[0,2\pi].
\end{aligned}
\tag{3}
$$

```
     epicycloid := proc(r,R,s)
     PLOT(
     # ROLLED OUTER CIRCLE
      CURVES([ seq([(r+R)*cos(s)+r*cos(t/20.),
      (r+R)*sin(s)+r*sin(t/20.) ],
      t=0..128)]),
```

```
# FIXED CIRCLE
CURVES( [ seq([R*cos(t/20.),R*sin(t/20.) ], t=0..128)],
COLOR(RGB, 0,0,0), THICKNESS(3) ),
# EPICYCLOID
CURVES([ seq([(r+R)*cos(t/20.)-r*cos((R+r)/r*t/20.),
(r+R)*sin(t/20.)-r*sin((R+r)/r*t/20.) ], t=0..20*s)]),
# POINT DRAWING EPICYCLOID
POLYGONS([
seq([(R+r)*cos(s)-r*cos((R+r)/r*s)+1/8*cos(t/20.),
(R+r)*sin(s)-r*sin((R+r)/r*s)+1/8*sin(t/20.) ],
t=0..128)], THICKNESS(2), COLOR(RGB, 0,0,0)),
AXESSTYLE(NONE))
end proc:
```

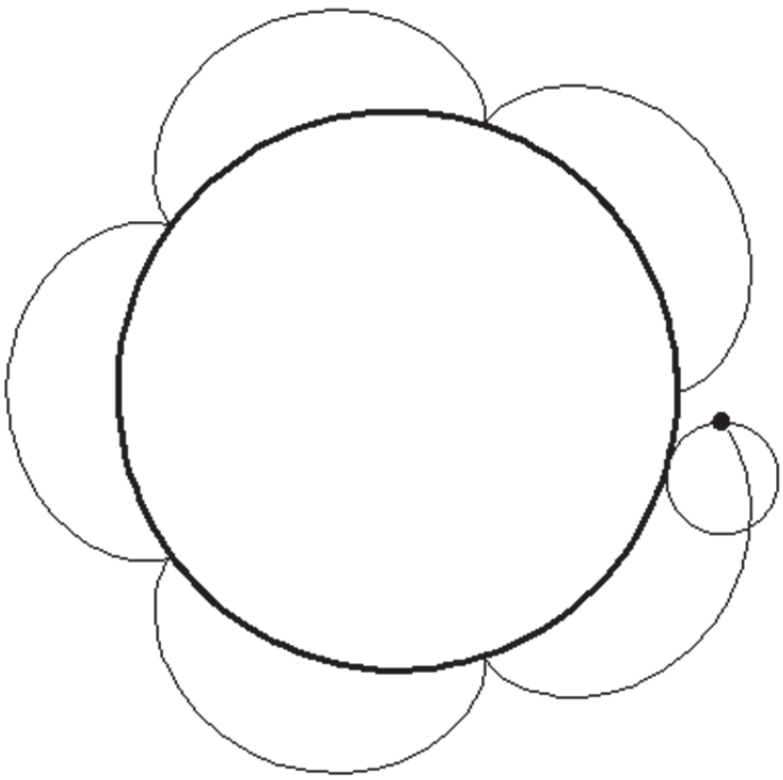

Figure 4: Animation of epicycloid

Conclusion

In this contribution we have shown some examples of creating animations using system Maple in the plane. In the similar way we can prepare animations in the space, but in this case we have to use many facts from computer geometry, for example linear transformations as translation, rotation and dilation (Martišek, 2002). Further we have discussed on challenges of using modern technologies in educational process slightly more general and primarily on using products of Maplesoft™ as software Maple and system for creating tests and assignments Maple T.A., which is destined for wide using at universities. This is documented by the University of Waterloo, which announced that Maple

T.A. enabled them to solve familiar problem with growing class sizes and decreasing budgets for teaching support. This original approach leads to savings hundreds of teaching assistants and undergraduate graders to help with the grading without compromising the quality of all mathematical courses at this university.

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Modelling the Student´s Transition Through the E–course „Discrete Math“ Using Petri Nets

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Abstract

Authors deal with the clarification of the issue of importance and justness of individual topics of the subject „Discrete Math“ in the teaching of technical-system subjects in the study programme Applied Informatics. Justness and importance of individual topics were analysed based on the evaluation of questionnaires, in which pedagogues teaching professional IT subjects alloted weighted coefficients to individual thematic units. Weighted coefficients were alloted based on the significance of the given topic of the subject Discrete Math, with regard to the IT subject they are teaching. Drawing from the results, authors of the contribution offered a proposal of the structure and adjusted the contents of the subject Discrete Math 1 and Discrete Math 2 in the form of an electronic support and Web 2.0 technology in the form of an e-course. Upon designing the e-course, experience with the creation of linear and branch teaching software were used. The main task of the linear teaching software is to ensure that all students have a fixed and definite sequence of steps in one line. The contents of education is presented in defined time intervals, in small sections, however, the best way is to present just a single section in each step. This teaching software was used with topics, which obtained the smallest weighted coefficient. The branch teaching software was applied with topics with the highest weighted coefficient. Upon solving the problems, the branched (non-linear) teaching software admits various procedures. Finally, alternatives of the software lead to the successful joint coping with the problem. Every student, however, takes his/her own way, while the length of study of individual parts of the e-course corresponds to his/her personality, knowledge and capability. For the simulation of the transition of students through individual lessons as well as the whole course, authors employed the method of the teaching process simulation using Petri nets.

Keywords

Discrete Math. Modelling and simulation. Petri nets. Technology Web 2.0. E-learning 2.0.

Introduction

Discrete Math is a rather new field of mathematics dealing with discrete mathematic structures. In their contribution authors describe the analysis of the current state of teaching Discrete Math, the justness of individual topics of the subject Discrete Math for individual subjects of the study programme Applied Informatics/Bc. Drawing from the obtained knowledge authors designed a new structure and content of the e-course of the subject Discrete Math with the support of Web 2 technology. The last chapter is devoted to the modelling of the transition of the student through the course using Petri nets.

Analysis of the current state of teaching discrete math

Mathematics and informatics – what they have in common and whether it is possible to separate them? These issues are analysed in the contribution, however, the answer is quite clear.

Discrete Math is a rather new field of mathematics dealing with discrete mathematic structures, which can be characterized by whole (integral) numbers, and are thus „countable“. It is an opposite of mathematics, which deals with continuous structures characterized by real numbers, such as mathematic analysis. Development of discrete math was conditioned mainly by the development of informatics. In fact, discrete math is often understood as a part of informatics. Some mathematicians integrate only new mathematic disciplines, which originated in connection with the development of computer technology, into discrete math (Jablonski, 1984).

Discrete math is a standard component of education in informatics. The subject Discrete Math is an obligatory subject not only in study programmes of informatics fields of study in the Slovak and Czech Republic, but also in other countries, where Informatics is taught. This information was obtained through an analysis of web-sites of individual universities in Slovakia and abroad. An important form, which offered relevant information on the study of informatics, were information sheets of study programmes based on the contents of which it was necessary to compare individual thematic units of the subject and to find out to what extent they are consistent with the information sheet, according to which Discrete Math is taught at the Constantine the Philosopher University in Nitra, Slovakia.

Based on the obtained contents of information sheets of the subjects Discrete Math 1 and 2 it is possible to define the aim and content of subjects Discrete Math 1 (*DM1*) and Discrete Math 2 (*DM2*):

DM1

This discipline focuses on the complementation and enlarging of the concepts forming the mathematical basis of informatics. Its task is to retrace and deepen basic concepts from the sphere of arithmetic, theory of sets, sententional calculus and boolean calculus, which find wide application in all spheres of informatics (Tomanová, 2006).

DM2

This discipline focuses on the complementation and enlarging of the concepts forming mathematic basis of informatics. Its task is to retrace and deepen basic concepts from the sphere of combinatorics and theory of graphs with the focus on graph algorithms. It is a continuation of the subject Discrete math 1 (Tomanová, 2006).

Having finished the analysis carried out at all universities within the Slovak and Czech Republic, which offered the study field Applied Informatics, we focused our attention to four Slovak and three Czech universities. The reason for this was to select adequate universities with a comparable focus and the study field/study programme mentioned above.

Within the Slovak Republic the following universities were included:

- Constantine the Philosopher University in Nitra
- Comenius University in Bratislava
- Technical University in Košice

- Slovak Technical University in Bratislava

Within the Czech Republic the following universities were included:

- Ostrava university in Ostrava
- Charles University in Prague
- Masaryk University in Brno

Having compared individual thematic units of the subject Discrete Math within the selected universities in the Slovak and Czech Republic we found out that information sheets of the subjects Discrete Math 1, 2 are comparable and identical as to the contents. We can thus state that the teaching of the subject Discrete Math at the Faculty of Natural Sciences, Constantine the Philosopher University in Nitra is comparable with the ones at other universities.

Justness of individual topics of the subject Discrete Math for individual subjects of the study programme Applied Informatics/Bc.

Verification of the justness of individual topics was carried out based on the questionnaires created by the authors of the contribution. The questionnaire was elaborated based on the method of creation of questionnaires obtained from the publication by Gavora (2001). The topics were taken over from information sheets for the subjects Discrete Math 1 and 2 for the study field Applied Informatics. The main task of the questionnaires was to find out the degree of importance and the meaning of thematic units of subjects Discrete Math 1 and Discrete Math 2 in the teaching of informatics study programmes.

The process of filling in the questionnaires took place at the Department of Informatics in the following stages:

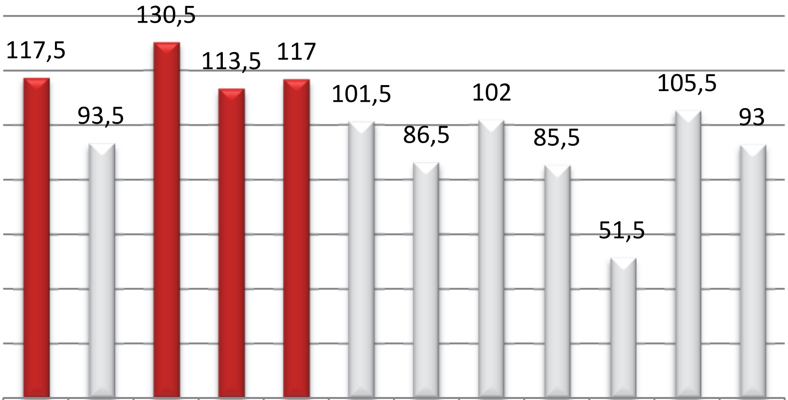
- Selection of pedagogues (12 pedagogues participated in the interview),
- Comparison of answers; the most frequent proposals were marked in the second questionnaire,
- In the second round median was marked in the scale dispersion in the questionnaire,
- Pedagogues were submitted the adjusted questionnaire repeatedly and were asked to allot the weighted coefficient to individual thematic units,
- For the evaluation of the results of evaluation by pedagogues the Delphi method known also as the Delphi oracle was used. The Delphi method is a scheme of procedure of expert´s answering aimed at activating the stimulation of expert´s knowledge. The peculiarity, differentiating the method from expert´s interview, consists in the fact that the process of answering is recurrent. In individual interlocked cycles pedagogues are individually acquainted with the results of previous cycles by an independent person, and based on that they can modify their evaluation (Bílek, 2008),
- Arithmetic mean with the application of all answers was used for the evaluation. The resulting value was calculated by dividing the sum of all answers by N pedagogues.

Weighted coefficients (the sum of the first and second cycle in the questionnaire), which were allotted by pedagogues to individual thematic units from the subject DM1 regarding their subject being taught, are presented in Table 1. The values in line one - T1 through T12 in the table represent individual thematic units, which are taught within the subject Discrete Math 1. In the first column are presented abbreviations of subjects. The units with the highest weighted coefficient follow the subjects of the technical-system nature. Among these subjects are Computer Architecture (AP), Operation Systems (OS), Computer Networks (PS).

Table 1: Weighted coefficient of thematic units in the subject DM1

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
AP1	**10**	**9.5**	**7**	**6**	**10**	**10**	**10**	**5**	**4**	**3**	**6**	**8**
AP2	**10**	**9.5**	**7**	**6**	**10**	**10**	**10**	**5**	**4**	**3**	**6**	**8**
OS1	**4.5**	**6**	**8**	**8**	**9**	**8**	**9**	**6**	**5.5**	**2**	**7**	**6**
OS2	**4.5**	**6**	**8**	**8**	**9**	**8**	**9**	**6**	**5.5**	**2**	**7**	**6**
PS1	**3**	**3**	**5**	**6**	**5**	**5**	**4**	**2**	**2**	**2**	**4**	**5**
PS2	**3**	**3**	**3**	**4**	**7**	**6**	**2**	**6**	**6**	**2**	**7**	**7**
KOD	10	8	6	6	8	4	8	10	8	4	8	4
PRO1	8	4	7	7	5	4	3	9	6	5	7	3
PRO2	7	4	6	6	5	4	2	6	5	4	6	4
PDA	6.5	3	8	5.5	5.5	5.5	2.5	2.5	3	2.5	4.5	4
DS	5.5	4	9	6	6.5	5	2.5	3	4	2	3.5	4.5
FJA	7	3	9.5	9	4	4	4	8.5	9	2	9	5
PG	7.5	6	7	6	5.5	5.5	6	7.5	7	3.5	9	5.5
PDM	2.5	2.5	6	4	3	3	2	2	2	2	4	4
UDM	2.5	2	6	4	3	3	2	4	2	2	3	3
TAZ	9	9.5	6	6	4	3	2	9	4	2	4	4
UI	10	5.5	9	7	9.5	6	4	4	3.5	3.5	4	4.5
IS	4.5	3	6	5	5	4.5	2.5	2.5	3	3	3.5	4.5
NMO	2.5	2	7	4	3	3	2	4	2	2	3	3
Total	**117.5**	93.5	**130.5**	**113.5**	**117.0**	101.5	86.5	102.0	85.5	51.5	105.5	93.0

It is obvious from the graphic illustration (Figure 1) that pedagogues marked as the most important the thematic units topics T3 (Relation of divisibility and its attributes), T4 (The least common divider, the least common multiple, Euclid´s algorithm), T1 (Basis of prepositional calculus), T5 (Diophant´s equations). This means that the given thematic units reached the highest weighted coefficient.



	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
Rady1	117,5	93,5	130,5	113,5	117	101,5	86,5	102	85,5	51,5	105,5	93

Figure 1: Graphic depiction of the evaluation of DM1

Weighted coefficients (the sum of the first and second cycle of the questionnaire), which were allotted to individual thematic units from the subject DM2 by pedagogues, regarding their subject taught, are presented in Table 2. The values in line one – T1 through T11 in the table represent individual thematic units, which are taught within the subject Discrete Math 2. In the first column are presented abbreviations of subjects.

Table 2: Weighted coefficients of thematic units in the subject DM2

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11
AP1	**4**	**4**	**8**	**8**	**6**	**5**	**5**	**4**	**3**	**2**	**2**
AP2	**4**	**4**	**8**	**8**	**6**	**5**	**5**	**4**	**3**	**2**	**2**
OS1	**3**	**4.5**	**7**	**7.5**	**9**	**7.5**	**5**	**4**	**3.5**	**3**	**3**
OS2	**3**	**4.5**	**7**	**7.5**	**9**	**7.5**	**5**	**4**	**3.5**	**3**	**3**
PS1	**4**	**3.5**	**10**	**10**	**8**	**7**	**7**	**4**	**4**	**5**	**5**
PS2	**5**	**2.5**	**9**	**9**	**9**	**9**	**8**	**6**	**6**	**7**	**7**
KOD	10	6	6	8	6	4	6	4	4	4	4
PRO1	8	7	10	6	5	5	4	3	3	3	3
PRO2	6	6	10	10	10	10	7	5	4	4	4
PDA	4	3.5	6	6.5	5.5	5.5	5	2.5	2	2	2.5
DS	3.5	3	6.5	6.5	6.5	6.5	6	2.5	2.5	2.5	2.5
FJA	4	2.5	5	4	7	2.5	4	2	2	2	2
PG	5.5	4.5	5.5	5.5	4.5	5.5	5.5	5	3.5	3.5	5
PDM	4	3.5	4.5	4	4	3	4	2.5	2	2	2
UDM	4	4	3	3	3	2.5	2	2	2	2	2
TAZ	10	2.5	10	10	10	10	10	10	10	10	10
UI	6	5	8.5	9.5	7.5	10	9	9	9	9	9
IS	4	3.5	4	4	4	4	3.5	2.5	2	2.5	3
NMO	4	6	3	3	3	2.5	2	2	2	2	2
Total	96.0	80.0	131.0	130.0	123.0	112.0	103.0	78.0	71.0	70.5	73.0

Values, which are presented in Table 2, are represented by Figure 2. The following topics were marked by pedagogues as the most important thematic units: T3 (Definition of the graph, the graph peak grade theorem, the theorem on the existence of the graph with the given grades of peaks, an algorithm for the finding out whether the given sequentiality is graphic), T4 (Continuity of the graph – sequence, route, trace, connection, course, the theorem on the number of sequences of the length between two peaks of the graph), T5 (Algorithm for the testing of graph continuity). This means that the given thematic units reached the highest weighted coefficient.

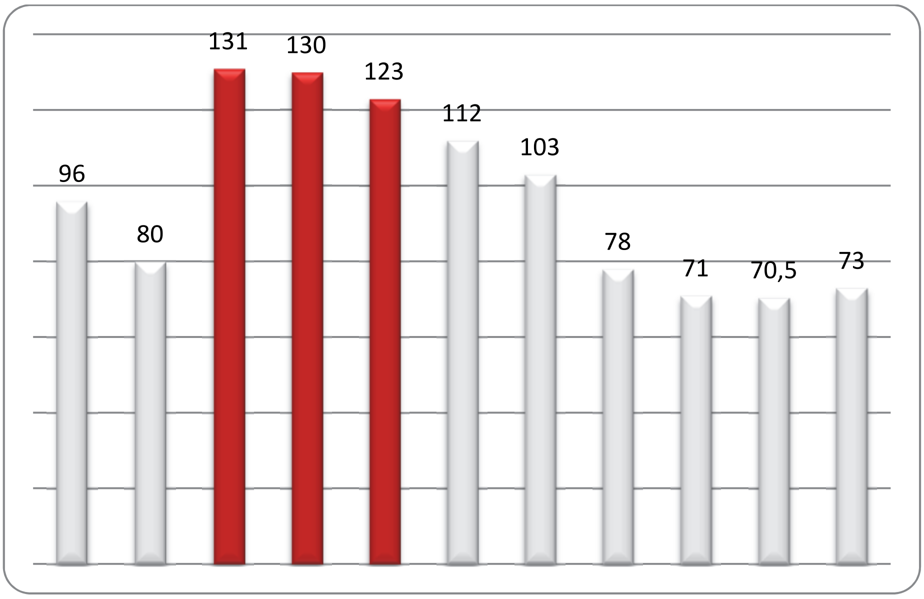


Figure 2: Graphic depiction of the evaluation of DM2

Proposal of the structure and content of the e-course of the subject Discrete Math with the support of Web 2.0 technology

The proposal of the structure of the course draws from the knowledge, which was obtained from the questionnaires, in which pedagogues allotted weighted coefficients to individual thematic units. In the subject DM1 the most important thematic units were as follows: T3 (Relation of divisibility and its attributes), T4 (The least common divider, the least common multiple, Euclid´s algorithm), T1 (Basis of prepositional calculus), T5 (Diophant´s equations).

In the subject DM2 the highest weighted coefficient was reached by the following units: T3 (Definition of the graph, the graph peak grade theorem, the theorem on the existence of the graph with the given grades of peaks, an algorithm for the finding out whether the given sequentiality is graphic), T4 (Continuity of the graph – sequence, route, trace, connection, course, the theorem on the number of sequences of the length between two peaks of the graph), T5 (Algorithm for the testing of graph continuity). Thematic units with the highest weighted coefficient show direct influence on further studies of students.

The input capital of inventions, themes and creativity, selection of the way and time of realization, lies within the pedagogue´s authority himself/herself. This would require a creative, well prepared teacher with competences, skills and knowledge not only from the sphere of technical education, but also many other areas, last but not the least, educated or literate in the sphere of ICT (Burianová, Magdin, 2009).

The solution of courses itself will be realized in two ways, either by a branch or linear teaching software. Branch software is particularly favourable when the provision and manipulation with new concepts is in question. Its fundamental asset is that it allows the student learning the content of education for choosing his individual way along the line, which corresponds to his intellect and previous knowledge. The linear teaching software is characterized by the fact that the learning contents is presented in small sections, however, the best way is to present just a single section in each step. The units with the highest weighted coefficient follow the subjects of the technical-system nature. Among these subjects are Computer Architecture (AP), Operation Systems (OS), Computer Networks (PS). These subjects form a part of the study programme Applied Informatics/Bc.

From the perspective of computer terminology, tactics are the individual steps (sub-processes of learning a student) that are observable, registrable and measurable. With the terminology used and its content, we will work in drawing up rules for assigning the appropriate parts of the study support to the different types of students.

Various teaching methods consist of meaningful sequence of learning steps. Learning process phasing into three basic parts can be found in many publications:

- Motivating - is intended to arouse the student interest in teaching content,
- Exposing - phase of the passing on the curriculum content,
- Fixing - allows consolidating of students' gained knowledge, skills and habits (Kostolányová, Czeczotková, Šarmanová, 2010).

Linear teaching software

By means of these Petri nets we modelled the structure of future e-course for the subjects Discrete Math 1 and Discrete Math 2. Petri nets seem to be the most effective way of their simulation and realization.

The beginnings of modelling the user stretch to teaching systems. The aim of modelling the user is thus preserving the values connected with the user, which reflect the level of his knowledge and their employment upon adjusting the system (Turčáni, 2009). They prescribe for all students a fixed and definite sequence of steps along one line. The teaching contents is taught in small sections of information, however, the best way is to present just a single section in each step. At need, the created concept is practised until the student manages it. Adding one concept to the other the student gets acquainted with the whole subject-matter and its whole problem. Conciseness of steps does not allow for the expansion of the prosaic style of explanation, so linear software is monotonous and after a certain time it becomes less interesting and very tiring. From the beginning until the end stretches one straight line compound of rules, exercises and answers (Figure 3). Opponents of a linear software state that very small steps interrupt the student´s trains of thought in an undesirable way. According to practical experience is linear programming suitable for the teaching of basis and principles of the problem, moreover, for the forming of the word-stock and new concepts (Klimeš, Balogh, 2010).

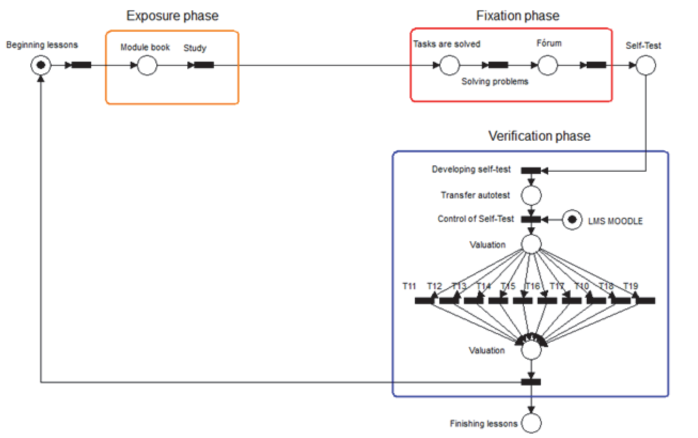


Figure 3: Linear model of the student´s transition in the lesson

Branch teaching software

When solving the problems, they allow for various procedures. Alternatives of „branches“ of the programme finally lead to the successful joint coping with the problem. Every student, however, passes the way defined in advance, while the length corresponds to his personality, knowledge and capability. When teaching facts the programme has a clear main line, from which side lines shaped in different ways evert and then connect again (Figure 4).

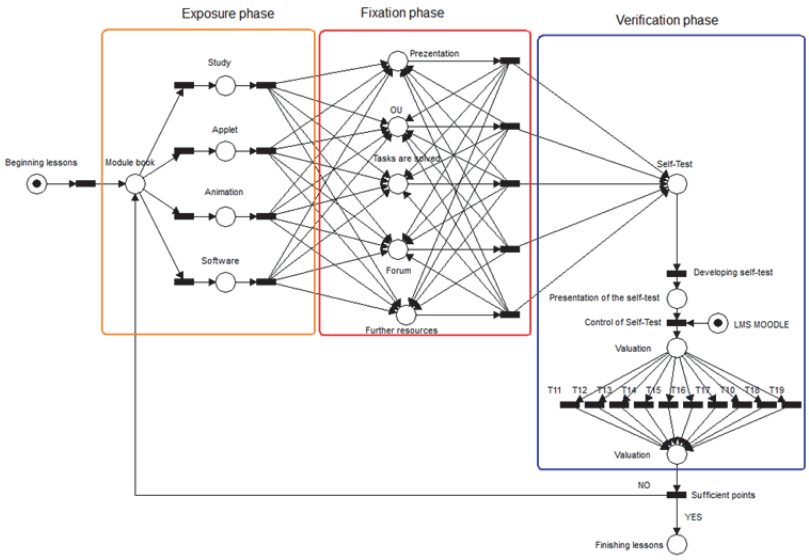


Figure 4: Branch model of the student´s transition through the lesson

The main line usually permits the procedure in larger and more demanding steps, which can be coped with only by a gifted student, correctly answering the inserted check questions; shorter and easier steps for less endowed students, or those working more slowly, are typical for side branches. Exercises for a successful practising of the given subject-matter, tasks, instructions and directives are inserted in them, facilitating the student´s solution of the problem, or using a visual aid or sequence, complementing the content of education in order to strengthen the opinion or fact. Larger information content of individual steps at the branch software admits its activation and for the student it is more interesting when presented in the form of a dialogue. Branch software is especially suitable in case when the provision and manipulation with new concepts are concerned. Its basic contribution is that it allows the student for choosing an individual way in acquiring the content of education along the line, which corresponds to his intellect and previous knowledge. Each of these basic types of software has two further variants according to the fact that whether the student forms the check questions, or chooses them out of the offered variants of answers (Klimeš, Balogh, 2010).

Modelling the student´s transition through the course using Petri nets

The student´s transition within the whole course is simulated using a linear Petri net (Figure 5). According to the current position of the token in the model Petri net we can find out in which section of the course the student is momentary situated, or to which lesson or setting he is addicted himself. The situation in reality need not be so simple. Settings, which should be elaborated by the student, will be submitted for inspection and subsequent evaluation to the pedagogue, who will assign the assessment. If the student does not reach the required number of points, he is allowed to make a correction to the setting. We expect that during the semester the student studied materials and continuously elaborated settings in all ten lessons over all the defined points in the Petri nets. We suppose that this procedure of the student was linear. The locations (L1, L2, L3, L4, L5, L6, L7, L8, L9, L10) represent individual lessons, through which the student passes, and points (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10) are the check settings (self-tests) for the verification whether the student understood the given lesson.

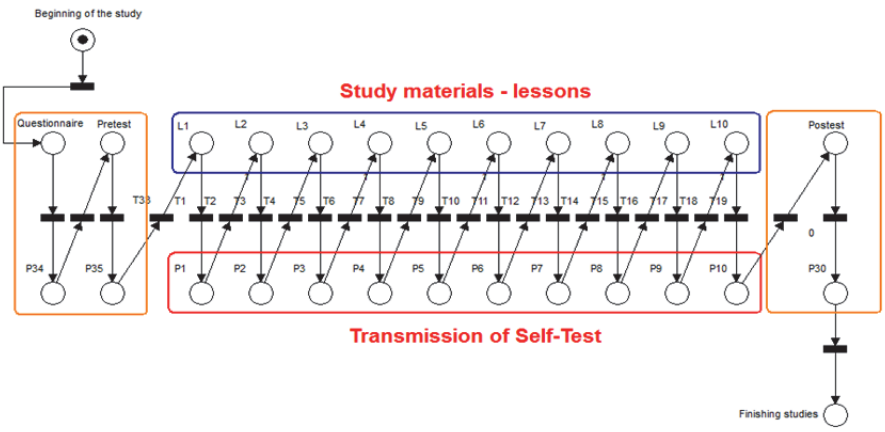


Figure 5: Transition of the student within the course using the linear Petri net.

The hand-over of settings takes place as follows:

- Study of materials
- Solution of setting
- Hand-over of setting
- Assessment by pedagogue
- Allotment of the number of points, or correction of setting and the following adjustment of the number of points.

If the student does not reach the required number of points, she/he will have to repeat the given lesson. If she/he reads the lesson through, she/he will be allowed to pass the check setting again.

Conclusion

Authors in their contribution attempted at describing the proposed structure of e-learning course in the subjects Discrete Math 1 and 2 in details. They expected that in this manner adjusted materials will have a direct impact on the knowledge of students. The knowledge could become long-lasting, which will cause an increase in their expertness upon their further studies. This knowledge will be verified within an experiment, where two comparable groups (experimental and reference ones) of students will be created. The reference group will continue in the actual courses, while the experimental group will proceed according to the newly designed structure. Prior to the beginning of the employment of supporting e-course both groups will pass a check test from the Discrete Math. After finishing the semester, students will pass the final test. Results of both groups in the tests will be compared and statistically processed by the proposed methods. The expected result should be manifested in an increased level of knowledge of the Discrete math.

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The Impact of Interactivity on Students´ Results When Passing Through an E-learning Course

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Abstract

Professionals in pedagogy and psychology have been dealing with the issue of employing interactive medial elements within the framework of educational process for the development of students´ cognitive and intellectual capacities for a rather long time. The importance of interactivity increased mainly after the implementation of an e-learning support of education, as its standard complement designed not only for the development of knowledge, but also students´ skills. In the contribution the impact of interactivity on students´ results obtained within academic years 2009/2010 - 2011/2012 while passing the subject Computer Architecture is described. In this period we executed a series of experiments focused on the evaluation of quality and method of instruction using a linear way of presenting study material (with and without a limiting condition) in an e-learning course, into which interactive animations were implemented. All experiments were verified in advance by means of a modelling tool – Petri nets. By means of this tool we expressly identified an ideal transition through the e-learning course. Results of these experiments as well as the comparison from the point of view of effectiveness of their employment are presented in the contribution. The impact of interactivity on the quality of study results obtained based on the method of presentation of study material by individual students has been proved.

Keywords

Linear transition. E-learning system. Petri nets. Study results. Interactivity.

Introduction

The issues of employment of interactive media in educational process for the development of mental and cognitive abilities of students (Mayer, 2001) have been concerned by psychologists, pedagogues (Renk, Atkinson, 2007), but also experts on information and communication technologies (ICT) for almost three decades. The idea of their implementation into educational process was expressed for the first time by Hannafin and Peck in 1988 (Domagk, Schwartz & Plass, 2010), who mentioned the fact that „perhaps the greatest advantage of computerized instruction over. . . . linear media is the potential for interaction during a lesson" (Hannafin, Peck, 1988). A certain parallel with this expressed idea can be observed also at the definition of concepts such as medial element and multimedia. In the mid 80s it was supposed that the concept "multimedia" could represent a combination of individual medial elements such as graphic, sound and text. However, with the gradual employment and improvement of ICT it was inevitable to modify this definition, or complement it with other medial elements such as animation and video. Some ten years later

Bransford started to deal with the employment of interactivity as a property of the given medial elements. According to him, interactivity makes it easy for students to revisit specific parts of the environments to explore them more fully, to test ideas, and to receive feedback. Noninteractive environments, like linear videotapes, are much less effective for creating contexts that students can explore and re-examine, both individually and collaboratively (Bransford, Brown & Cocking, 1999).

Possibilities of student´s passing through an e-learning course

The idea expressed by Bransford in 1999 we can, by analogy, employ also upon parallel employment of virtual learning environments. Their advantage when compared with the classical method of education is quoted mainly upon parallel massive education of students.

Due to staff, time and space capacities, it is not possible to cover the increased number of students of both distance and full-time study by an increase of the number of face-to-face lectures. Therefore, implementation of e-learning tools is one of the significant approaches of possible solutions to the problem (Kostolányová, Šarmanová & Takács, 2009).

Interactive learning environments are viewed as a promising option not merely for presenting information but for allowing the learner to engage actively in the learning process (Renkl, Atkinson, 2007).

Among the benefits of virtual environment belongs first of all an opportunity to:

- employ elements of interactivity based on implemented interactive medial elements (interactive animations, video, etc.), eventually interactive tests representing conceptual task designed for the development of psychomotor skills and abilities,
- manage his/her own course of study from the point of view of the student,
- increase motivation within the study and influence the results of learning using suitably selected methods and procedures,
- simulate conditions of the real world thus inducing situations allowing for deeper comprehension of the given problem,
- create an instant feedback,
- provide autonomy in decision making,
- verify, from the point of view of the student, various variants of solution to the given problem without a sense of threat.

In each of the given benefits, an e-learning system affecting the student with certain limitations (i.e. has not a linear character of providing study material) is a basic prerequisite. What differentiates a classical linear transition from a linear one with a limiting condition, is interactivity. According to Mareš, the concept “interactivity” means a reciprocal activity between the learning man and the e-learning system. Action/reaction of the learning man depends on the action/reaction of the system itself (Mareš, 2011).

Every e-learning course is characterized by (Pavlíček, 2004):

- content and structure,
- educational goal,
- didactic function.

Although the process-oriented nature of collaborative learning is quite evident, current e-learning systems mainly concentrate on individual learning tasks rather than on learning processes.

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To describe the management of communication between human being and the computer it is appropriate to employ graphic tools in order to describe and formulate the basic rules underlying this interaction. Interaction between student and LMS in the process of teaching and learning is a composite process and it is highly recommended to employ Petri nets for this purpose. Petri nets are used in several courses, both required and electives, as a fundamental tool in conceptual modelling of concurrent computing systems, in model-driven software development, in performance evaluation of concurrent computing systems, and in design and analysis of workflow management systems. There are a lot of modelling and analysis tools available for workflow, but Petri net is more preferable because of its solid mathematical foundation and graphical nature, for evaluation structural and behavioural properties of students (Balogh, Klimeš, 2010; Frosh et al., 2008; Mikolajczak, 2008, Wang, Ding, 2009).

E-learning course in LCMS Moodle system on a regular basis consists of the total number of N lectures, while each of them can be divided into a theoretical and practical part. Such division is suitable mainly from pedagogical and psychological point of view, when the student based on the description of each of these mentioned parts knows the requirements for its successful acquisition. Theoretical part is the one, which is divided into chapters and subchapters, in which exposition of the contents of lecture is situated in the textual, video or audio form. Practical part is the one, which is designed for the verification of acquired skills and knowledge. Testing is executed based on self-tests, which consist of questions defined in advance.

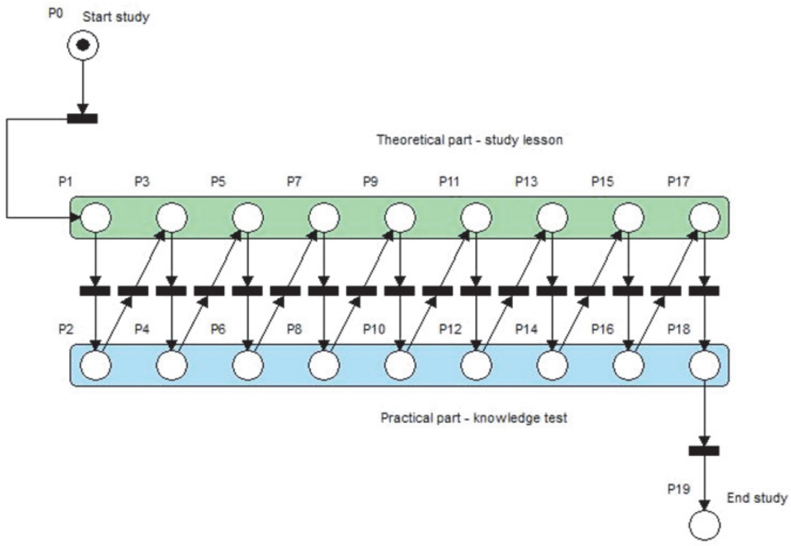

Figure 1: Transition through an e-learning course “Computer Architecture” without any limiting condition – linear transition

Linear transition through an e-learning course without any limiting condition (Figure 1) is characterized by the fact that it accentuates only minimally the needs of students, development of their skills and abilities. The submitted study material within the theoretical part of the course can be processed for example in PDF format, while these materials consist of mostly static medial elements. From this point of view, it is obvious that upon linear transition there does not exist any limiting condition, which would force, in a certain sense, the student to enter the process of study in order to actively cooperate not only with the submitted study material, but at the same time participate in the knowledge verification.

Student crossing through the course is created using linear Petri net (Figure 1). According to the current position of the token in the Petri net model we can determine in which part of the course is student currently located as well as which lesson he goes about (Kuna, 2011).

The state, when students employ within theoretical and practical part of the course individual implemented interactive medial elements, can be considered a linear transition with a limiting condition. Results of the student´s work, or manipulations with them are registered in the system database (Balogh et al, 2011). Upon linear transition with a limiting condition it is necessary that the student based on the submitted study material not only worked with it in order to acquire the necessary knowledge, but also to duly apply it within control points, such as self-tests. An example of such system can serve LCMS Moodle 2.X+.

At our university we use LMS Moodle as the central environment for five faculties and all the departments. In the last few years were created many courses for supporting teaching and also for testing process (Tomanová, Cápay, 2010).

This way the defined transition of the student is in this system carried out using self-tests with continual evaluation of results within the feedback. Student in this mode (Figure 2) is obliged based on the defined condition (e.g. successful passing of the test – minimum result is 80%) to pass through the whole course. This means to simultaneously pass both theoretical and practical parts of the e-learning course.

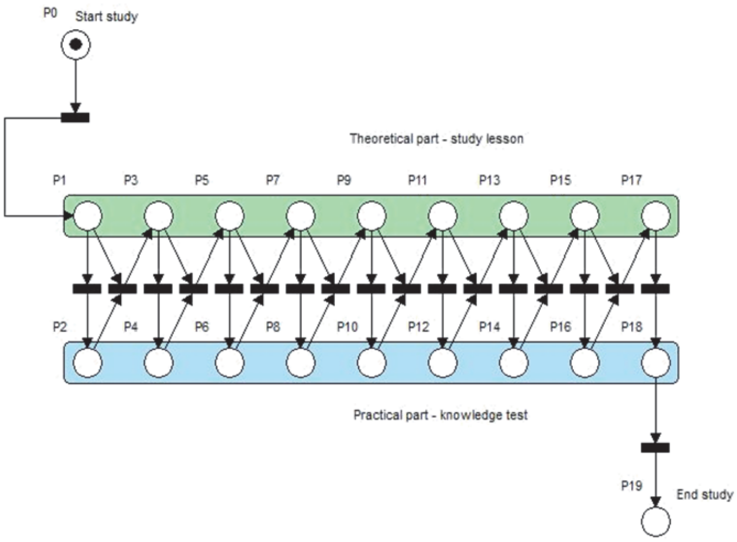

Figure 2: Linear transition through an e-learning course "Computer Architecture" with a limiting condition (Balogh et al, 2011)

Comparing the effectiveness of students´ transition through an e-learning course – study personalization

Method of presenting the study material, as well as the personalization of the needs of students in an e-learning course itself has been the subject of investigation for almost two decades (Hsiao, Sosnovsky & Brusilovsky, 2010, De Bra, Post, 1994).

The impact of interactivity on the increase in the quality and didactic effectiveness within educational process has been proved by several empirical studies (Mayer, 2001, Mayer & Chandler, 2001). However, at the same time several authors point to the potential limitations (Moreno, Valdez, 2005). In fact, a high degree of interactivity of the system does not necessarily ensure a high degree of comprehension - cognitive load (Mareš, 2011).

For the comparison of effectiveness of transition of students through the created e-learning course based on the evaluation of study results reached by the students in the academic year

2009/2010 (linear transition/LT), 2010/2011 (linear transition with interactive animations/LTIA) and 2011/2012 (linear transition with interactive animations and condition/LTIAC) the following experiments were executed. The aim was to find out, at which method and form of presenting the contents of the study material students reach better study results, and thus also which of the methods and forms suits their study requirements most.

Table 1: Comparison of results of the transition of students through an e-learning course in the monitored period

			Final evaluation of the subject					
Academic year/WS	**Type of transition**	**Count of students**	**A**	**B**	**C**	**D**	**E**	**FX**
2009/2010	LT	89	10	7	19	20	32	1
2010/2011	LTIA	119	23	22	26	22	22	4
2011/2012	LTIAC	155	45	20	21	16	27	26

We watched the study results of students from the evaluation of the subject Computer Architecture at three different type of transition (LT, LTIA and LTIAC). We set the following hypothesis H0.

H0: There are significant differences in study results between different type of transition.

At the significance level α = 0.05, we assessed whether existing statistically significant differences in study results between different type of transition.

Table 2: Statistical method ANOVA - Assessment of statistically significant differences

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Row 1	6	89	14,83333	122,966666
Row 2	6	119	19,83333	62,566666
Row 3	6	155	25,83333	104,566666

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	364	2	182	1,80108857	0,186512	3,68232
Within Groups	1515,75	15	101,05			
Total	1151,75	17				

We do not reject H0, there are significant differences in study results between different type of transition (P> α, the null hypothesis cannot rejected. It means that the difference measured in a sample can only be random).

When comparing the students´ results in individual academic years 2009/2010 – 2011/2012 we shall find out that with each academic year the number of students passing the subject “Computer Architecture” has been gradually increasing. Their results depended not only on the method of presenting the study material, but also character of the knowledge verification control during transition through the e-learning course.

Upon linear transition through the e-learning course in the academic year 2009/2010, 10 students obtained mark A, and only one student failed at the exam (mark FX). In this academic year we distributed questionnaires among students, in which they could express their opinion on the quality and way of teaching. Based on the obtained results we can state that the students missed visual character of certain topics of the e-learning course and also interactivity and support of multimedial elements were required.

We tried to apply this finding also within the course evaluation and that is why the course was complemented by interactive animations in this academic year (Balogh et al, 2011). Regarding the growth in the number of students from 89 up to 119, they passed the study successfully, when 23 students reached mark A, while only 4 failed (FX). A positive increase in the number of students passing with B mark (22 students) was also observed. In the academic year 2011/2012 we distributed among students the questionnaire again, in which they had to express their opinion on the quality and way of teaching. Based on the results of the questionnaire we can state that students evaluated the method of instruction highly positively and that is why we decided to create also interactive self-tests within the course. During the next academic year 2011/2012 students passed linear transition through the e-learning course with a limiting condition.

The subject “Computer Architecture” was passed by 155 students in the academic year 2011/2012. Positive growth in the evaluation comparing to the previous academic year, was observed. The number of students with A mark increased. The growth was twofold when compared with the academic year 2010/2011, 4,5-fold when compared with the academic year 2009/2010. This fact gives us pleasure, however, it was shown that also the number of failing students (reaching FX mark) increased. Totally 26 students reached this evaluation, which represents a dramatic growth when compared with the previous academic years. The number of remaining evaluations (B –E), however, does not markedly differ from the number of evaluations obtained in the academic years 2009/2010 and 2010/2011. However, high rate of failure was not connected with the problems of accessing the study material, but the reason was the inaccurate direction of the study and field of study.

Discussion and 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. As stated by several authors of professional publications dealing with its employment and implementation in educational process, inadequate amount of interactivity can cause the system a cognitive load. This statement was proved also by the series of experiments carried out. The number of students were compared in the academic years were influenced by the number of students admitted to bachelor study. We assume that despite the small sample count of students results can be regarded as relevant. The way we determine interactivity students of the course has been described in detail in Article: Interactivity elements implementation analysis in e-courses of professional informatics subjects (Balogh et al., 2011). It is accruing from the results that the most suitable method of presenting the study material upon e-learning support of education can be considered the linear transition through an e-learning course, into which were implemented interactive animations, but the course transition itself was not influenced by any limiting condition. At this method of presenting the study materials students reached on average better evaluation than in case of the remaining two experiments.

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Distance Education with E-learning Support in Project Center for Innovative Education

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Abstract

The authors decided to devote this article to the project called Center for innovative education (ESF 2010-2012), which they participate on by solving it. The project is implemented at the Faculty of Natural Sciences (FPV), Constantine the Philosopher University (UKF) in Nitra and has two specific objectives. Main objective of this project is to upgrade the education at the FPV UKF in Nitra, adaptation to the needs of academia by improving quality and human resources skills development. The strategic objective of the project is related to the global objective of operational program through their specific objectives and activities that specifically contribute to increase the quality of the key responsibilities of project participants. The authors have a several positions in this project. One of the author's tasks is to develop educational materials and their subsequent implementation into the LMS Moodle system. To the attractiveness of materials contributes not only the support of multimedia such as videos, support programs, applications that students can run during a study, but also the LMS Moodle that supports course personalization for student. We expect that such adapted materials should have a direct impact on students' knowledge, thanks to which thus acquired knowledge should be longer-lasting. This step should cause an increase of student proficiency. The authors of this article further describe the structure of selected courses and their work.

Keywords

E-learning. Project. Course. Distance learning. Discrete mathematics. Numerical mathematics. Optimization.

Introduction

The main objective of the project A-Center is the upgrade of education process at the FPV UKF in Nitra, its adaptation to the needs of knowledge society by improving the quality of human resources and development of their competencies. Strategic aim of the project is related to the main objective of the Operational Programme, through its specific objectives and activities that specifically contribute to increase the quality of the key responsibilities of project participants. The authors have more than one position in this project. One of them is to develop educational materials for the courses Discrete mathematics and Numerical mathematics and Optimization and then to implement these materials into the LMS Moodle system. The materials are divided into the individual lessons, which serve as support for teaching not only to teachers, but are primarily designed for students education, whether full-time or part-time study. The task of these materials is to get closer, impress and to drag students into the teaching process. We tried to make the courses attractive for students by using multimedia such as interactive animations, applications, supporting programs that complementary the courses for a better imagination and thus allow improved memorizing knowledge. This type of presentations was created for the course Numerical mathematics and Optimization and they were used in teaching process. The results of the use of these presentations are described in the last chapter. The project theoretical background and selected e-learning courses we introduce in other chapters of this article.

A-Center FPV UKF in Nitra – Innovative Education Centre

The project Center for innovative education has two specific objectives. The first one is the development of new forms of education with an emphasis on virtual learning. The second objective is innovation and creation of educational activities for target groups of academia on the FPV UKF in Nitra.

Information and Communication Technologies (ICT) Virtual

Project developing of virtual learning facility concept which is appropriate for implementation of distance method of study program Applied Informatics with e-learning support. Objective of this activity follows-up on the legitimate activity: Wider use of information technologies and new forms of education especially in the external study (virtual universities, distance learning, etc.). The specific objective is to increase the efficiency of Applied Informatics study, through the development of modern virtual learning facility. The activity is aimed at improving the quality and attractiveness of the content as well as formal aspect of courses and materials, taking into account the possibility of their use in distance form of education.

The objective of this activity should be closer specified as follows:

- design and implement the concept of virtual learning facility,
- specify the methodology of distance learning with e-learning support,
- specify the forms and activities suitable for efficient and high quality exchange of requested information in distance education,
- Implement the proposed approach to the study program Applied Informatics,
- prepare materials for the accreditation of study program Applied Informatics (distance method with e-learning support).

The specific objective is to increase the efficiency of Applied Informatics study, through the development of modern virtual learning facility. The activity is aimed at improving the quality and attractiveness of content as well as formal aspects of e-materials and e-courses, taking into account the possibility of their use in distance education methods. The target group for this activity are university teachers of FPV UKF in Nitra.

The purpose of this activity is to transform the established practices in the development of electronic materials into usable forms for distance learning organization. Output of the activity will be transformed courses for individual subjects of study program Applied Informatics eligible for accreditation of distance education. In addition to courses will be created the methodology of such courses, which can be applied to other faculty educational programs, respectively the University programs. The LMS Moodle environment will be used during implementation, which does not exclude use of the general methodology in other environments. (Aktivity projektu, 2011)

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Creation methodology of the e-learning courses in science education

The objective of this activity is proposal of single methodology for creation of e-learning courses to the development of lifelong learning programs for teachers in science, mathematics and informatics. The target group of the activity are university teachers of FPV UKF in Nitra, PhD students of FPV UKF in Nitra and post PhD students of FPV UKF in Nitra. Setup of target group will be implemented in several stages. In the first stage it should acquire the skills to work with ICT and in the next stages of preparation it will go on to gain knowledge and skills needed for use of ICT directly in the educational process. Achievement of these competencies, knowledge and skills of the target group is objective for preparation and development of current - modern virtual learning facility. (Aktivity projektu, 2011)

E-learning in academic environment

The activity's aim is to intensify the activities of the Centre for e-learning in lifelong learning on FPV UKF in Nitra (CEV FPV UKF in Nitra) – creation of e-learning courses in LMS Moodle, professional guidance and tutoring for university teachers at UKF in creation of e-learning courses and e - materials to the improvement of computer-aided education. (Aktivity projektu, 2011)

The spirit of science

This activity aims to innovation of the teaching of natural sciences, particularly physics, through examination of selected natural phenomena using digital tools and methods. The specific objective is to develop and realize an experimental tasks in a virtual laboratory. (Aktivity projektu, 2011)

Author's role in the project

The authors have several positions in this project. Among other things, the role of authors is to develop educational materials for specified study subjects, their methodological processing and subsequent implementation of these materials into the LMS Moodle, which is now already an integral part of education at the UKF in Nitra. The role of these materials is closer approach, engage the attention and draw students into the teaching process. To the higher attractiveness of materials contributes support not only of multimedia aspects such as videos, support programs, presentations, applications that students can run during the study, but also the LMS Moodle that supports personalization of courses for students.

E-learning has become an increasingly popular learning approach in universities due to the rapid growth of web-based technologies. 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, Skalka, 2011) Needs of society in field of education are nowadays based on higher level of quality and quantity comparing to the past. The number of applicants for the study is rising from year to year. How is it possible to find an optimal solution of this problem? As a both practical and logical solution seems to be exploiting of new teaching forms with application of new information and communication technologies. (Turčáni, Fojtík, Polák, 2010)

Characteristics and content of the courses

The course Numerical Mathematics and Optimization

Subject Numerical mathematics and optimization is being taught in the Bachelor's degree program in Applied Science program in Teaching academical subjects - informatics. Subject is one of the compulsory courses in both study programs and it is also a part of the state exams. The goal is to become familiar with the basic methods of numerical mathematics and optimization, and their algorithm and understanding their nature. Knowing their programming to implement and apply to specific tasks in practice.

Content of the subject are Numerical Mathematic and Optimization methods. In numerical mathematics are taught parts as direct and interactive methods for solving simultaneous linear equations - the method of backward substitution, Gaussian elimination method, Jacobi and Gauss-Seidel method, an algorithm for solving systems of nonlinear equations. Furthermore, students will learn to solve nonlinear equations numerically with Newton's method, bisection method and the method of simple iterations. Using the relative differences, differences ahead and cubic spline, students learn how to count interpolation polynomial coefficients. Next chapter is devoted to the numerical calculation of derivatives and approximate computation of certain integrals of rectangular, trapezoidal and Simpson's rule. End of first half of semester consists of methods for numerical computation of differential equations - Euler's method, Predictor-corrector and Runge-Kutta methods.

The second half of the semester works with basic methods of optimization. In the introduction, attention is paid on the least squares method of discrete and continuous case. From non-linear programming and single parametrical methods are taught: Fibonacci method, method of golden section and Newton's method. Multi parametrical methods are represented by the gradient method, the method of the largest descent, penalty function and the method of Lagrange multipliers. As a part of linear programming will be mentioned simplex method, linear programming task. All these methods are lectured with a detailed derivation of algorithms, which are programmed by students on exercises in MATLAB.

The examination of this subject consists of two parts. In the first part the students solve practical examples with help of customised programs developed in the exercises. If they are successful, they proceed to the second part of the examination in which they are examined by theoretical knowledge.

The course Discrete Mathematics 1

Subject Discrete Mathematics 1 is a compulsory subject in the Bachelor's study program in Applied Informatics in Teaching of academic subjects - informatics in daily and external form of study. Subject is one of the compulsory courses in both study programs and is a part of the state exams.

Subject content consists of completed and extended concepts forming the mathematical basis of informatics. Its task is to repeat and enhance the basic concepts of number theory, arithmetic, set theory and combinatorics, which have wide application in all areas of informatics. We deals more with divisibility of natural numbers and divisibility criterias, the transfer of whole and decimal numbers from one number system to another, matrix and their equivalent adjustment, vector spaces, the concept of sets, binary relations between sets and on the set, functions and combinatorial tasks. Discrete Mathematics 1 is a compulsory subject for first-year students of Applied Informatics, Computer modeling in science and Teaching of academical subjects for the combination with informatics. (Tomanová, Vozár, 2006)

Course content Discrete Mathematics 1 consists of the following thematic units: Introduction to propositional numbers, Boolean algebra, Relation divisibility and its properties, the smallest common divisor, smallest common multiple, Euclid algorithm, Diofant´s equation, divisibility criteria, the concept of sets, binary relation, showing as a special case of relation, Feasible and countless sets. Teaching itself takes the form of lectures and their related exercises.

Structure of the courses

Since this is a project in which participate all departments of FPV it was necessary to create a unified structure on the faculty, which is obligatory for all courses. This system was chosen because of the uniformity for students to become accustomed to a single structure, and thus more orientate themselves in e-learning courses with different content. There was a proposal of a structure not only throughout the course of individual lessons also given the task of the staff team from the Department of Computer Science, whose members are also the authors of this article. Other department then took over the structure.

Courses are divided into individual lessons, which serve as support for teaching not only for teachers, but are primarily intended for graduate students, whether full-time or part-time study. Lessons in the courses are chronologically divided, so their number depends on two aspects as the length of the semester as well as an aspect in which year the student is studying.

The agreed structure of the course is as follows (Fig.1):

Introduction

- Information Sheet,
- The recommended study literature,
- Conditions for successful completion of the subject,
- Glossary of terms,
- Discussion for the subject.

Lesson

- Short summary of lectures and exercises,
- Study material for lectures (book module),
- Study material for exercises (book module),
- The Forum,
- Test from actual lesson,
- More resources.

Figure 1: Preview structure of e-learning course Discrete Mathematics 1.

Final evaluation of the subject is in teacher´s competence. This means that it´s on his decision what form he uses to complete the course. Most used form to investigate students' knowledge is a test or project.

When entering formulas into LMS Moodle ordinary characters are not always sufficient. Often, especially in professional texts are used various special characters. Inserting these special characters can be made by using the editor for insert equations Dragmath, which is directly implemented in the LMS Moodle. This editor has its advantages and disadvantages. The advantage is certainly rapidity at which characters are inserted into the text. Its disadvantage is the limited number of symbols and characters, which may have been insert this way. If a user needs a character that is not in the menu, he is forced to study the corresponding code in TeX, and then insert it. Such parts of the text, which represent formulas is therefore necessary to specifically identify, so LMS Moodle could to process them before displaying. (Drlík, 2011)

Because of high frequency of complicated mathematical formulas in textbooks for both mentioned subjects, respectively e-learning courses are by inserting formulas used equations as editor, as well as knowledge of TeX. To improve the output of TeX filter built in LMS Moodle it was more appropriate to set output not as the GIF format, but as the PNG format which are visually different.

Support materials in the courses

In Discrete Mathematics 1 and Numerical Mathematics and Optimization courses is possible that student determine the way of study. First option is with support of book module directly in LMS Moodle (online course). The second option is to download all the materials in PDF format (offline course). Online course offers support materials for student such as various applications (it is an interactive teaching applications, testing applications in which the student either before or at the end of the study verify their knowledge), PPT presentations, which are designed to further clarify discussed issues and thereby get closer to a student.

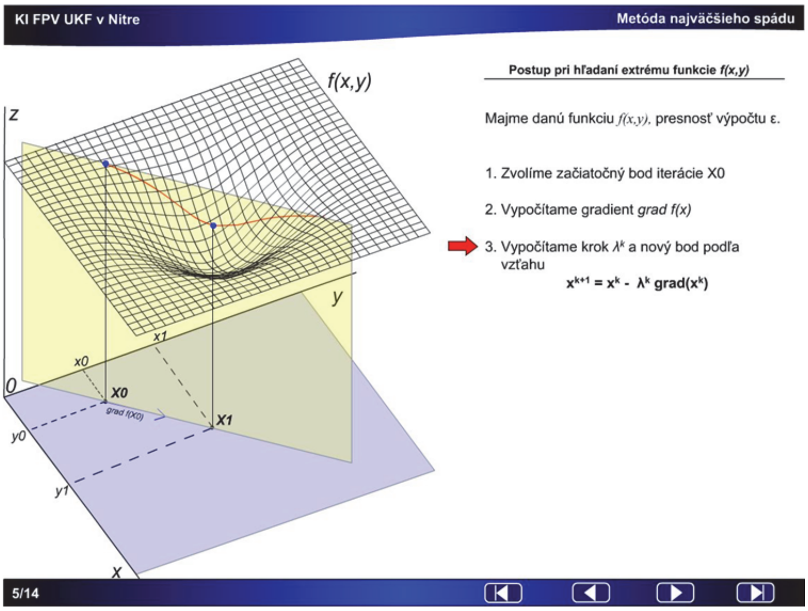

Figure 2 Illustration of interactive multimedia presentation.

The lessons of the course Numerical Mathematics and optimization, whose content is aimed at optimizing are except agreed modules are also links to interactive multimedia presentations (Fig. 2). In one lesson can be included several presentations, because each one is designed for one optimization method. Since the curriculum is very difficult, presentations are given to support students imagination and so help them to better understanding of the curriculum and also contribute to better quality and more durable student´s knowledge. For creating of presentations we used a graphic editor based on vector graphics, e.g. Macromedia Flash MX. There are presentations created for each individual method and a teacher is free to use them while giving a lecture or at the seminars. The whole presentation emulates the form of the e-learning course. Each page of the presentation is divided into two parts. On the right, there is an algorithm written. The algorithm is supplemented by a multimedia part on the left where there is a derivational process described following a concrete example. The last page of a presentation contains an algorithm of the method chosen written in a quasi Delphi language. Students are obliged to program the algorithm at the seminars as well as to use the algorithm for solving of the optimality problems. (Vozár, 2007)

Testing and verification of knowledge

In order to streamline the testing of students and also to meet the objectivity on practical part of the test we used the activity Test and created question categories according to the tasks type to which we have entered the examples. From these are randomly generated different questions (examples) for each of students, which are part of practical test. Because of the fact, that only one number is not always the correct answer on the question that represents function extreme, we were forced to use questions of such type, which allows the selection of multiple answers. When it happens, that answer is represented only by one number (extreme value), we have to test it, if the result falls within the specified allowable range of solutions for the task. After all question are answered, respectively all examples are solved and test is ended, students answers are automatically evaluated and students are immediately informed if they passed the written form of test. Based on this feedback, they know if they could enter second part of exam.

Statistical evaluation of the enquiry

In order to verify the implementation of presentations into teaching, we implemented a survey designed to assess the presentations. Respondents were Master students of Computer Science that is future teachers and they answered the questions from the questionnaire, from which we select the following three:

- Question 1: Lectures were supplemented by a lectured optimization methods presentation. As future teachers, do you think that the use of such a teaching aid makes sense?
- Question 2: Was your lesson more interesting by using these presentations?
- Question 3: Do you think you are able to understand the lectured curriculum without these presentations?

The questions No. 1 and No. 2 had a three-point scale rating and the question No. 3 had a five-point scale rating as indicated in Table 1.

Table 1: Scales of rating.

Three-point scale rating	Five-point scale rating	Label in chart
Yes	Strongly agree	1
I don’t know	Agree	2
No	Neither agree nor disagree	3
	Disagree	4
	Strongly disagree	5

On the question 1, respondents had a choice of three answers: Yes - I do not know - No. The answer Yes marked the 78 respondents, representing 97%. The answer No marked no one and two respondents (3%) identified the answer I don’t know. According to the answers above, we can conclude that students clearly accepted the inclusion of presentations in the learning process. This confirms that the student accepted used teaching method. Graphical evaluation of the question is in Figure 3 and it is labelled q1.

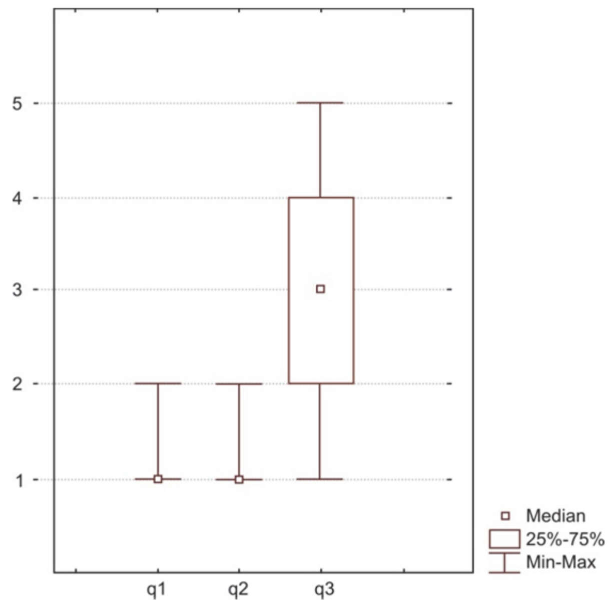

Figure 3 Box chart showing the answers to the questions q1, q2 and q3.

For the Question 2 was used the same rating scale as in the previous question. The answer Yes marked the 67 respondents, the answer No marked 0 respondents and the answer I don't know marked 13 respondents. According to these answers we can conclude that the use of classroom presentations attracted 84% of the students. Graphical evaluation of the question in Figure 3 is labelled q2.

Graphic representation of the answers to Question 3 can be seen in Figure 3 labelled q3. The most frequently occurring responses were Agree, Neither agree nor disagree and Disagree. Prevailing tendency to answer according to the median answer is Neither agree nor disagree. According to the answers to this question we have not received a clear answer whether students are able to understand the subject matter with or without a presentation. The decisive factor to answering was a self-assessment of the respondents rating their own knowledge, which obviously is not at all the same. We think that the most frequently occurring answer students selected because they could not assess how the use or non-use of presentations affected their approach to lecture curriculum.

Discussion

According to the answers to question 1, where 97% of the students marked Yes answer, we can state that the students clearly accepted the inclusion of presentations in the teaching process. This confirms that the students meet the used teaching method.

According to an analysis of responses to other questions we can express this conclusion: nearly half of the students considered the introduction of presentations to teaching process the interpretation as imaginative and almost a third of respondents find it easier to understand. More than 80% of respondents do not see in the introduction of presentation any disadvantages and for 84% of respondents was lesson more interesting by using created teaching aids.

In further work on the project the authors plan to implement a similar survey to evaluate the created electronic teaching aids for the course Discrete Mathematics 1.

Conclusion

The authors in the article further described the structure of the selected e-learning courses and creation of materials for courses in subjects Discrete Mathematics and Optimization and Discrete Mathematics 1. According to established e-learning courses with quality content and varied selection of different types of support materials we assume, to achieve our set objectives of the project A-Center and streamline education for students at FPV UKF in Nitra. We also expect that such adapted materials will have a direct impact on students' knowledge, which should be longer-lasting and will result in increasing their expertise.

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