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New technologies are rolling into schools

Dear readers.

Perhaps each of us noticed the booming market of new information and communication technologies such as the Internet of things, wearable technologies, and devices for augmented or virtual reality. We can anticipate most likely that the producers and distributors of these technologies will not be satisfied with the consumer markets only, but they will try very hard to push these new “toys” into schools and universities. So is the next revolution in education coming (again)? Or just one more marketing hype (again)?

New technologies break into schools and universities in each case. Therefore, it is necessary to project their use in education in advance and eliminate situations, in which ways, methods and forms of instruction are developed only after the technologies are already purchased in schools. It is, therefore, necessary to require the technologies to adapt to teaching and not teaching to technologies.

But back to the magazine. Can its authors get our readers ready for the future with new technologies in education? You can assess it in the current issue. Its thematic focus is really wide and it ranges from expert systems and adaptive LMS to social media in the classroom. Maybe, the future of ICT in education emerges somewhere in these areas. Or elsewhere?

The appendix of the current issue discusses educational portals created by students. Although we do not know how the future of ICT in education will look like, but we definitely know who will create it. Of course, students and young people. Therefore, we invite them as authors to write us about our (their) future. Our readers will be interested in their ideas and visions of ICT in education.

We wish you inspiring reading.

Pavel Kapoun,
Executive Editor

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DEVELOPING TECHNICAL SKILLS OF PUPILS IN PRIMARY AND SECONDARY SCHOOLS

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Abstract

The paper is aimed at the development of technical skills of pupils in primary and secondary schools. Technical courses are usually not popular among pupils. Therefore, within the scope of the “Windows of Science Wide Open” project, we prepared a number of activities, which should encourage pupils’ interest in the technical courses and help develop their technical skills. During the academic year we held several workshops for primary and secondary school pupils. The workshops contained activities such as the programming of robotic kits, the use of electric microscope in education, the use of measuring systems and a computer for the measuring of quantities around us, or the use of modern technology when creating an audiovisual project. Approximately 150 primary and secondary school pupils participated in the workshops.

Keywords

robotic kit, EdLab measuring system, electric microscope, audiovisual technology, ICT

Introduction

In the majority of cases, primary and secondary school pupils do not find instruction of technical courses attractive. Pupils and students lack the motivation and dedication to learn algorithmization, programming, physics and chemistry. (Nagyová, 2014, Krpec, et al., 2011) Only avid and enthusiastic pupils find these courses attractive. As a result, the technically-oriented secondary schools and universities have fewer applicants than the humanities-oriented schools. The aim of the “Windows of Science Wide Open” project is to make the technical courses more attractive to pupils and spark their interest in further study of those.

The “Windows of Science Wide Open” project is financed from the “Education for Competitiveness” Operational Program. The University of Ostrava is both the applicant and recipient of the project. The Faculty of Science and the Pedagogical Faculty of the University of Ostrava participate in the project.

Within the scope of one of the key activities, the "Windows of Science Wide Open" project aims to introduce primary and secondary school pupils to the technical courses, spark their interest in them and thus deny the established notion that they are difficult to learn. In so doing, the project uses ICT and technical devices in the teaching of courses such as informatics, physics, chemistry or biology (Tvarůžka, 2015). Within the scope of the project, pupils visited a specialized laboratory at the Pedagogical Faculty of the University of Ostrava where they participated in a number of activities aimed at the use of ICT for the programming of robotic kits, the measuring of physical and chemical quantities, the examination of microscopic preparations or the creation of an audiovisual project.

Technical Resources

The LEGO Mindstorms robotic kits and the EdLab measuring system are the key elements of the activities for pupils.

Nowadays, the robotic kits (LEGO Mindstorms) are used more frequently in schools. A number of researches were conducted, which focused on the use of robots as an educational support. The study comes to a conclusion that robots help pupils develop their logical and creative thinking, the ability to solve problems and to learn programming, mathematics and science. (Scaradozzi et al., 2015, Veselovská, 2015) For instance, a study documenting that a robotic kit competition helps increase pupils' interest in ICT in their university studies was conducted at the Department of Computer Science at Qatar University. (Qidway et al., 2013)

Primary and secondary schools can use virtual laboratories to conduct various physical and chemical experiments. (Bílek et al., 2010) Some of the currently used measuring systems – EdLab, Vernier, Pasco – can be used for illustrative and real experiments. (Oujezdský et al., 2015) These measuring systems have measuring sensors, a measuring interface and a computer which is used for visualization, archiving and analysis of data. As a result, the computer-supported experiments are becoming more attractive for pupils. (Koníček, 2014)

Activities for Pupils

The courses "A Day with a Robot" and "Measurement around Us", which were realized during the course of the project, were attended by primary and secondary school pupils. From October 2014 to February 2015, five courses were held for the 5th, 6th and 7th grade primary school pupils and two courses for the secondary school pupils (the pupils from Secondary Grammar School of Prof. Otto Wichterle). During the courses, the following activities were prepared for pupils:

- Robotic kits Lego Mindstorms EV3,
- EdLab measuring system for the measuring of various quantities around us,
- Electric microscopes with preparations,
- Audiovisual technology for the creation of an audiovisual project.

Robotic Kits

The LEGO robot kits allow to build different types of robots and to solve tasks of various difficulty. The robot control is made possible through the programmable brick that controls engine (wheels, belts, robotic arm) and also can read and process the data measured by the robot's sensors such as distance, brightness, direction, etc. The orders for the robotic brick can be entered directly in the interface by assembling and setting of simple icons. The commands and programs for robot can be also inserted by the computer connected with the robotic brick, which allows solving even relatively difficult tasks.

The different activities were prepared for both groups of students (elementary and high school) with the robotic LEGO Mindstorms EV3 set, mainly with regard to the different difficulty of the tasks. Elementary school pupils had the possibility to develop mainly technical skills by building blocks and constructing the robot itself. The high school students were focusing on the robot controlling, work with engines and sensors of the already assembled robot and they also focused on the creation of programs for robotic brick in the environment of LabView programming language.

Fig. 1: The construction of a robot

Within the scope of "A Day with a Robot" the primary school pupils spent three hours with the robot. They were divided into groups of four to five pupils; each group worked with one robotic kit. Following the introduction and concise guidance, the pupils constructed the first robot according to the instructional manual in which the basic programs for the robotic brick are listed (see fig. 1). After the pupils constructed one part of the robot, they tested the possibilities of a given program and then, according to further instructions, modified and expanded the basic program. There are interesting extensions in the form of small programs created in the environment of robotic brick like:

- Advanced robot motion – forward, backward, turning, etc.
- The move by regular geometric patterns (triangular, square, circle) with the possibility to repeat parts of the movement sequences.
- An ultrasonic sensor usage to detect obstacles complemented with move backwards from the obstacle. If the robot turns for 180° while detecting the obstacle, it can

endlessly move between two opposing obstacles. If the robot goes backward and right while detecting the obstacle, it creates a game for pupils in the form of circle: the robot detects a pupil, then goes backwards and goes towards another pupil, who will be again recorded.

- The robot rotation using gyroscope, which allows to move on eight-pointed star.
- The detection of dark line using a light sensor and robot movement in the space defined by a dark line on the mat.
- The movement of robotic arm – the fun part is to oscillate repeatedly with robotic arm.

On “A Day with Robot” the pupils’ work was not limited. Some were attracted by the work and they created fairly complex program structures or built all sorts of mazes. They tried to lead the robot through the maze afterwards. Other pupils were rather intrigued by the building and they enhanced the basic form of robot with extensions – wings, shovels, moving trucks, etc.

After a short break, students had the opportunity to create simple programs directly in the computer. Then there are far greater possibilities; the robot activities are more accurate and fine. The program templates were prepared for the pupils, who modified and edited them. The program environment has an integrated editor for working with sound and black and white pictures. Pupils were able e.g. to design and record the cry which was played on the robot’s movement. They set a sound to play in the template and edited and complemented its movement. They could draw a logo too, which was drawn on a robotic brick display. The linking with yelling and robot’s movement allowed all sorts of work.

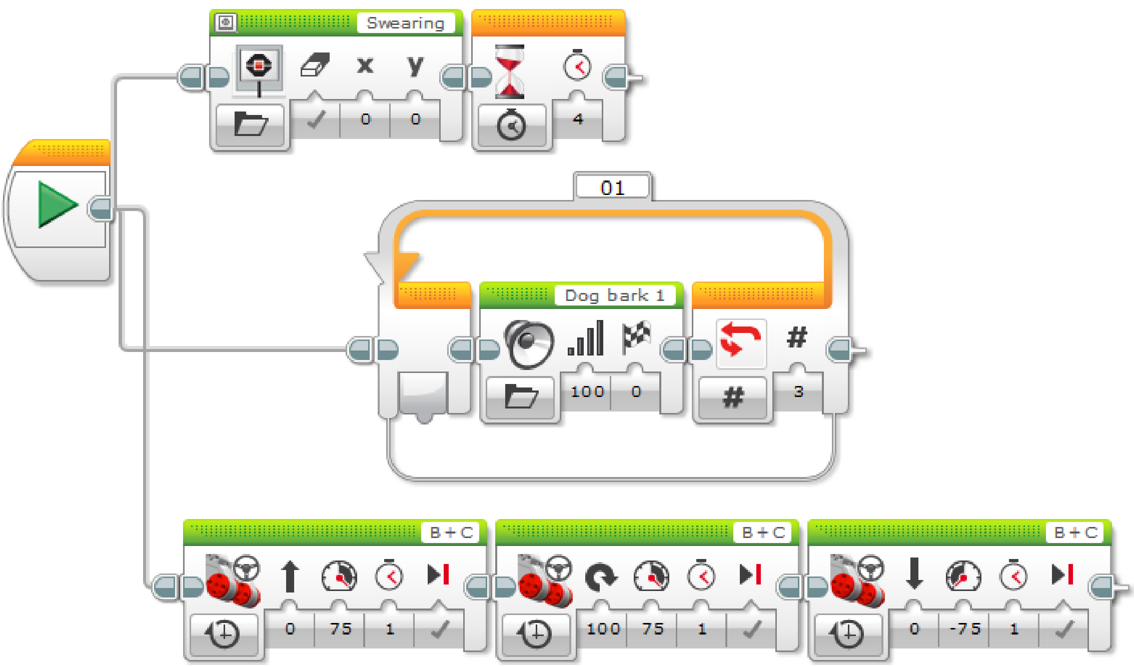

Fig. 2: Program template for working with sound and robot motion in the LabView

The robotic brick can be controlled through applications in the touch mobile devices, which are connected to it via Bluetooth and this allows to control the assembled robot remotely.

A competition for pupils, where the main goal was to go in a defined path in the shortest possible time, was appreciated mostly by the boys.

“A Day with Robot” was unusually challenging for elementary school pupils. The lessons lasted ninety minutes which is unusual length in Czech grammar schools. Nevertheless, the pupils managed to work and were often so impressed that they might be able to work even longer. On the other hand, there was always a little group of three to five kids, who were not interested at all and who would prefer some activities from different areas.

High school students completed “A Day with Robot” in the subject Informatics. The basics of programming was introduced to them in the school already, they learned basic programming constructs – sorting of instructions, repetition and branching. Working with robots thus required a different concept. Students did not build a robot, they only programmed it. They worked in pairs on the computer. The programs were created according to a task, which included about twenty concept ideas. Each group addressed a task according to its interests. Some devoted themselves to work with a light sensor and tried to control the movement of the robot by colors on the mat. Other were more focused on ultrasonic sensor and tried to park robot in a certain place. The girls were interested in the ability to write music tracks using notes and to adjust the movement of the robot according to played melody. In all groups, the created programs had the relatively high levels. The prior knowledge of basic programming structures was evident. At the end each group showed the work they created.

Experience and comparison of the work with both elementary and high school confirmed the assumptions in the area of interests and motivation, but also in the area of algorithms and programming. Working with the robot was most appreciated by the pupils of the sixth and seventh grade, who assembled the robot with genuine enthusiasm and passion. Younger pupils of fifth and sixth grade worked also with great passion, but the work itself was significantly slower and often required more explanation and support from teachers. The younger kids were unable to edit and create programs for the robot independently. This work did not catch their interest much and the possibility to program-control the robot was hard to understand for them, they often did not get the meaning.

On the other hand, the high school students, even though they had the opportunity to build the robot, did not use that option much. They were intrigued by the possibility to create their own programs and to control the movement of the robot from the beginning. They solved many of the tasks quickly and even implemented another variants and extensions of program sequences by themselves. Especially the boys oriented in the issue quickly and were able to solve the tasks with ease. The girls were more reasonable and precise in the work. Their progress was slower, but systematic approach and ambition led them to the solution even in the most difficult and time-consuming tasks. The boys did not show such persistence.

EdLab Measuring System

The EdLab measuring system is a special device that is used as an educational support in the natural history and technical courses in primary and secondary schools. It is used mainly in physics and chemistry classes where it helps conduct a number of experiments. The system consists of a measuring interface, which is connected to a computer through USB. Sensors for the measuring of electric and non-electric quantities are connected to the interface. The six analog and two digital sensors can be connected to the EdLab system.

Within the scope of the “Measurement around Us” day, a number of tasks with the EdLab system were prepared for the pupils. The pupils could measure quantities such as air temperature, humidity, static pressure, lighting in the room, noise in the room, but also the concentration of oxygen and carbon dioxide in the air. The EdLab measuring interface and several sensors were used for each task. The measured quantities were displayed on mobile computers.

The secondary school pupils were more inventive and creative. Not only were they interested in a particular task, but also in how the individual sensors worked. They tried to realize their own ideas such as the measuring of the telephone temperature by the infrared thermometer, depending on the CPU load. Another idea was to use the spirometer for the measuring of the volume of inhaled air of a smoker and nonsmoker.

Fig. 2: Measuring of noise by the sound level meter and the EdLab measuring interface

Electric Microscopes

For examining biological preparations, the primary school pupils used electric microscopes equipped with a video camera that were connected to a computer. The pupils examined approximately 50 different biological preparations. The main advantage was that the preparations were displayed on a computer monitor so more pupils could see it. The pupils mastered the operation of both the microscopes and the software application for the displaying of the preparations. As a result, the microscopes and the biological preparations enabled them to visit the micro world. In one case, a biology teacher who accompanied the pupils was glad to join them in the process because their school did not have as many preparations.

Fig. 3: Examining a preparation by an electric microscope

Audiovisual Technology

The secondary school pupils expressed their interest in modern audiovisual technology and wanted to create an audiovisual project. Using a HD video camera, a studio microphone and a green screen they made a video clip to a song which one of them sang. The entire project was realized according to a short script, which was prepared by the pupils themselves. First they shot a dance performance (choreography by the pupils themselves) and then recorded the singing part using a prepared audio device. Using the chromatic key, they added the singer to the dance scene. The professional editing software application Adobe Premiere CS6 was used for the creation of the project. The pupils were creative and modern audiovisual technology enabled them to realize their ideas.

Educational movies

In the project called "Windows of Science Wide Open" were also created educational movies whose content are robotic LEGO Mindstorm kits and measuring system EdLab. The half-professional Canon Legria HF G30 cameras were used to capture the film. An audio commentary was recorded by a studio microphone RODE. (Bijnens et al., 2006)

Robotic Kits

The educational movie about robotic LEGO Mindstorm kits originated as a live recording of several events called "A Day with Robot." It is a compilation of more days of recording. The movie was divided into two parts in post-production. The first part contains the building the robot and its programming directly on the control brick, the second part focuses on the programming of the robot by a computer.

Shooting took place in the classroom with the kids and there was no possibility to prepare a script in advance and deploy cameras in the room. The whole shooting was dynamic and with regard to the development of the situation and activity of children. Because the final movie was created as a compilation of several events filmed on different days, it was necessary to cut the individual images in chronological order and to select from the several possible scenes. Movies were also complemented by audio commentary.

Fig. 4: The video of event “A Day with Robot”

The final movie about working with robotic kits can be used as an inspiration for teachers how to implement teaching with robots.

EdLab Measuring System

Educational movie about working with measuring EdLab system was captured as live shooting. There was always a scene prepared according to a scenario. Recording was captured on more than one camera and multi-camera cut was used in the post-production. Movie was complemented by audio commentary too. (Dancyger,2007)

Filming took place in a small classroom where was prepared a notebook, the measuring system EdLab and sensors to be used. The filming tasks were divide on the measurement of variables around us (such as temperature, pressure, humidity, etc.) and electrical values (voltage, current, electrical resistance).

Fig. 5: Recording an education movie about the measuring system EdLab

The movies were exported to modern multimedia MP4 container, where H.264 video codec for compression was chosen. The movies are captured in high definition resolution called Full HD (1080p).

Conclusion

Within the scope of the "Windows of Science Wide Open" project the courses "A Day with a Robot" and "Measurement around Us" for the primary and secondary school pupils were realized. The aim of the courses was to motivate the pupils to use ICT in class and thus make the natural history and technical courses such as algorithmization, programming, physics or chemistry more attractive to them.

During the courses, more than 150 primary and secondary school pupils visited a specialized laboratory at the Pedagogical faculty of the University of Ostrava where they were engaged in a number of activities such as the programming of the LEGO Mindstorms EV3 robotic kits, the use of the EdLab measuring system for measuring quantities around us, the use of electric microscopes with a computer for examining biological preparations or the use of modern audiovisual technology for creating an audiovisual project.

Students showed great interest when working with ICT. Younger pupils built a robot from bricks, invented yells for the robot and drew pictures. Older students especially appreciated the opportunity to create their own programs and ability to control the robot through the environment LabView. They were all highly motivated using the robotic LEGO set and they competed with each other. The more creative high school students invented their own tasks and they also created their own audiovisual project.

There were also filmed the educational movies, which cover the topic how to work with robotic LEGO Mindstorms EV3 and the work with measuring system EdLab too. A movie about robotic kits emerged as a montage of live shooting of events called "The day with robot." A movie about measuring system EdLab was created as a live performance where several electrical and non-electrical tasks were recorded. Both movies were given a narrative commentary in the postproduction.

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EXPERT SYSTEMS AND ADAPTIVE PROCEDURES OF THE COMPUTER EDUCATIONAL SYSTEM ADEPT

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Abstract

Current pedagogical research has striven to create an adaptive computer educational system which would come closest to each student's needs and skills, and would ensure the quickest and the most effective way of acquiring the necessary knowledge in the field concerned. Modern informational technologies are fundamental which make use of unconventional methods of artificial intelligence to mechanically and abstractedly formalize mental models of experienced educators, which leads to mechanical representation of their sophisticated teaching methods and procedures. The structure of the adaptive educational system includes fuzzy expert modules which formalize mental decision-making functions of an experienced educator. Two adaptive loops execute the processes of the adjustment of study materials according to the continuous study results shown and of learning the system according to the information about the student's modified learning procedure.

Keywords

adaptive educational system, learning style, evaluation, expert systems, fuzzy model, model learning, adaptation

Introduction

In 1960s, knowledge from cybernetics and mainly algorithmization started to be implemented into the learning process. That is how the programmed learning was born and its basic idea is to control the student's work completely. This form of schooling wasn't extensively executed at that time owing to the lack of technical background. Only when microcomputers and later personal computers entered the scene in the 1980s, the programs following the programmed learning principles have developed significantly. Several expressions were used such as computer controlled learning, and computer assisted learning. These computers assisted learning systems (CAL) were complemented by artificial intelligence elements and tried to create a certain model of an artificial teacher.

In 1990s, there was a rapid development of informational and communication technologies, which influenced the educational field as well. After the Internet appeared, e-learning has expanded significantly. E-learning has served for individualization of learning, as each student prefers their own learning style. In order to individualize the learning, it is necessary to adjust it, or adapt it in accordance with the student's needs. The importance of this accordance between learning and a teaching style leads to better achievements; it also makes learning easier and increases the effectiveness of students' learning (Bajraktarevic, Hall, Fullick, 2003; Brusilovsky, 2003).

Adaptive learning system is such a system which tries to customize the schooling process to students' individual characteristics and needs. Its aim is to create such an environment which will motivate a student to such extent that s/he is willing to learn by himself/herself even if not forced. The system tries to accommodate the most to the student; it responds to his/her incorrect answers in a different way, explains the subject matter more slowly or in more detail. It also tries to draw the student's attention to his/her errors, give examples, etc. It will also inform the student clearly what s/he has to know and to what extent; if s/he has already achieved the required level of knowledge and which grade they will be awarded. In adaptive learning systems, there are artificial intelligence elements used for formalizing mental models of experienced educators – experts in the field of learning process government and management.

Relevant parts of the adaptive learning system (ADaptive Educational Programme Tool) are presented in the paper, which represent its decision-making and adaptive procedures. Decisive tasks of choosing the student's learning system and evaluation of the learning material suitability according to their individual learning style are executed using artificial intelligence tools – the on-line fuzzy-logic expert systems. The system includes two adaptation tasks. The first of these modifies student's learning material structure in the course of study according to his/her current results, the second adaptive loop continuously modifies the specification model of study material suitability according to its real effectiveness in the learning process.

The paper introduces the ADEPT system principles as well as results of simulative functional examination of both expert systems and functions of both adaptive loops.

Computer Learning System ADEPT

The basic structure of the computer educational system ADEPT is depicted in Fig.1. The simplified scheme is focused mainly on decisive blocks and adaptive loops which ensure increased system efficiency in the student's learning process.

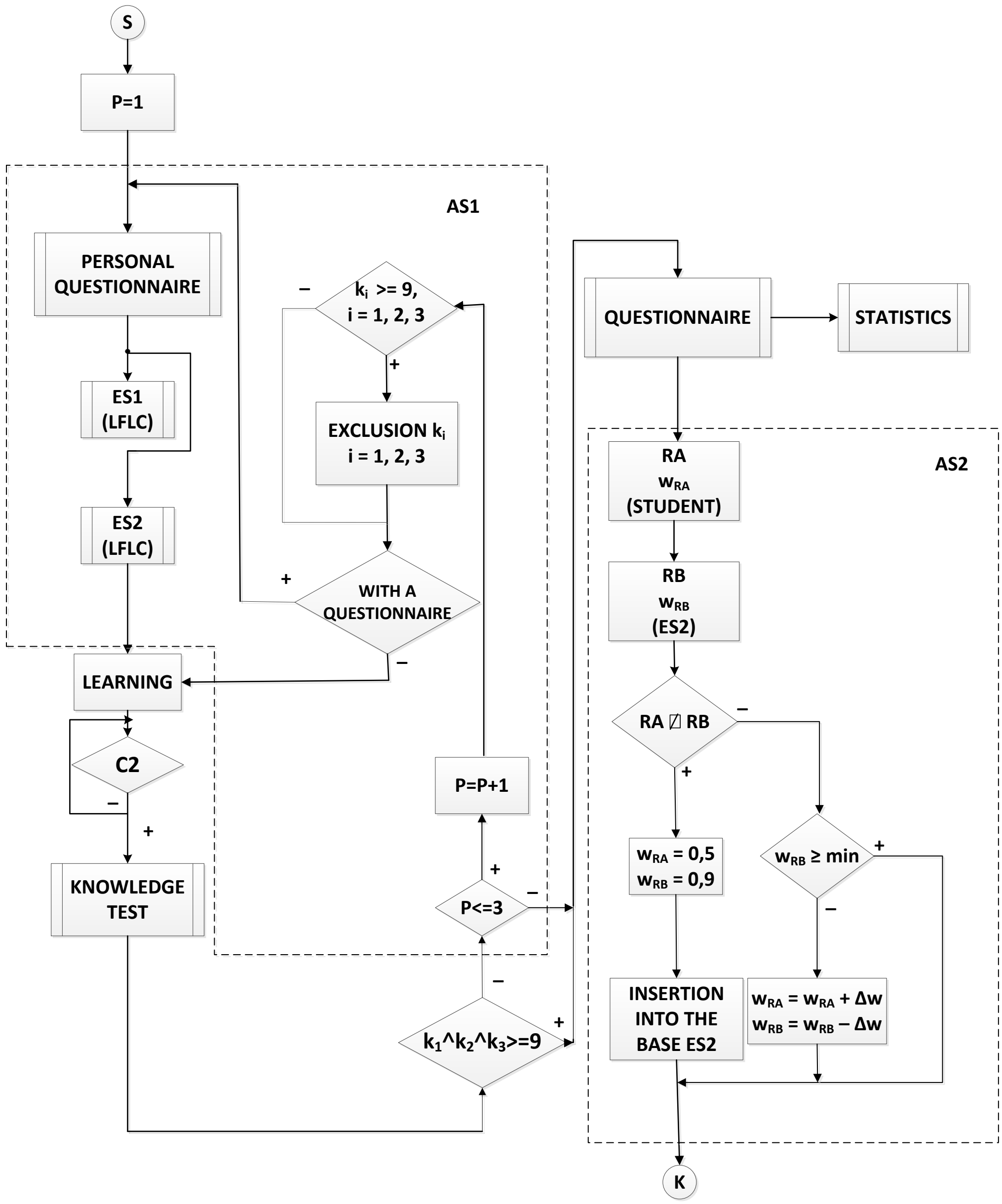

Fig. 1: The system ADEPT scheme

The system base consists of two on-line decision-making blocks which make use of fuzzy-oriented expert system technology (Buckley, Siler, 2005). Above all, the system recommends the student the most suitable version of study materials in agreement with his/her study type. On the basis of study results in particular cycles, it modifies the study materials in the first adaptive loop and carries out the student's final evaluation after his/her learning process has ended. In the second adaptive loop, it modifies the materials according to the learning rule for recommending study materials.

At the beginning, the student's study style is diagnosed before his/her expert system learning ES1 starts (preliminary diagnostics). Information about the amplitude of particular system input values is obtained in the form of results after the particular student has filled in the preliminary questionnaire called PERSONAL QUESTIONNAIRE. The student's learning style estimation is important information about his/her characteristics.

The information from the questionnaire further serves as an input for the expert system ES2 which recommends the student the most suitable study materials. After the procedure LEARNING is completed that is when the student's first cycle of learning finishes (p = 1) and when his/her current knowledge gets tested in the block called KNOWLEDGE TEST. If the evaluated results are not satisfactory, the student proceeds to the second cycle (p = 2) unless the number of his/her learning cycles (p = 3) is depleted. The system enters the first adaptive loop AS1 which will recommend modifications of the second cycle study materials on the basis of the existing evaluation. The student gets a chance to modify the second cycle materials by completing the diagnostic questionnaire again where s/he can modify (specify) his/her opinion on characteristics decisive for his/her learning style. After finishing the second learning cycle, student's current knowledge is evaluated and in case of need the learning cycle is repeated including the adaptation of the materials.

If the evaluation is satisfactory after finishing individual cycles or always when the student runs out of a prescribed number of cycles, learning is finished and the system enters the phase of the learning cycles' process being evaluated by the student in the block QUESTIONNAIRE. Its results are both saved in the data base STATISTICS and made use of in the second adaptive loop AS2 for modifying the expert system model ES2.

Detailed functions of expert systems ES1 and ES2 are described in Chapter 4 and Chapter 5 in addition to a description of adaptive loops AS1 and AS2's function.

Decisive Fuzzy Modules of the System

Expert Systems

Expert systems are computer programs which simulate experts' decisive activities when solving very complicated and problematically narrow focused tasks (Buckley, Siler, 2005). There is no doubt that their function is closely connected to both human and artificial intelligence. These systems are based on the idea of knowledge take-over from an expert (meaning his/her objective and subjective knowledge) and its convenient computer representation which would enable a computer programme to make use of this knowledge in more or less the same way the expert does.

The core of such a system (Fig.2) consists of a control (inferential) mechanism which specifies (updates) the general model and infers an answer – conclusion by making operations above the knowledge base on the basis of current data.

The knowledge base as a general behavioural model of the studied framework is made of expert knowledge formalized by a convenient representation.

An explanatory subsystem is a user-important part of the expert system. It provides information about a particular procedure which has led to the conclusion. This way the user can assess the quality of the knowledge base by himself/herself as well as the inferences; moreover, s/he can subsequently modify the inference result eventually.

It is possible to say that the aim of the expert system is to reach high-quality conclusions analogous to those of expert people in the particular field when dealing with complex problems.

Expert systems are capable of using efficiently possible uncertainties in both the knowledge base and the data base.

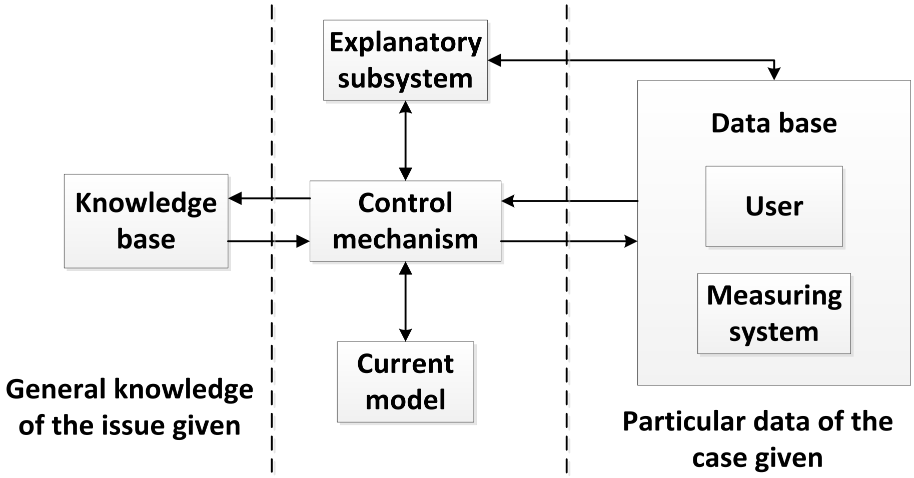

Fig.2: The expert system scheme

The typical characteristic of the expert systems is the skill to efficiently use uncertainty of unconventional models in indeterminate (vague) frameworks. The computer representation of expert knowledge (experts' mental models) has become the basis of these models. In a practical environment, expert systems which are very common are those using knowledge representation in the form of conditional IF-THEN rules and formalizing their uncertainties via mathematical fuzzy set apparatus. These models make use of linguistic fuzzy logic approaches (Buckley, Siler, 2005; Novák, Perfilieva, Močkoř, 1999) as inferential mechanisms.

Linguistic fuzzy modelling and inferences

If we consider the issue of creating a computer system which would deal with a particular problem so well as an expert (experienced educator) would, it is necessary to solve two basic tasks:

a) how to formalize subjective expert knowledge on the computer, or how to formalize the mental model on the computer,

b) on what principles to build logical algorithms which will function above this knowledge with the aim to use the linguistic model in a similar way the expert – educator uses his/her mental model.

The computer representation of linguistic descriptions requires using such methods which allow formalizing a very important characteristic of natural language words – vagueness, their natural uncertainty. Several methods have been developed to formalize vagueness, the most common of which is the method using fuzzy sets. We can easily express a meaning and vagueness of word concepts via fuzzy sets.

The linguistic rule fuzzy model is the basis of computer systems for expert cogitation simulation. The experience shows that any human knowledge can be expressed by means of language rules of the IF-THEN type (Novák, Perfilieva, Močkoř, 1999). The general form of the linguistic model rule is

$$\text{IF } (x \text{ is A}) \text{ THEN } (y \text{ is B}), \tag{1}$$

where fuzzy proposition (x is A) is a proposition of input linguistic variable size and is called the antecedent (condition, prerequisite), fuzzy proposition (y is B) corresponds to the size of output linguistic variable and is called the consequent (consequence, conclusion). The fuzzy logic rule (1) expresses the relation between linguistic variables x and y and can be simply interpreted as: If the linguistic variable x gains its linguistic value A, a status when another linguistic variable y gains its linguistic value B is the consequence.

In case of multiple input variables model, the statements about their size in so-called complex antecedent are tied by a fuzzy-logic connective fuzzy conjunction. When describing the framework including n-input variables x1 - xn and a single output variable y, we get a k-rules framework in this format:

R_1 : IF (x_1 is A_{11}) and (x_2 is A_{21}) and … and (x_n is A_{n1}) THEN (y is B_1)

R_2 : IF (x_1 is A_{12}) and (x_2 is A_{22}) and … and (x_n is A_{n2}) THEN (y is B_2)

R_k : IF (x_1 is A_{1k}) and (x_2 is A_{2k}) and … and (x_n is A_{nk}) THEN (y is B_k) (2)

Antecedents of rules usually contain all linguistic value combinations of input variables; a particular size of the input variable in consequent is decided by an expert.

The form of a modified output fuzzy set B0 when placing particular values of variables x1,0 to xn,0 is acquired by a deductive algorithm which uses fuzzy logic rules. Deductive algorithms differ in their interpretation of fuzzy-logic conjunctions (Buckley, Siler, 2005). A Mamdani type mechanism is used for drawing conclusions in the article concerning expert systems involved. The form of affiliation function of the output fuzzy set B(y) is determined by the relation

$$B(y) = \max_{1<r<m}\left(\min\left(B_r(y), \min_{1<j<n}\left(Cons\left(A_j x, A_{rj} x\right)\right)\right)\right) \tag{3}$$

An explanation of this operation called fuzzy composition can be found i.e. in (Buckley, Siler, 2005; Novák, Perfilieva, Močkoř, 1999).

The Expert System ES1

The expert system ES1 serves the diagnostics of a student’s learning style before learning starts as well as later in the course of learning (Krišová, Pokorný, 2013).

A learning style is a learning procedure which a student uses in a particular life period in most pedagogically-oriented situations. Up to a certain degree, these are independent on the subject studied. They originate from congenital basis (cognitive style) and develop by co-operation of inner and outer influences. There is a huge amount of influences having an immediate effect on the student’s learning style (Kostolányová, 2012). The proposed solution focuses on individual learning via e-learning and that is why the characteristics chosen for the student's learning style diagnostics are those which are utilizable in e-learning environment and can be directly used for managing electronic learning. In the expert system ES1 linguistic model, the student's learning style is set on the basis of these parameters – input linguistic variables: social aspect, information processing method, sense perception, and learning procedure (Table 1).

Linguistic variable	Id	Scope of universe	Linguistic values	Id
SOCIAL ASPECT	SA	[0,15]	INTROVERT	INT
			EXTROVERT	EXT
INFORMATION PROCESSING METHOD	ZZI	[0, 15]	THEORETICIAN	TEO
			PRACTICIAN	PRA
SENSE PERCEPTION	SV	[0, 15]	GRAFIC	GRA
			VERBAL	VER
LEARNING PROCEDURE	PU	[0, 15]	HOLIST	HOL
			PERFECTIONIST	DET

Tab. 1: Input linguistic variables of the ES1 module

SV – Sense perception describes which information form suits a student best. It characterizes the sense by which the student perceives the most, what way s/he understands and remembers the information best. The system is derived from the opinion that students gain information by visualization (pictures, symbols, diagrams) or listening (via sounds and words) (Felder, Silverman, 1988). ES1 recognizes two types of students:

- *Graphic type* remembers best what s/he sees – e.g. pictures, diagrams, timelines and so-called flow charts which show the graphic realization of e.g. steps the teacher will include in the class. Information might be forgotten if transferred to students only orally.
- *Verbal type* remembers much of what s/he hears and even more of what s/he hears and interprets afterwards. Discussions suit these students best as they learn a lot from them. They prefer oral explanations to visual demonstrations. They learn effectively by explaining things to others or listening to them.

SA – Social aspect characterizes the way of involvement in a surrounding social environment which the student prefers while studying. On the basis of this characteristic the system ES1 differentiates two types of students (Mareš, 2004):

- *Introvert* prefers self-study or work in pairs – learns with a colleague or friend. S/he does not seek a bigger group, s/he listens rather than enters a conversation.
- *Extrovert* focuses on contact with people and reality, s/he prefers learning in a bigger group, discussing with classmates, and seeks cooperation with people.

ZZI – Information processing method recognizes preference of theory or practical experiments. On the basis of this feature the system ES1 divides students into two groups (Sternberg, Grigorenko, 1999):

- *Theoretician* prefers theoretical deduction and deep thinking about newly-gained knowledge.
- *Practician* is an experimenter who prefers an active try-out of the knowledge gained, as practical as possible. S/he seeks a way to utilize each piece of information and what the information can be useful for.

PU – **Learning procedure** differentiates students according to what amount of information they are able to process at once. The system ES1 describes two types of students (Riding, Cheema, 1991):

- *Holistic type* tends to perceive situations globally, as overall ones. S/he focuses on large parts of general information, following them gradually to get to detail. S/he finds detail analysis difficult.
- *Detail-oriented (perfectionist, analytic) type* focuses on small parts of particular information out of which s/he composes the entire picture. S/he has a difficulty to understand a situation at a global scale.

The system ES1 also considers a **social aspect combination with the information processing method,** and defines other four student types: active type, reflexive type, actively-reflexive type and reflexively-active type. It employs the fact that complex psychological processes transferring perceived information to knowledge comprise of two categories – active experimenting and reflexive observation (Felder, Silverman, 1988).

- *Active type* cannot learn much from lectures, because they transfer information passively. S/he learns better in situations which allow group work and active experimenting.
- *Reflexive type* requires situations which provide opportunities to think over the information presented. S/he is a theoretician and prefers working alone or eventually with another person
- *Actively-reflexive type* – a theoretician who prefers group work (extrovert).
- *Reflexively-active type* – a practician (an experimenter) who prefers working alone (introvert).

The steps (Felder, Solomon, 2004; Mareš 2004; Novotný, 2010; Riding, Cheema, 1991; Sternberg, Grigorenko, 1999) serve as a source for the student's questionnaire, the analysis of which provides current numeral values of all four input variables in the system ES1. In the questionnaire, a scale was added to questions which expresses the degree of the agreement with the statement (a, rather a, b, rather b). Particular answers are ascribed from 0 to 3 points. The student can receive ranking between 0 and 15 points as each characteristic is tested in five questions. In the expert system ES1 linguistic model, the aforesaid access to the student type decision is formalized by three output linguistic variables with linguistic values described in Table 2.

Linguistic variable	Id	Linguistic value	Id
REFLEXIVE or ACTIVE TYPE	REF/AKT	REFLEXIVE	REF
		REFLEXIVELY-ACTIVE	RA
		ACTIVELY- REFLEXIVE	AR
		ACTIVE	AKT
VISUAL or VERBAL TYPE	VIZ/SLO	VISUAL	VIZ
		VERBAL	SLO
HOLISTIC or PERFECTIONIST TYPE	HOL/DET	HOLIST	HOL
		PERFECTIONIST	DET

Tab. 2: Output linguistic variables of the ES1 module

Knowledge base of the system ES1 is formed by the framework of conditional IF-THEN rules (2) the conditional parts of which symbolize all linguistic value combinations of input variables. Individual combinations were expertly assessed by assigning particular linguistic values of output variables. For example, the rule R1 has a form

R_1: IF (SA is INT) and (ZZI is TEO) and (SV is GRA) and (PU is HOL) THEN (REF/AKT is REF) and (VIZ/SLO is VIZ) and (HOL/DET is HOL)

it formalizes this knowledge:

If the student prefers individual and theoretical learning, remembers better what s/he sees and prefers big information clusters while learning, then the student is reflexive, visual and a holist.

The expert system ES1 is implemented in a developing environment LFLC (Linguistic Fuzz Logic Controller) (Dvořák, Habiballa, Novák, Pavliska, 2003). Linguistic values of input and output variables in the fuzzy rule model are represented by fuzzy sets (Fig.3).

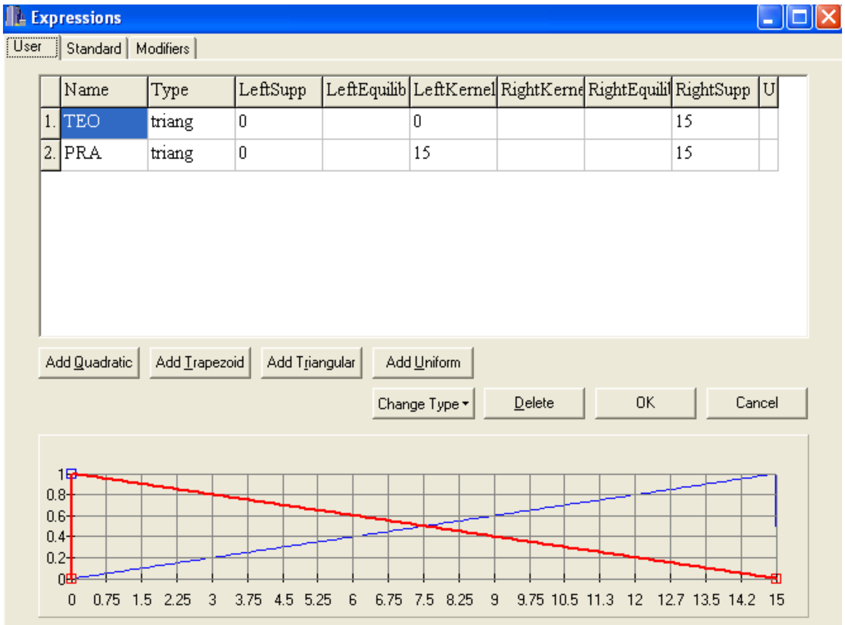

Fig. 3: LFLC image – input linguistic variables of the model ES1

Approximate deduction of the model's output linguistic values is carried out by the Mamdani method (Buckley, Siler, 2005. Learning styles become the output, assessed with options level <0,1> according to current values of outcome variables (Fig.4).

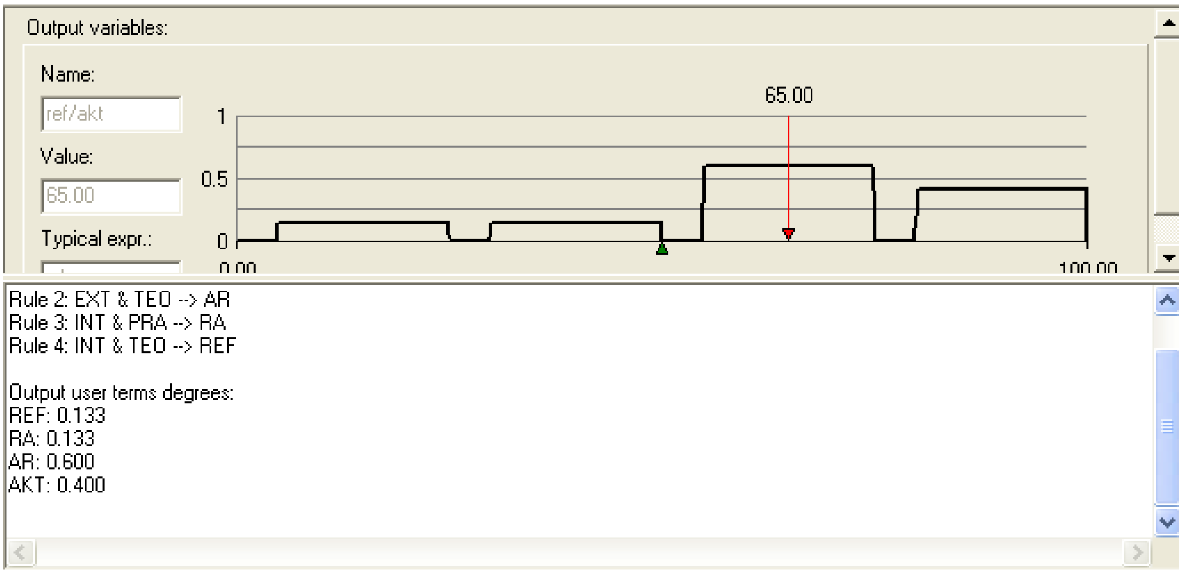

Fig. 4: LFLC image – assessed output values of learning styles ES1

The Expert system ES2

The expert system ES2 follows the system ES1. The expert system ES2 recommends the student a particular study material to learn from after evaluating the student's learning style by the system ES1. It results from the student's learning style – from the evaluated student's questionnaire.

The expert system ES2's linguistic model has 4 input linguistic variables (Table 1) and one output linguistic variable with 16 linguistic values which represent versions of recommended study materials (Table 3).

Variable	Id	Linguistic values (study types)
VERSION OF MATERIALS	V1	visual, reflexive and a holist
	V2	visual, reflexive and a perfectionist
	V3	visual, actively-reflexive and a holist
	V4	visual, actively-reflexive and a perfectionist
	V5	visual, reflexively-active and a holist
	V6	visual, reflexively-active and a perfectionist
	V7	visual, active and a holist
	V8	visual, active and a perfectionist
	V9	verbal, reflexive and a holist
	V10	verbal, reflexive and a perfectionist
	V11	verbal, actively-reflexive and a holist
	V12	verbal, actively-reflexive and a perfectionist
	V13	verbal, reflexively-active and a holist
	V14	verbal, reflexively-active and a perfectionist
	V15	verbal, active and a holist
	V16	verbal, active and a perfectionist

Tab. 3: Output linguistic variable of the module ES2

The expert system ES2 knowledge base is constituted by a file of IF-THEN rules (2) the conditional parts of which represent all combinations of input variables' linguistic values.

Individual combinations are expertly assessed by assigning particular linguistic values of an output variable. For example, the rule R1 has the form:

$R_{1:}$ IF (SV is GRA) and (ZZI is TEO) and (SA is INT) and (PU is HOL) THEN (VERZE is V1)

and formalizes this knowledge:

If the student remembers better what s/he sees, prefers individual studying and theoretical learning as well as big informational clusters, then I recommend the student to use the version V1 of study materials.

This rule thus concerns the visual, holistic and reflexive student (theoretician and introvert) who is assigned the version V1 of study materials according to Table 3.

The expert system ES2 is implemented in developing environment LFLC (Linguistic Fuzz Logic Controller) (Dvořák, Habiballa, Novák, Pavliska, 2003). Fuzzy sets of its input variables' linguistic values are shown in Fig. 6, of its output variables in the fuzzy rule model are represented in Fig. 6.

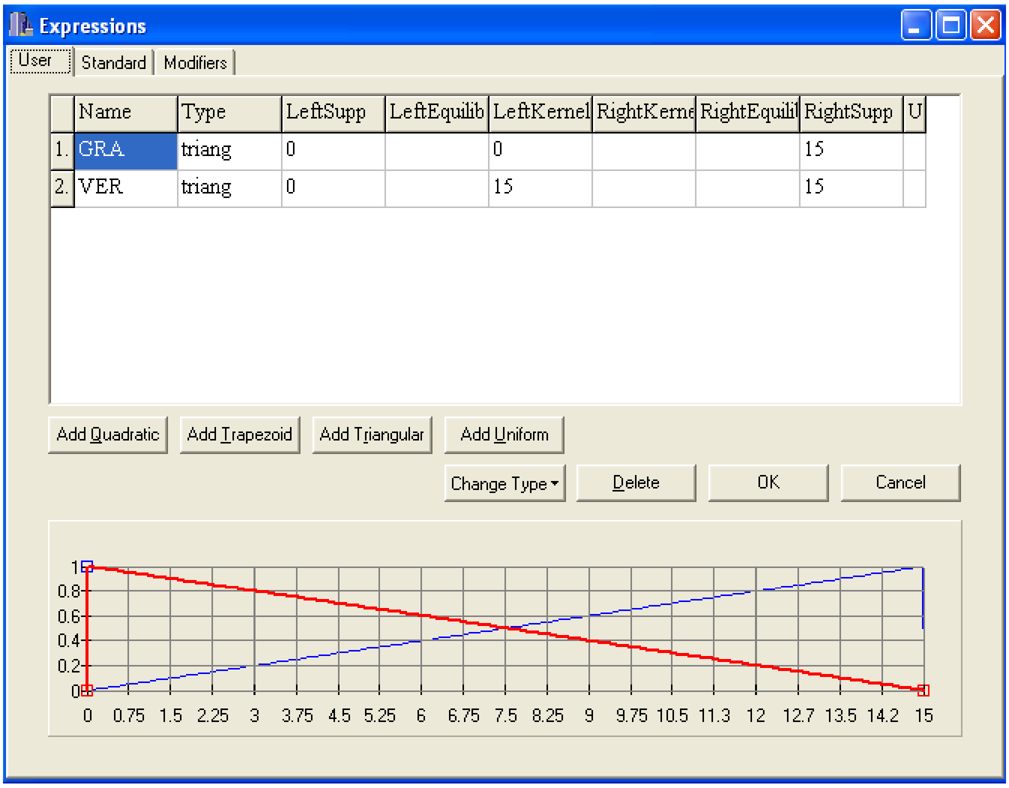

Fig. 6: LFLC image – input linguistic variables of the model ES2

Approximate deduction of the model's output linguistic values is again carried out by the Mamdani method (3). Learning material variants become the output, assessed with suitability levels <0,1> for a particular student according to current values of outcome variables (Fig.7).

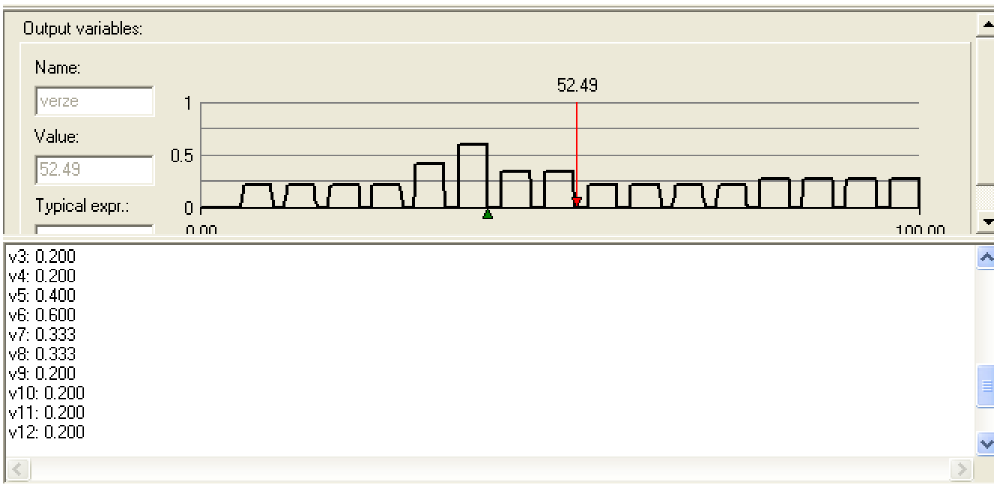

Fig. 7: LFLC image – assessed versions of study materials ES2

A particular version of recommended study materials V1 – V16 depends on the particular study subject. Chapter 6 introduces the linguistic model of the system ES2 which is targeted at teaching the subject Numeral systems.

System Adaptive Procedures

The Student's Learning Process Adaptation AS1

After evaluating the current level of the student's knowledge in the particular p- th learning cycle (the KNOWLEDGE TEST block) – see Fig. 1 – the student's knowledge is evaluated in the block R1 whether it is satisfactory in all studied chapters (three chapters in this case, named k1, k2, k3). If yes, the system offers the student an output questionnaire to fill in (QUESTIONNAIRE). If not, exhaustion of the number of granted learning cycles (R2) is checked and the system continues by pinpointing those study chapters which showed unsatisfactory results (R3). Furthermore, study materials for the next cycle are restricted and put forward to the student to learn. Simultaneously, s/he has an option to refill the questionnaire (PERSONAL QUESTIONNAIRE) and react on suitability of recommended materials by modifying answers to its questions. It is another option for the adaptive loop AS1 to modify the next learning cycle materials.

The expert module ES2 adaptation

In the course of the system ADEPT exploitation, the initiatory linguistic model of the expert module ES2 declared by an expert is modified (defined) by extending the number of its rules, or broadening the knowledge scope used for making decisions about suitability of individual 16 types of study materials (V1 – V16) for the particular student (Fig. 7).

The linguistic model contains 16 IF-THEN rules, the i- th rule of which recommends the material Vi in its consequent, i = 1,…,16.

After the last learning cycle is finished, the student fills in the form QUESTIONNAIRE in which s/he confirms or changes the order of material suitability previously recommended by the system ES2. If the student does not utilize for learning the material with the highest rank and, after consideration, s/he substitutes it by another one, then the new rule is generated which reflects this fact (knowledge) (RULE ASSIGNMENT).

If such a rule does not exist in the base (block R5), it is described as a NEW RULE and with lower weight of its influence (w = 0,5) it is inserted in the base ES2.

If such a rule does exist, this fact is taken into account only by rising the weight of its influence ($w = w + \Delta w$). After a prescribed number of occurrences of such a new rule the rule reaches the full influence (w = 1) in the base. Simultaneously, influence weight of the initiatory rule (determined by an expert) is being reduced. The learning function of the rule model ES2 is executed via this adaptive procedure. In Chapter 6, the function of the loop AS2 is also explained using a simulating process.

Simulative Verification of Decisive Procedures

Effectiveness of proposed fuzzy modules is verified in the Matlab-Simulink programme environment which is compatible with LFLC. The Simulink system is an upgrade of MATLAB for dynamic systems' simulation and modelling (Matlab, 2012).

The Expert System ES1

Simulation calculations in the adaptive learning system are carried out by filling in the questionnaire ES1, machine evaluation of which gives us concrete numerical values of four variables SA, ZZI, SV and PU. These values become inputs in the module ES1. ES1 derives appropriate values of three output variables. Table 4 introduces particular input values for simulating experiments.

Experiment no.	SA	ZZI	SV	PU
1	6	4	10	7
2	9	13	5	11

Tab. 4: Values of input variables ES1

Experiment 1 simulates the student who prefers individual studying and thinks about everything in detail. S/he remembers better what s/he hears or reads and focuses on big parts of general information in order to get an overall picture. The system has deduced correctly that the student is rather reflexive, verbal and holistic (Table 5).

Experiment 2 simulates a situation when the student prefers working in a group making attempts and errors. S/he remembers better what s/he sees and processes smaller information clusters. The system has deduced correctly that such a student is rather active, visual and a perfectionist (Table 5).

Experiment	Output linguistic values							
	REF/AKT				VIZ/SLO		HOL/DET	
	REF	AKT	RA	AR	VIZ	SLO	HOL	DET
1	0,6	0,4	0,27	0,27	0,33	0,67	0,53	0,47
2	0,13	0,6	0,4	0,13	0,67	0,33	0,27	0,73

Tab. 5: The student's learning style typology assessed by an expert

In both experiments, results of the student's learning style diagnostics corresponds with presumptions. They show an important characteristic of the system E1 – individual learning styles for the particular student are ascribed interconnected in interval <0,1> with a possibility to interpret the outputs in the form of orderings. This global output has a denser informational content than a pure estimation of the student's learning style allocated into an acute numeral interval.

The Expert System ES2

Study materials created for simulating verification deal with numeral systems (one of the topics from the subject IT for economists). Materials are divided into three chapters: Numeral systems issues, Transfer among numeral systems, and Arithmetic operations in the binary system. In ES2, we could generally use study materials of any scientific subject, and those would be adequately modified to suit the needs of the system ES2.

For the system ES2 simulation, the same numeral values are used as an input for the expert system ES1 (Table 4). The expert system ES2 derives assessment of all 16 linguistic values of output variable VERSION (version of study materials) with regard to individual persons of students from experiments 1 and 2. For simulating experiments, particular input values are mentioned in Table 4, in Table 6 there are values of the output variable ascribed and derived by the expert system ES2.

Experiment no	1						2				
Suitability assessment	0,53	0,47	0,40	0,40	0,33	0,27	0,6	0,4	0,33	0,27	0,13
Order recommended	1	2	3	4	5	6	1	2	3	4	5
Recommended versions	V9	V10	V11	V12	V1, V2, V3, V4	V5, V6, V7, V8, V13, V14	V8	V6	V14, V16	V5, V7, V13 V15	V1, V2, V3, V4, V9, V10, V11, V12

Tab. 6: Order of study materials recommended by the system ES2

Experiment 1 chooses study materials for the reflexive, verbal and holistic student (Table 5). The system thus correctly designated the version V9 as the most suitable material (Table 6). Remaining versions of study materials have lower ascribed values, the student can also utilize versions V10, V11 and V12 for his/her knowledge completion (the value of these materials is 0,4 or higher), remaining versions of materials are rather irrelevant for the student of this type.

Experiment 2 designates study materials for the student who is rather active, visual and a perfectionist (Table 5). The system ES2 correctly recommends the version V8 as the most suitable material (Table 6). The student can utilize the version V6 as well to complete his/her knowledge (but the value of this version is lower).

The Adaptive Loop AS1

Modification of recommended study materials for the following learning cycle has two options:

a) we assume that the result of the evaluative test KNOWLEDGE TEST (Fig. 1) will be the knowledge evaluation of three studied chapters in

$$k_1 = 3$$
$$k_2 = 1$$
$$k_3 = 2$$

The result means that the chapter k_1 subject matter has been mastered, the subject matter of chapters k_2 and k_3 needs to be revisited in the following learning cycle. That is why the chapter k_1 is eliminated from the study materials recommendation for the following learning cycle.

b) after the preceding learning cycle, if the student ratiocinates that s/he did not estimated his/her study characteristics correctly, s/he can use the offer of filling in the questionnaire PERSONAL QUESTIONNAIRE once again (Fig. 1). That would start the process of a new cycle of both the expert system ES1 and ES2 as well as recommending new and modified versions according to the new expert system ES1 result.

The Adaptive Loop AS2

We may assume that the expert system ES2 recommends the student a relevant study material V1. It means that during derivation the dominant rule was the rule RB (5) which has full weight (WRB = 1) in its initiative base of the expert system ES2

$$\begin{aligned}&RB: IF(SVisGRA)and(ZZIisTEO)and(SAisINT)and(PUisHOL)\\&THEN(VERZEisV1)\\&W_{RB}=1\end{aligned} \tag{5}$$

But the student marks the version V2 as the subjectively relevant material (from which s/he studied successfully) in the output questionnaire QUESTIONNAIRE. Consequently, a new rule RA will be added to the knowledge base of the system ES2 (6)

$$\begin{aligned}&RA: IF(SVisGRA)and(ZZIisTEO)and(SAisINT)and(PUisHOL)\\&THEN(VERZEisV2)\\&W_{RA}=0{,}5\end{aligned} \tag{6}$$

Dynamics of (learning process) knowledge base ES2 modification is retained via rule balance W_{RA}, $W_{RB} \in <0,1>$. If it is the case of first modification occurrence, the new rule *RA* will be ascribed lower weight W_{RA} = 0,5. If the same modification *appears* in another student's questionnaire, the rule *RA* weight will be improved to $W_{RA} = W_{RA} + \Delta$ and the original rule *RB* will be improved to $W_{RB} = W_{RB} - \Delta$. If the rule *RA* occurs again, the process will be continued till full weight W_{RA} = 1 is reached and the original rule *RB* will be kept in the base with lowered weight W_{RB} = 0,25.

That formalizes the importance of new rule *RA* dynamics in the learning process of the model ES2.

Conclusion

Current pedagogical research has striven to create an adaptive computer educational system which would come closest to each student's needs and skills, and would ensure the quickest and the most effective way of acquiring the necessary knowledge in the field concerned. Modern informational technologies are fundamental which make use of unconventional methods of artificial intelligence to mechanically and abstractedly formalize mental models of experienced educators, which leads to mechanical representation of their sophisticated teaching methods and procedures.

The structure of the adaptive educational system ADEPT presented includes two on-line fuzzy-logic expert systems. Both expert systems formalize mental decision-making functions of an experienced educator via computer. The first system is dedicated to deciding about the student's study type, the second is dedicated to deciding about recommended structure of a study material for a student of a particular study type. Furthermore, the ADEPT system contains two adaptive tasks. The first adaptive task deals with the issue of continuous modification of the recommended study material on the basis of study results in individual learning cycles. The second adaptive task deals with the issue of continuous knowledge base studying of the expert system for recommending the study material according to the information about the student's possibly modified learning procedure.

The ADEPT system is implemented in developing environments LFLC and MATLAB. Simulating tasks which were carried out show the results of both expert systems' decision-making functions applied to two different study types of users. Simulations results confirm correctness of their function. Functions of both adaptive loops are also introduced via simulations.

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LEARNER PREFERENCES AND REJECTIONS OF SELECTED TEST FORMATS

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Abstract

The article presents the results of the survey on student preferences and rejections of selected types of tests (test formats) reflecting their learning preferences. The survey was conducted at the Faculty of Informatics and Management, University of Hradec Kralove, Czech Republic in the sample of 203 students of Applied Informatics, Information Management, Financial Management and Tourism&Management study programmes. Data were collected by two questionnaires: (1) Learning Combination Inventory by Johnston, which was exploited to detect learner preferences, and (2) Preference/Rejection of selected types of tests, which enabled learners to express their opinions on seven selected types of tests on 10-level Likert scale. The results clearly showed strong preference of questions and tasks pre-defined before the credit test or exam, both in the oral and written forms. This finding might lead to a conclusion that student flexibility and creative thinking are not sufficiently developed for autonomous work and searching for new solutions, as required by numerous educational documents.

Keywords

assessment, evaluation, testing, types of test, test format, LMS, ICT, adaptive e-learning

Introduction

Assessment and evaluation are essential elements of the teaching/learning process. Without an effective evaluation it is impossible to know whether students learned what they had been expected, whether/how much the teaching/learning process was efficient, what should be improved. The processes of assessment and evaluation are closely connected to learners' performance, particularly monitoring and collecting learners' feedback on their knowledge. At the Faculty of Informatics and Management (FIM), University of Hradec Kralove (UHK), Czech Republic, the assessment/evaluation process was considered from the view of students learning preferences. For this process the C. A. Johnston´s approach was applied (Johnston, 1996). Within the assessment/evaluation process, the main question is what is assessed, what is evaluated and what is tested within the process of instruction. In other words, what do we mean by assessment, evaluation and testing? (Assessing and evaluating student learning. p. 263).

Theoretical background

All three approaches are explored to measure to what exptent the acquired learning content has been mastered by the students, how well the students met the learning objectives. However, scholars and researchers make distinctions between assessment, evaluation, and testing. These are three different terms for referring to the output of the process of teaching/learning to show how much learners know about a given topic – from different points of view:

- Assessment is the process of gathering information on student learning.
- Evaluation is the process of making judgments based on criteria and evidence (ibid, p. 263).
- Testing student knowledge is a special part of the assessment/evaluation process which examines learner knowledge and determines what s/he has learned and knows. The test measures the level of knowledge (and skills) that has been reached.

If analysed in detail, the assessment means the process of documenting knowledge, skills, attitudes and beliefs, usually in measurable terms. The target of assessment is to make improvements, as opposed to simply being judged. In an educational context, assessment is the process of describing, collecting, recording, scoring, and interpreting information about learning (Differences between Testing, Assessment, and Evaluation, p. 2).

Assessment must be an integral and ongoing part of the learning process itself, not limited to final products (ibid, 42 Assessment procedures gather information on all areas of learning Assessment practices should promote equity by giving each student optimal opportunity to learn and to demonstrate what s/he knows (ibid, p. 47). This approach correlates to the Johnston´s question: How would you show your teacher what you have learned? (Johnston, 1996).

Teacher-developed assessment and evaluation have a wide variety how they can be explored, particularly to provide feedback towards improving students learning, to determine whether students have achieved the required level of knowledge (including skills), to set future learning objectives, and last but not least to provide feedback to teachers on the efficiency of their teaching (Differences between Testing, Assessment, and Evaluation, p. 51). To discover how well students are learning, what assessment strategies should be designed to systematically collect information on reaching the learning objectives and achieving learning outcomes are the main criteria to be considered. A broad range of strategies should be used to give students *multiple* opportunities to perform their knowledge, both in the oral and/or written forms, in individual and/or group formats etc. On the other side, evaluation involves teachers in analyzing and reflecting upon information on student learning collected from various sources, particularly through developing clear evaluation criteria (including defining grades for the detected knowledge), considering information from various, reliable and valid sources and applying high-level professional approach (Assessing and evaluating student learning, pp. 263-264).

Within the assessment/evaluation process at FIM UHK student learning preferences were detected by the Learning Combination Inventory (LCI) designed by C. A. Johnston which is based on her concept of ´Unlocking the will to learn´ (Johnston, 1996). Johnston emphasizes that the traditional learning process arises from the 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 (ibid, p. 16). To describe 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; if 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. Thus Johnston compares human 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. The LCI differs from other widely used inventories (e.g. by Kolb, Honey and Mumford etc.), as it emphasizes not the product of learning, but the process of learning; it focuses on how to unlock and what unlocks the learner motivation and ability to learn, i.e. on the way how to achieve student optimum intellectual development. This was the main reason why LCI, not any other traditional tool was applied for detecting individual learning styles. The responses to LCI describe the schema (pattern) that drives the will to learn. Respondents are categorized into four groups where sequential, precise, technical and confluent ways of processing information are combined:

- the sequential processors are defined as the seekers of clear directions, practiced planners, thoroughly neat workers;
- the precise processors are identified as the information specialists, info-details researches, answer specialists and report writers;
- the technical processors are specified as the hands-on builders, independent private thinkers and reality seekers;
    - the confluent processors are described as those who march to a different drum beat, creative imaginers and unique presenters.

Assessment/evaluation/testing processes at FIM UHK

The FIM UHK has had a more than two-decade long tradition in the implementation of learning management systems (LMS) into the higher education (in 1999 Learning Space, since 2000 WebCT, which few years later merged with Blackboard). Since 2012/13 virtual desktops have been available to students and teachers, mainly for work with software not providing free/open access (e.g. MS SQL Server, Enterprise Architect) and in 2013/14 the Blackboard Mobile LearnTM version 4.0 for Apple and Android devices was piloted and has been exploited since (this version supports iOS6+, i.e. iPhone 3GS, iPad 2+, IPad mini, iPod Touch 4+ and Android OS 2.3+).

Therefore, the blended learning concept assessment/evaluation/testing is used at FIM UHK to monitor student knowledge in all subjects. Reflecting the results of world-recognized researchers (e.g. Coffield, 2004; Leither, 2011; Felder, 2010; Gregorc, 2004), not only student learning preferences should be considered but they also included the preference in special assessment formats. In other words, some types (formats) of tests and exams are more preferred, from various reasons. Weak/non-hardly working students often think multiple choice tests are easier because they can select one of the provided answers (this conclusion is valid for multiple-choice tests with one, not more correct answers), as well as speaking or writing on the topic they are interested in, etc.

Having analysed 48 syllabi of selected subjects in IT, Management and Humanities, it was discovered that some assessment formats were applied more frequently than others. The analysis showed that

- multiple-choice written tests are the most frequently used format for credit tests (both as applied during the semester or at the end),
- oral exam format is mostly used for final consideration of student knowledge,
- designing and presenting the project is mostly used in IT subjects.

Survey on monitoring student preferences/rejections of selected testing formats

Considering the results of analysis, student feedback on the most frequently applied types of tests and exams was collected so as to discover whether they are preferred or rejected by students of various learning preference patterns.

Methodology and tools

The process of monitoring student preferences/rejections was structured into two phases:

- First, the Learning Combination Inventory (LCI) was applied to defined student learning preferences.
- Second, student preferences/rejections of frequently exploited types of tests were monitored.

The LCI consists 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?
- How would you teach students to learn?

Student preferences/rejections of frequently exploited types of tests were monitored by another questionnaire which focused on following types of tests:

- Student is asked a question from the pre-defined list (O1).

- Student is asked a question from the unknown list (O2).
- A question (problem, topic) from pre-defined list is set for essay writing (W1).
- A question (problem, topic) from unknown list is set for essay writing (W2).
- Multiple-choice test with 1 correct answer (W3). As within this type of test other types of tasks were also included for more detailed detection: Multiple-choice task with 2+ correct answers (W4); Yes/No task (W5) and True/False task (W6).
- Students introduce results of the project they worked on during the semester; topic was set at the beginning of the semester (W7).

Student preference/rejection of each type was expressed on 10-level Likert scale (from strongly preferred: 1 to strongly rejected: 10). Data collected under levels 1–5 were considered the preference, data under 6-10 were considered the rejection of the particular type of test. Both questionnaires were available online in LMS Blackboard for three weeks and all students were addressed to fulfil them. Despite the process was anonymous, multiple submissions by one student was not allowed by the system.

Research sample

Totally 203 respondents of FIM UHK bachelor and master study programmes participated in the survey and administered both questionnaires. Other characteristics of the sample are as follows:

- gender: male – 121; female – 82;
- study programme: Applied Informatics – 84; Information Management – 44; Financial Management – 21; Tourism&Management – 54;
- age: below 20 – 4; 20–24 years old – 143; 25–29 years old – 27; 30–39 years old – 22; 40+ – 7 respondents.

Results of survey

Reflecting the survey structure, the collected data were considered from two views: (1) student preferences/rejections within the complete sample; (2) student preferences/rejections from the strongest type of learning preference according to LCI.

Ad 1) Student preferences/rejections in the complete sample

Results under this criterion are displayed in figure 1. Data show that the most preferred types of tests were O1 (Student is asked a question from the pre-defined list; 41 %) and W3 (Multiple-choice test with 1 correct answer; 35 %). As for other types of tasks widely used within W3, W5 (Yes/No task) were preferred by 9 % of respondents, whereas W4 (Multiple-choice task with 2+ correct answers) were rejected by the same amount. Moreover, O2 (Student is asked a question from the unknown list) and W2 (A question, problem, topic from unknown list is set for essay writing) were also rejected by 19 % each and W1 (A question, problem, topic from pre-defined list is set for essay writing) was preferred by 16 % of respondents. Considering these results we can conclude that students prefer to answer questions and solve problems *known (listed) to them before* the exam, which they can prepare for – or even worse – to memorize their solution. This result does not show they are able to be independent and creative in thinking and problem solving, as required by crucial educational documents, e.g. the concepts of key competences development and framework educational plans (in the Czech Republic). Moreover, the preference of multiple-choice type of test (W3) and Yes/No tasks (W5) proves our experience and respondent opinion mentioned above that the weak/non-hardly working students expect the multiple-choice tests with 1 correct or Yes/no answer to be easier for them as they can ´only´ select one of the proposed answers or solutions.

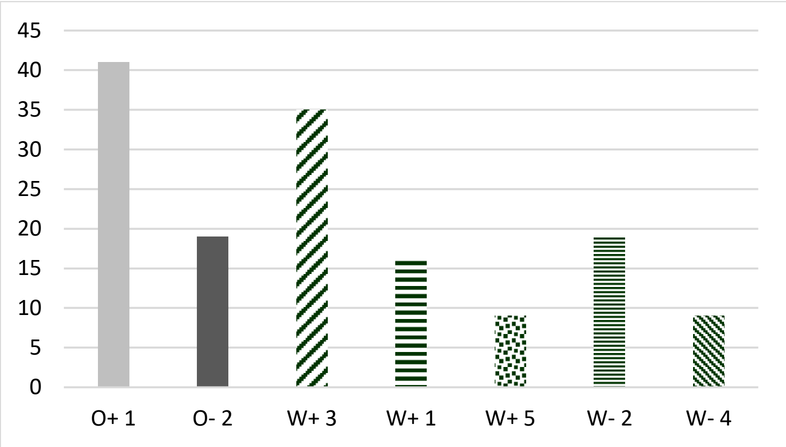

Fig. 1: Preferences/rejections of selected types of tests (%)

More detailed results were discovered if data were considered under the criterion of learning preferences.

Ad 2) Student preferences/rejections from the view of strongest type of learning preference according to LCI

Learning preferences in the sample are displayed in figure 2. As clearly visible, the ´accept´ fields in all four processors are prevailing. This results means that students are able to learn through various teaching methods, using various types of study materials etc. In the group of sequential processors 22 % of respondents have learning preferences of some type, as well as 14 % of technical processors. On the other hand, rejections were detected with 9 % of confluent processors; however, hardly any rejections were detected with other groups.

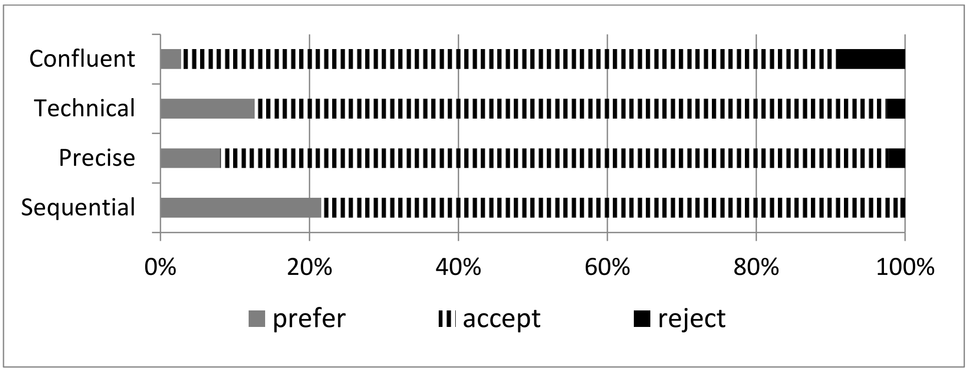

Fig. 2: Learning preferences in the sample group (%)

Without regard to single types of processors, as displayed in figure 3, preferences and rejections were nearly identical with all four groups; they differed in the strengths of preferences or rejections of the presented types. In all groups

- the preferred test types were O1 (Student is asked a question from the pre-defined list) and W3 (Multiple-choice task with 1 correct answer), including Multiple-choice task with 2+ correct answers (W4); Yes/No task (W5) and True/False task (W6);
- the rejected test types were O2 (Student is asked a question from the unknown list) and W2 (A question, problem, topic from unknown list is set for essay writing);
- and, W7 type of test (Students introduce results of the project they worked on during the semester; topic was set at the beginning of the semester) was listed as preferred by confluent processors.

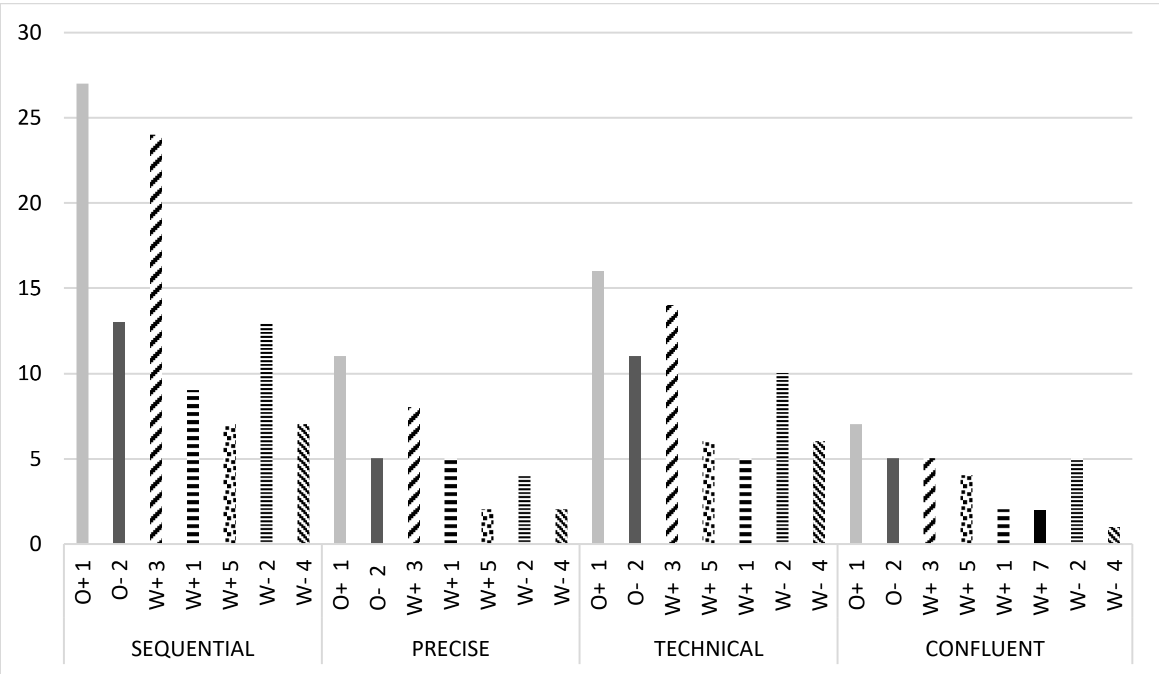

Fig. 3: Preferences/rejections of selected types of tests reflecting learning preferences (Plus (+): preferred type of test, Minus (-): rejected type of test) (%)

Discussions and conclusions

It is not easy to find other publications focusing on assessment, evaluation and testing from the view of student learning preferences because these areas are usually researched separately. Despite this fact, similar results as in our survey were presented by Montequin, Fernandez, Balsera and Nieto (2013). They dealt with technical and human aspects reflected in group dynamics, it means they studied how different combinations of student profiles could explain different group dynamics and at the same time predict the final success of the group. They produced conclusions similar to those of technical processor group in our survey. Contrary to this result, Markovic et al. (2013) focused on adaptive distance learning and testing system and discovered that personalized profiles adapted the learning and assessment process to learner preferences through designing and using adaptive testing systems as part of the curriculum. If multimedia materials were used, the visual/verbal preferences were activated and final knowledge performance was tested by adaptive tools reflecting individual preferences (Chen, Sun, 2012).

Compared to this work, Al-Hudhud (2012) expressed complaints about the lack of adaptive interaction tools in the current LMSs; consequently (in his opinion) the LMSs were not able to reflect learner preferences, neither in learning, nor within the assessment process. In the study he produced design requirements to be implemented so that the LMSs were able to accommodate learner´s preferences.

In the Czech education environment the theory of adaptive e-learning is being developed at the university of Hradec Kralove, Faculty of Informatics and management (Simonova, Poulova et al.) and University of Ostrava, Faculty of Education (Kostolanyova, Kapounova, Sarmanova et al.). However, the process of assessment/evaluation/testing within adaptive e-learning has not been sufficiently worked out.

Reflecting the fact that current process of instruction is widely supported by modern information and communication technologies, we strongly recommend the problem of approaches to assessment/evaluation/testing to be taken into consideration not only in the traditional way of teaching/learning but also in the ICT-enhanced or mobile-assisted instruction. Widely used multiple-choice tests in electronic version are the first step within this process which should be definitely followed by considering their appropriateness to learners with different learning and testing preferences. Whether these will be detected by the LCI (as in our research), or by another tool is the subject of individual researcher decision and the research design reflection.

Considering the Leither´s results (Leither, 2011) in the future we are going to continue this research focusing on verification of correlations between single types of processors and types of tests, as presented in this work, by comparing the test scores collected from various formats which match/mismatch to single processors.

Acknowledgment

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Social Media at Czech and Polish Universities: a Comparative Study

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Abstract

The study defines terms from the social media field within the scope of the electronic educational environment as well as social media and social networks as a means of study support at a university. The research on a representative sample of the University of Ostrava and the University of Silesia students, which was carried out within the scope of the 7th RP IRNet project, is aimed at the analysis of the current situation regarding the use of social media by the university students and at the differences in the use according to the country of study.

Keywords

Social media, social networking, support, study, university students

Introduction

Current digital technologies change how children relate to the world – they influence the process of acquiring and processing information, communication, self-expression and creativity. According to the current Eurostat statistics, 76% of the Czechs between the ages of 16 and 24 use social media.

According to the latest “Adults’ Media Use and Attitudes” report (2015), 93% of the 1,640 adult respondents in Great Britain use social media, the most of all the compared groups. 72% of all adult respondents (16 to 65+ years old) use social media. 97% of users use Facebook, 48% of which use it exclusively. More than eight in ten social media users consider their Facebook profile to be their main social media site.

The use of social networks is the most diverse in the 16–24 age group which includes university students: 80% of them use Facebook, 10% of them use Twitter and the remaining 10% use Whats App, LinkedIn, YouTube and Instagram.

"Two thirds of adults with a profile use social media more than once a day. Close to one in four (23%) say they visit social media profiles more than ten times a day, and this has increased since 2013. In total, eight in ten (81%) do so at least daily. A third of those aged 16–24 (34%) and 25-34 (33%) with a social media profile visit more than ten times a day, and this is more likely than average (23%). In contrast those aged 45- 54 (11%) and 55+ (8%) are less likely. Men (22%) are more likely than women (16%) to say they visit less often than daily."

Social media is most commonly undertaken on a smartphone, particularly by younger adults. This is more likely among those aged 16–24 (64%) and 25–34 (58%).

Rosen (2010) introduces the term iGeneration, which he uses for the contemporary elementary and high school students. The iGeneration members are always online, take digital technologies for granted and they are an integral part of their lives.

As far as the school instruction is concerned, the traditional concept of classroom teaching is beginning to change as the formal education and informal education are connected more than ever. We think that social media is one of the ways to make school and education more attractive to students – social media is their natural environment, it offers countless opportunities for the support of educational activities and teamwork, it encourages creativity and peer learning (by sharing skills, experience and ideas). And what is the situation at universities? Are social media and social networks used for education?

Social Media – what is it?

Both the professional and general public have become acquainted with the term social media. Mostly, the terms social media and social networks are considered to be synonyms. However, scientific publications offer several definitions. Bouda (2009) introduces several definitions from various authors who define social media as:

- Tools that "provide easy use of collaborative working spaces by using various communication tools";
- A means that enables communication, which has a different purpose than the traditional media. Social media is based on interaction between people. The public feedback (be it in the form of commentaries or editing the original text or content) is the key element;
- All Internet media, which enable gathering of the like-minded groups of people and the discussion about various topics;
- The so-called new media, or media 2.0.

Wikipedia, the free encyclopedia, states that social media "are computer-mediated tools that allow people to create, share or exchange information, ideas, and pictures/videos in virtual communities and networks". It falls within the subset of mass media. It consists of highly interactive platforms, which use mobile and web-based technologies to create user-generated content. Social media differs in many respects from traditional media. The main difference is that, unlike in the initial model where there was only one source, the information is distributed by many sources. Another major difference is the possibility of an immediate reaction, editing, comment or other modifications of the content.

The following definition, Wigmore (2015), stresses the importance of communication for the use of social media, "Social media is the collective of online communications channels dedicated to community-based input, interaction, content-sharing and collaboration. Websites and applications dedicated to forums, microblogging, social networking , social bookmarking, social curation, and wikis are among the different types of social media".

The authors of the SMILE (Social Media in Learning & Education) project (2013) argue that generally speaking, social media contains at least some of the following characteristics:

- Social media challenges traditional models;
- Social media allows people to communicate;
- Social media allows people to collaborate;
- Social media gives people an audience;
- Social media services often remove hierarchy and are built from the bottom up;
- Social media is open and transparent.

Whether you have your own definition for social media or even disagree with some of the characteristics above, the one thing that everyone seems to agree on is that social media, social networks and the social web is moving from strength to strength. The term given to this by the website socialnomics is the 'Social Media Revolution'. Socialnomics has also produced a viral YouTube video that provides a number of interesting facts and figures about the rise and growth of social media.

The facts include:

- If Facebook was a country, it would be the world's 3rd largest with more than 3× the size of the U.S. population;
- There were over 75 million more people playing Farmville than there were real farmers;
- A new member joins LinkedIn every second;
- 1 in 5 couples meet online.

The video concludes by stating that, 'Social media isn't a fad, it's a fundamental'.

Social media and education

Bouda (2009) refers to David Meerman Scott's scientific paper entitled "Asking the Right Questions about Social Media" when he argues that the media in the form of the mass-media touch every person and thus are omnipresent. The man encounters television, radio, the Internet or newspapers everywhere.

Social media

As far as social media is concerned, Bouda (2009) highlights three points:

1) We access information through social media as it is included in the search results of the Internet browsers.
2) Social media is present on the portals of Internet newspapers or on information portals.
3) If a person asks their friends for information, they are often provided with a link or a blog or other social media with a discussion on a particular topic.

Digital technologies are becoming more accessible to a number of teachers and students. It is only up to them which one they decide to use in their teaching and studying, respectively. Jelínek (2015) introduces the typology and overview of the new generation websites based on the study by Matt Bower from Macquarie University (Australia). The study helps both teachers and students organize educational tools and at the same time helps them choose the optimal tool for teaching and learning, respectively. The study divides the individual tools into 32 groups and 14 categories. Those are tools based on discussion, tools for working with images, tools for working with sound, tools for working with video, tools for the creation of presentations, books, animations, social networks, web applications, tools for organization and sharing of materials, tools for working with data, tools for event logging, tools for the creation of tests, tools for 3D modeling and tutor tools.

Biernátová (2012) summarizes the possibilities of social media in terms of information education:

1) Social media serves as a supplement to the classic instruction. It enables discussion between the students and the teacher.
2) Through social media the teacher shares study materials (Slideshare presentations, YouTube videos, etc.) or uses embeds and links to concentrate them in the e-learning environment (web bulletin board, LMS or social network).
3) The teachers create private social networks, which replace the LMS, where the students can engage in discussion, share their materials or submit their homework.
4) The instruction takes place on one of the public social networks (e.g. Facebook).
5) Some of the Facebook pages (Twitter accounts, etc.) primarily used for promotion can also be used for sharing relevant information.
6) Social media is used as a source of information (Twitter, YouTube, geotagging).
7) Social media is used as tools in instruction or as a means to achieving educational goals (e.g. blogs, wiki, podcasts). Students themselves create the content, acquiring the required knowledge in the process.

Rhanem (undated) argues that social media fulfils needs that can be hierarchized, the lowest level being everyone’s need to acquire information anywhere (content), followed by the need for massive networking with no or only low costs (technology), the need for participatory culture that enables sharing, commenting and collective storing of information (WIKI) and the need to live in the real-time environment which is made possible by a number of distribution channels for a continuous period of time.

Social Networks

Social networks are becoming an integral part of their users' lives. The main advantage of social networks lies in the fact that the users can communicate not only with people who live close to them, but also with people who live on the other side of the world. The interconnection of social networks and education is a current topic. As technology is playing an ever-important role in people's lives, this kind of education could have an enormous impact on the future image of the entire educational system. The use of social networks is on the rise as the number of users, and with it the potential for advertising and business plans, is increasing every year. As far as the future is concerned, social networks offer a vast number of opportunities – from influencing large interest groups (well-targeted advertising) to customized applications to the offer of services based on deduced behaviour on the Web.

Jelínek (2015) argues that social networks are not used exclusively by teenagers as more and more adults are starting to use them. In the Czech Republic, approximately 50% of the Facebook users are aged between 20 and 35. This fact tells us that social networks are used not only by students but also by teachers (which makes the education process more attractive to both groups). The following are the social networks intended for the field of education: Twiducate, Class Tools, Edmodo.

Smetánková (2014) refers to the T.H.E. Journal (Technological Horizons in Education) when she claims that social media is a suitable educational tool. It extends the possibilities of learning outside of school and helps students become acquainted with real-life problems and situations (they can learn from one another and from experts). As a result, teachers can incorporate new teaching methods into instruction. Moreover, being connected to social networks helps teachers in self-education.

A number of other authors (e.g. Haddon, 2015) mention the issue of online victimization of youth caused by social media which can take a number of forms and have a number of serious consequences. In younger children, this issue is associated with the parent's insufficient management of their children's time while the older children are not aware of the risks social media may pose, i.e. their so-called digital literacy is insufficient.

The use of social media at universities

Social networks at universities

While the university students use all types of unspecified social networks (Facebook, Twitter, etc.), they could also make use of the following more specialized networks (Ross, 2016):

Snapchat, the popular photo and video messaging app, which can engage students with learning materials in real time.

Trello, essentially an online sticky-note tool. Trello links pictures, videos, and documents in threads that can be shared between group members. The tool organizes discussions into boards like Pinterest, and allows to share and curate relevant information.

Vine, six-second, looping videos are all over social media – and they can be a resource for higher education institutions, too. They can be used to present the university campus or promote events, but they are also a useful tool for wider engagement.

Pocket, this bookmarking service allows users to collect and download article links to curate their own online magazines. Users can follow the curated feeds of other "pocketers", which means that students can link with professors who have publicly shared relevant links and articles. It saves the hassle of a group email and can be updated instantly.

Google Docs, using collaborative documents is not a new thing, nor is giving peer feedback on assignments. Mixing them together, however, to enable students to give instant feedback on each other's work, is immensely useful. Google Docs allows tracked editing and comments, which means that students can work in groups in their own time, without having to take part in structured seminars, and the document can be sent to the lecturer for feedback.

Italk, primarily used as a recording tool, this is one of the best ways to capture lectures and upload them online, or share via email. There's an option to change the quality of sound recording, and transferring between devices is quick and simple.

Wunderlist, some students are more organized than others, and the disorganized ones can be the bane of their tutors' lives. Organizational app Wunderlist allows students – and lecturers – to create folders for each module, with notes, due dates, comments, contact lists and, perhaps most crucially, reminders of upcoming deadlines.

Instagram, the image-sharing tool can be harnessed to collect real-time data for coursework. Rather than passively relying on data collected by others, students can engage in their own collection of all kinds of evidence. Instagram also provides an opportunity for collaboration – students can upload, tag, and comment on pictures on each others' feeds, thus expanding the reach of discussion.

Research on the use of social media at universities

Luton (2014) has recently conducted a research on the kinds of social media used at universities and their benefits. The sample of the international research consisted of 711 academic scholars and post-gradual students (i.e. M.A. and Ph.D. students) of social sciences. They currently use (in sequence) Twitter, LinkedIn, Academia.edu, Facebook and ResearchGate, with Twitter being considered the most useful medium by the academics.

For the majority of respondents, the principal benefit they gained from using social media was related to the connections or networks they had established with other academics, students and also those outside academias.

The second benefit is openness and sharing. The opportunity to reach individuals and groups outside the university was particularly valued as part of this ethos of openness and sharing. The third benefit is self-promotion. Many respondents mentioned the opportunities for promoting their own research and discussing their ideas in early form with colleagues. The fourth benefit concerns the area of university research. A number of respondents stated that social media allowed them to keep them in touch with new developments and events and provided them access to unpublished and new articles in their field of research. The fifth benefit is instruction.

Some respondents mentioned using social media in their teaching. They remarked that social media helped them engage their students and a way in which online students in particular can easily connect with academic staff and each other. Finally, several postgraduate students and early career researchers wrote that social media connections often gave them emotional as well as academic support, which they found particularly important at their stage of academic career.

The respondents also described ten other phenomena and feelings associated with the use of social media in the university environment:

- privacy and the blurring of boundaries,
- the risk of jeopardizing one's career,
- lack of credibility,
- quality of content posted,
- time pressures,
- social media use becoming an obligation,
- becoming a target,
- too much self-promotion by others,
- plagiarism,
- the commercialization of content and copyright issues.

The results of the National Survey of Entrepreneurship Education (2014), conducted in 4-year dormitories and universities in the U.S.A., revealed the social media the students use and what they use them for. Out of 206 institutions, 49% use social media in particular areas and 25% of them use blogs. Facebook is used most often (33% of all uses), followed by LinkedIn (26%) and Twitter (25%). The least used media are Instagram (2%), Pinterest (4%) and Google+ (10%). To survey the offerings that U.S. schools provide outside of the classroom, survey respondents were asked to indicate whether or not they offered any of the following opportunities - internships, online learning, continuing education or executive development courses. A large number of respondents (114) indicated that they offered internship opportunities. It also confirms that entrepreneurship education has still not made a big move toward offering online courses (43 schools), as this option was the lowest ranked only behind executive development courses (34 schools). 52 institutions stated that social media is used in continuing education.

DeAndrea et el. (2011) present the results of the research on the use of social media to improve a new student's adaptation to the university environment they conducted at Michigan State University. The social medium called SpartanConnect is used to support the adaptation of the freshman students. It was designed to improve the relationship between freshman students and their roommates at the university campus. It is interconnected with other social media such as Facebook, etc. Even though no direct relationship has been found between the use of the website and academic self-efficiency, the research indicates that the social support has a positive impact on the student's adaptation to the university environment.

When investigating the relations between social networks and students' performance in extended student communities, Cadima, Oleja and Monguet (2012) verified the validity of three hypotheses based on the previous assumption that in the educational environment, social networks play the key role of a channel for sharing knowledge and are the source of social support. The first hypothesis assuming that their results improve with the number of their interactions was confirmed. For curiosity, the students of Polytechnic University of Catalonia had 6.8 interactions per week, with a standard deviation of 4.4. Also the second hypothesis "The closer is an individual with their peers in the community, the better their results", based on the average distance between individuals, was confirmed. The Czech environment uses the term path length which is measured by the number of interactions constituting a joint (Busštíková, 1999). However, the third hypothesis assuming that the student's performance improves with the level of their networking with others (which is determined by the network density or centralization) was not confirmed.

The latest data (2014) about the number of users of two main social networks show that they are widely used at universities. If we compared the number of Facebook and Twitter users at the University of Ostrava with the total number of students (not assuming that all the users are current students), then at the time of publication of the abovementioned information the number of users would be 70%.

University	Facebook	Twitter
Charles University	19,019	562
Masaryk University	16,724	769
Czech University of Life Sciences	10,997	591
University of Economics	9,879	129
Technical University of Liberec	8,360	-
Academy of Arts, Architecture and Design	7,543	179
University of Pardubice	7,282	-
Mendel University	6,894	-
Palacký University	6,802	156
University of Ostrava	6,736	242

Table 1: Ten Czech universities according to number of social network users in April 2014

Research on use of social media by University of Ostrava and University of Silesia students

Research objectives

The subject of the research was the use of social media by university students. The goal of the research was to collect and analyze data about the current situation concerning the use of social media and learn whether it varies in various forms of study.

Research problem and research questions

The authors of the study formulated the basic research problem as follows: There are no relevant data concerning the University of Ostrava students' use of social media, which kinds of social media they know/use and what their needs and expectations are as far as this area is concerned. The formulated research problem was further specified by the following research questions:

1) How do students evaluate the need to cooperate when solving educational problems?
2) In what ways do students use social media within the scope of cooperation?
3) What is the reason for students' participation in virtual communities or social networks?
4) What motivates students to share the results of their activities in an electronic environment?

Research hypotheses

Corresponding research hypotheses were formulated on the basis of preliminary findings regarding university students' learning habits and their orientation in corresponding studies:

- H1: The University of Ostrava students and the Silesian University students differ in the need of cooperation during solving study problems;
- H2: The University of Ostrava students and the Silesian University students differ in the degree of use of social networks;
- H3: The University of Ostrava students and the Silesian University students differ in the reasons for participating in virtual communities;
- H4: The University of Ostrava students and the Silesian University students differ in the motivation for presenting one's results in the electronic environment.

Research file and data collecting

The students of the Pedagogical Faculty of the University of Ostrava in the Czech Republic and the students of the Faculty of Ethnology and Educational Science of the University of Silesia in Poland, which are both participating in the international research IRNet conducted within the scope of the 7th framework program in 2014-2017, were the research file of this research.

All of the Faculties' students were asked via a bulk email to fill out a questionnaire, which was compiled by a consortium of project solvers. Considering that students' participation in the questionnaire research was voluntary, the selection of respondents was random.

A larger portion of women and students of teaching study programs in the research sample is determined by women's naturally greater interest in (the mostly feminized) teaching professions and the prevailing portion of teaching study programs at the Faculties. Moreover, in the sample the portions of students of all three levels of study and of daily attendance students and combined study students correspond to the real portion as represented at the Faculty. More than half of the Czech students consider themselves intermediate ICT users and only a small number consider themselves beginners. The level of digital literacy of the Polish students was not part of the research.

The data collecting took place in April and June 2015. The students answered the questionnaire questions through the electronic system Google Questionnaire.

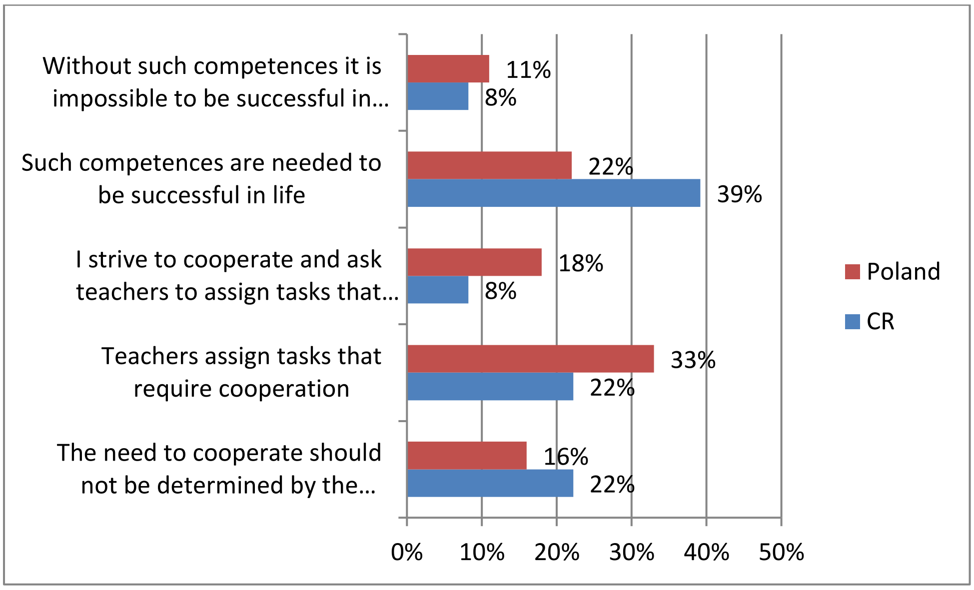
Results and their interpretation

The research results were calculated using Pearson's chi-squared test.

Evaluation of the need to cooperate when solving educational problems

In this question the students evaluated the need to cooperate (when working in a group or a team) when solving an educational problem. The students were asked to choose one of the following answers:

- The need to cooperate should not be determined by the teacher;
- Teachers assign tasks that require cooperation;
- I strive to cooperate and ask teachers to assign tasks that require cooperation;
- Such competences are needed to be successful in life;
- Without such competences it is impossible to be successful in business.



Graph 1: Evaluation of the need to cooperate when solving educational problems

The data presented in Graph 1:

- Compared to the Czech students, the Polish students cooperate with teachers and realize that without the cooperation competencies it is impossible to be successful in business more often.
- Compared to the Czech students, the Polish students state that teachers assign tasks that require cooperation more often.

- However, compared to the Polish students, the Czech students think that the teacher should not tell them when to cooperate and that cooperation competencies are needed to be successful in life more often.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.382[a]	4	**.004**

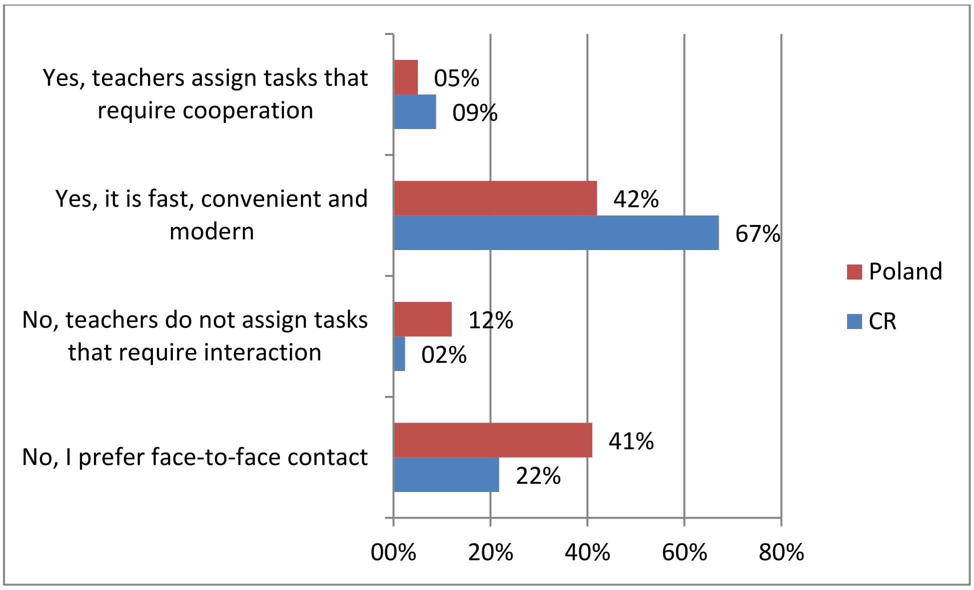
Chart 1: Chi-Square Test Result for H1 Hypothesis

We can claim that the H1: "The University of Ostrava students and the Silesian University students differ in the need of cooperation during solving study problems" was confirmed.

Students' use of Social Media

In order to learn whether or not the students use social media when studying, we asked them the following question: Do you use social services, e.g. social networks, for cooperation and teamwork? The students were asked to choose one of the following answers:

- No, I prefer face-to-face contact;
- No, teachers do not assign tasks that require interaction;
- Yes, it is fast, convenient and modern;
- Yes, teachers assign tasks that require cooperation.



Graph 2: Students' use of social media (answers to the question "Do you use social media?")

The data presented in Graph 2 show that:

- Compared to the Czech students, the Polish students consider social services realized through social media to be fast, suitable and modern,
- The opinion of the Polish students probably reveals that they, unlike the Czech students, prefer face-to-face contact,
- Compared to the Czech academic teachers, the Polish academic teachers assign their students tasks that require cooperation less often; 12% of the Polish students (compared to 2.4% of the Czech students) state that teachers do not assign them any tasks that require interaction.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26.038[a]	3	**.000**

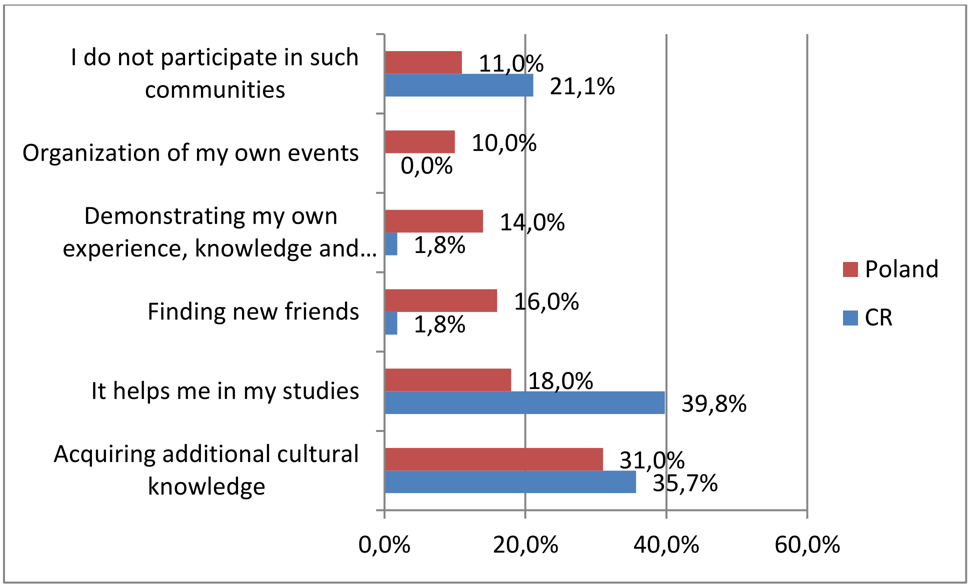
Chart 2: Chi-Square Test Result for H2 Hypothesis

We can claim that the H2 "The University of Ostrava students and the Silesian University students differ in the degree of use of social networks" was confirmed.

Main reasons for participation in social media

In order to learn the main reasons for students' participation in social media, we asked them the following question: What is the main reason for your participation in the student virtual communities (scientific, artistic, sports) on social networks or other Internet services? The students were asked to choose one of the following answers:

- Acquiring additional cultural knowledge (to learn about various events, to broaden my horizons, to have cultural experiences);
- It helps me in my studies (knowledge sharing, asking to help me solve a problem);
- Finding new friends
- Demonstrating my own experience, knowledge and achievements;
- Organization of my own events;
- I do not participate in such communities.



Graph 3: Reasons for students' participation in social media

The data presented in Graph 3 show that

Twice as many Czech students as Polish students state that social media help them in studying.

Slightly more Czech students than Polish students use social media to expand their cultural knowledge.

Twice as many Czech students as Polish students state that they do not participate in the virtual student communities.

Nearly eight times as many Polish students as Czech students participate in these communities to share their experience, knowledge and successes.

Many times more Polish students than Czech students participate in the virtual student communities on social networks to make new friends.

Every tenth Polish student uses the virtual student communities to plan their own events. However, no Czech student uses them for such a purpose.

It can be said that the Czech students use the virtual student communities on social networks for studying and cultural purposes while the Polish students use them for social purposes, i.e. for sharing their experience and successes, for making new friends.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	63.951[a]	5	**.000**

Chart 3: Chi-Square Test Result for H3 Hypothesis

We can claim that the H3 "The University of Ostrava students and the Silesian University students differ in the reasons for participating in virtual communities" was confirmed.

Presenting student's results

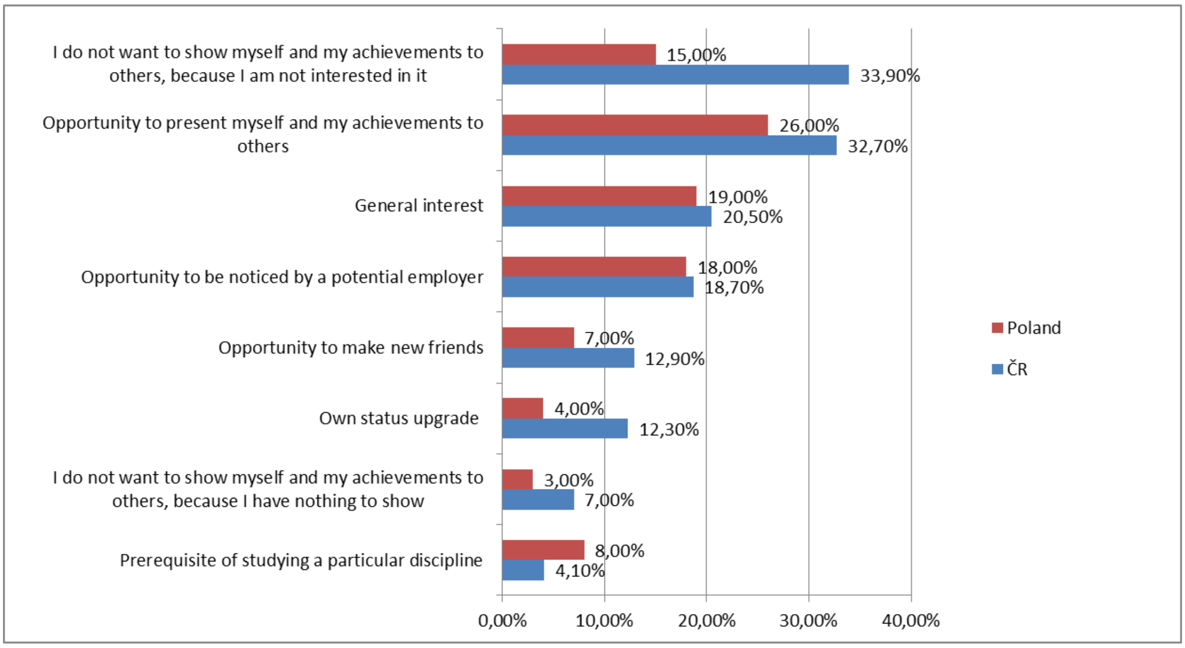
In order to learn students' motivation to present their results, we asked them the following question: Choose the reasons which motivate you to present the results of your academic, artistic or sports activities in the university electronic environment (on the university website, social networks, etc.). Students answered each of the following questions Yes or No; the number of selected answers was not limited:

- Opportunity to present myself and my achievements to others;
- Opportunity to be noticed by a potential employer;
- It can help me acquire a scholarship;
- General interest;
- To upgrade my own status;
- Opportunity to make new friends;
- I do not want to share my achievements with others because I have nothing to show;
- I do not want to share my achievements with others because I am not interested in it.

	Czech Republic	Poland
Prerequisite of studying a particular discipline	4.1%	8.0%
I do not want to show myself and my achievements to others because I have nothing to show	7.0%	3.0%
Own status upgrade	12.3%	4.0%
Opportunity to make new friends	12.9%	7.0%
Opportunity to be noticed by a potential employer	18.7%	18.0%
General interest	20.5%	19.0%
Opportunity to present myself and my achievements to others	32.7%	26.0%

I do not want to show myself and my achievements to others because I am not interested in it	33.9%	15.0%

Table 2: Students' motivation for presenting their results



Graph 4: Students' motivation for presenting their results

Note: The average of favourable answers of the Czech students was 1.42 while the Polish students always selected only one favourable answer which best described their opinion on the particular question

		Country		sig. chi-square
		Czech Republic	**Poland**	
Opportunity to present myself and my achievements to others	Count	56	26	.243
	%	32.7%	26.0%	
Opportunity to be noticed by a potential employer	Count	32	18	.884
	%	18.7%	18.0%	
Prerequisite of studying a particular discipline	Count	7	8	.175
	%	4.1%	8.0%	
General interest	Count	35	19	.770
	%	20.5%	19.0%	
Own status upgrade	Count	21	4	**.023**
	%	12.3%	4.0%	
Opportunity to make new friends	Count	22	7	.132
	%	12.9%	7.0%	
I do not want to show myself and my achievements to others because I have nothing to show	Count	12	3	.163
	%	7.0%	3.0%	
I do not want to show myself and my achievements to others because I am not interested in it	Count	58	15	**.001**
	%	33.9%	15.0%	
Total	Count	243	100	-
	%	142.1%	100.0%	

Chart 4: Chi-Square Test Result for Partial Hypotheses within H2 Hypothesis

The data presented in Chart 4 and Graph 4, respectively show that:

The hypothesis H4 as a whole cannot be accepted as there is not a statistically significant difference between the Czech and Polish students in 6 of the 8 parts of this question. In the two national groups of students, a statistically significant difference was found in two reasons that (un)motivate students to present their results. The students: wanted to present their results to improve their status (more often stated by the Czech students); did not want to present their results because they were not interested in it (more often stated by the Czech students).

Discussion

The results acquired from the questionnaire showed that the Czech and Polish university students (both universities are humanities-oriented and relatively geographically close) have different needs regarding cooperation and the use of social media. When they use social networks, they do it for different reasons. In both groups, only one third of students use social networks to present themselves or the results of their academic activities to their peers or public. As far as using social networks for self-presentation is concerned, the reasons of both the Czech and Polish students are similar. The Czech students seem to be more individualistically-oriented. They use social media mainly to individually solve the assigned tasks. Half of the students are willing to share their results and present them to others, including their future employers. The Polish students, on the other hand, are more cooperative in solving the assigned tasks. They wait for the teacher to encourage them to use social media for cooperation and interaction. They prefer face-to-face communication and use social media mainly to make new friends and to share their successes with them.

The conducted comparative research calls for discussion about its results as the field, geographical and economic proximity of the two departments focusing on educational and ethnological studies suggests the answers to individual questions should have been less different than they turned out to be. The fact that three hypotheses assuming differences in approaching social media and its use may point to different relationships of students to their peers and to different relationships of teachers to their students and their study and social needs, which may be the result of differently defined or differently perceived roles shared by the community. Different structures of the two electronic environments may also have been behind the different results of the two groups.

Our research did not factor in the individual social media. As a result, it is impossible to compare our data with the data of the researches aimed at the use of the individual social media. However, due to the globalization of the user environment, it can be assumed that there would not be significant differences. The University of Ostrava uses the following social media: Facebook, Twitter, YouTube, Google, Instagram, LinkedIn and RSS.

Conclusion

In the university environment, social media is gaining in importance as it represents an effective means of communication within the university and between the universities and their surroundings. The majority of universities, including the Czech ones, already use a number of established media. At the same time, they are designing their own specialized networks with a variety of functions supporting cooperation between teachers and students and among students. The positive effects of social networks can be seen in study results or performance, social integration, sharing of information, students' adaptation to the university environment. However, even in the university environment risks arising from the use of social media can be found, e.g. violation of privacy, career threat, plagiarism. Knowing about them makes it possible to prevent them. The results acquired from the questionnaire showed that the Czech and Polish students have different needs regarding the use of social media, different reasons for (not) using it and that they differ in how often they use it for social and studying purposes. As far as using social networks for self-presentation is concerned, the reasons of both the Czech and Polish students are similar. The future researches should be aimed at the study, emotional and interpersonal effects of social networks, which will factor in the data related to study results, students' behaviour and the data describing the individual's place in social media based on the analysis of social media, all of which can be seen in the recent researches.

Acknowledgments

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TESTING IN ADAPTIVE LMS

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Abstract

For a number of years now, the research activity at the Department of Information and Communication Technologies at the Pedagogical Faculty of the University of Ostrava has been aimed at improving the quality of instruction. A team of experts has been assembled who can create new study materials that can be used in the electronic environment and are able to adapt to students' individual characteristics and needs. As feedback is an integral part of instruction (be it the e-learning or the classic one), the proposition of electronic adaptive testing has been included in the process. In the proposition, the authors ponder a number of alternative possibilities of adapting test tasks – suitably formulated tasks, suitable reactions to the student's correct and incorrect answers, suitable selection of individual test tasks. This paper aims to introduce the basic principles and rules of electronic adaptive testing and consider other adaptation options.

Keywords

adaptive testing, adaptive LMS, groups of questions, question status, difficulty level

Adaptive instruction

Before we proceed to electronic adaptive testing, let us introduce the basic principles and rules necessary for the proper functioning of adaptive instruction. What does the term adaptive instruction really mean?

Paramythis' description (2003) captures the essence of adaptive instruction. He argues that *"a learning environment is considered adaptive if it is capable of: monitoring the activities of its users; interpreting these on the basis of domain-specific models; inferring user requirements and preferences out of the interpreted activities, appropriately representing these in associated models; and, finally, acting upon the available knowledge on its users and the subject matter at hand, to dynamically facilitate the learning process"*.

He also argues that there are four categories in the adaptive learning environment:

1) Adaptive Interaction

   The first category refers to modifications intended to facilitate or support the user's interaction with the learning environment. Examples of modifications at this level include the use of alternative graphical and color schemes, font sizes, etc. to accommodate the user's requirements.

2) Adaptive Course Delivery

   The second category constitutes adaptation techniques aimed at the adaptation of the course/instruction to the individual users. The intention is to optimize the fit between the course contents and user characteristics.

3) Content Discovery and Assembly

   The third category refers to the creation of an adaptive study material based on adaptive techniques and knowledge about users derived from previous "sessions".

4) Adaptive Collaboration Support

   The fourth and final category captures communication between people (so-called social interaction) and collaboration toward common goals. It is important to support communication, collaboration and cooperation as the individualist approach to learning can lead to complete isolation.

Different view offers us Spencer (2011), that there are 4 stages of personalization in the teaching (in the last two stages we see elements of adaptive learning):

1) Standardization

   This level includes the entire classroom (group): What does the classroom need? How to motivate the entire group? The teacher has one material for the entire classroom and hopes the majority of students will find it interesting and satisfactory.

2) Differentiation

   This level takes into account different levels of knowledge that are to be found in the classroom: What do the groups with different levels of knowledge need? Based on the students' skills and knowledge (or their learning styles), the teacher divides them into groups and works with them in a differentiated manner.

3) Adaptation

   This level offers an individual choice: How can I best determine the student's needs and adapt the instruction accordingly? Based on the teacher's recommendation, the student should learn exactly what they need.

4) Personalization

   The students learn on their own: What does each student need and how can they express those needs? It is based on respecting the individual's autonomy and identity; each student controls their own learning process.

All the levels can be taken as the gradual development of the teacher, their ability to improve their material-preparation skills, their skills regarding the organization of the education process.

Hill (2013) also distinguishes between types of teaching deals with the adaptive learning and points to some differences between the concepts of adaptivity and personalization:

1) Differentiated learning

   Differentiated learning is a kind of learning with a number of ways in which students approach a new curriculum. Students are divided into categories, with each category being different in the way of learning and approaching new information.

2) Personalized learning

   Personalized learning is a kind of learning where each student takes different paths to achieve their educational goals. Before the start of instruction, the student takes a pretest, which determines their individual "path".

3) Adaptive learning

   Adaptive learning takes into account the student's results during the entire time of instruction. It is a dynamic process as the student's "path" can be changing all the time.

Theory of Adaptive Education

For a long time, the theory of adaptive education (TAE) has been a research focus of a team of experts at the Department of Information and Communication Technologies at the Pedagogical Faculty of the University of Ostrava. The research results – system development (Drápela, 2013); system fine-tuning using simulation (Kostolányová, 2013); proposition, creation and implementation of rules (Takács, 2014); verification through an experiment in instruction (Horký, 2014), supporting the holistic approach to the curriculum using a semantic network (Šeptáková, 2016) – have been published as diploma theses, dissertations and habilitations. The theory is being further developed as new aspects are constantly emerging.

The proposed TAE comprises three main sub-systems: *Student*, *Author* and *Virtual Teacher*.

- The *Student* module contains students' qualities and characteristics (those who participate in the course/instruction) based on which they are presented with personalized study materials.
- The *Author* module contains the adaptive study material, various texts, images, audio recordings, videos and other detailed information about the study material.

The most important part of the TAE, securing its proper functioning, is the *Virtual Teacher*. On the basis of the student's characteristics and the structure of the study material, the Virtual Teacher assigns the student an ideal way through the course. Moreover, it contains Event log, recording and storing the information about the student (the time spent on individual parts of instruction, answers to questions, their way through the course, etc.).

Four Stages of Learning

In what stage of knowledge acquisition can the TAE be used? Learning a new curriculum is a development process. First, the student *becomes acquainted with it* – reads the study material, focusing on the main chapters, headlines; tries to understand the curriculum as a whole, not focusing on the details.

Another step is the actual instruction, *re-reading the material*. The student tries to better understand the curriculum, focusing on the details. Highlighting the important parts and making notes is typical of this stage. In this stage, the student also tries to answer the questions and solve the tasks included in the study material or at the end of each chapter.

That is followed by *fixation of what the student has learned*. If the student feels they have mastered the curriculum, they can undergo the so-called "sample testing". That means that during testing, they can answer repeatedly, look inside the study material, or have the entire solving process displayed to them. Therefore, the feedback is immediate.

The final stage of the entire learning process is *self-testing*. In the previous stage, the student found out what they were good at and, on the other hand, what they need to improve and can now enter the final stage. They solve the test tasks without any help and learn the result at the end of the test (Prextová, Šarmanová, 2014).

From what we know, we can assume that the TAE is applied predominantly in the first two stages. In the remaining two stages, **adaptive testing** can be applied (Figure 1).

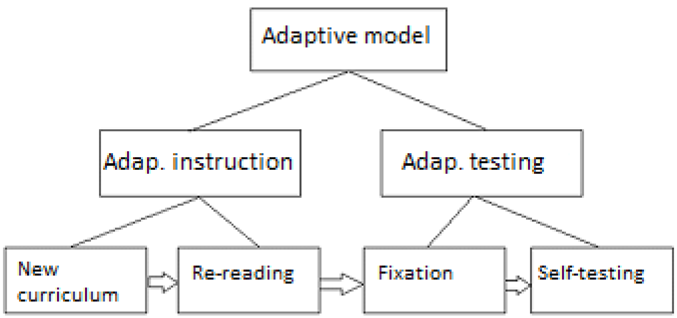

Fig. 1: Adaptive Model

Adaptive testing

In adaptive testing the selection of test questions is based on the current answer of the tested user. The user tested for the first time starts with a question of the medium difficulty. If there are 5 levels of difficulty (1 being the most difficult), they start with Level 3. If they answer the question correctly (as they did in Figure 2), the next question is more difficult. On the other hand, if they answer incorrectly, the next question is less difficult.

You can see the entire process in the following, simplified model:

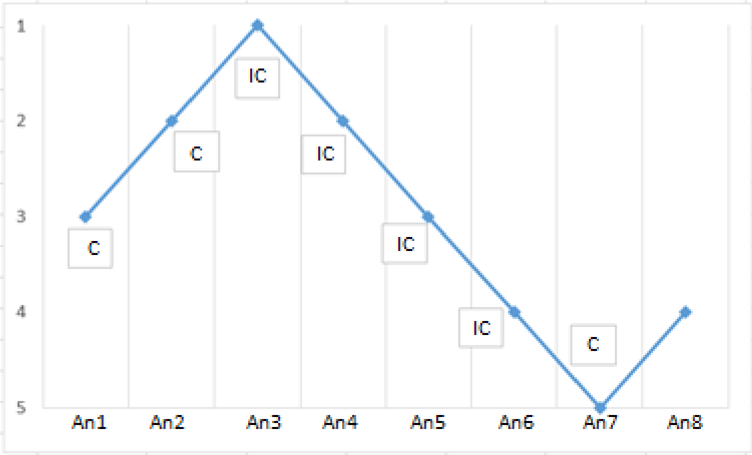

Fig. 2: Adaptive testing model

It is clear that an electronic system managing both adaptive instruction and adaptive testing will be necessary. Within the scope of the project "Adaptive Individualized Instruction in E-learning", the adaptive LMS Barborka (the current version is Barborka 4) was designed. It is a program system able to manage adaptive instruction, record and store user information and their way through the learning environment. It contains all three systems – Student, Author and Virtual Teacher (Šarmanová, 2011).

Apart from instruction (acquiring new information, building on the existing knowledge), the student, sooner or later, will have to take the test. The first stage of the creation of the adaptive system and the TAE was aimed mainly at adaptive instruction – what the study material should look like, to what student's characteristics it can be adapted, what the rules for assigning the optimal study material, finding suitable learning paths should look like, etc. Naturally, the testing is included in the system. However, only in the basic form used in schools. Therefore, up until now the testing was not adaptive.

Adaptive LMS Components

During the development of the adaptive study material and the Barborka LMS, we had to bear in mind that the education process needed to be adapted in various ways. As a result, the LMS is divided into smaller parts based on "classic" instruction (Figure 3):

Course: a typical school course.

Chapter: a thematic unit of a course.

Class: a typical class (45 minutes, 90 minutes).

Frame: an agent of the instructional information. There are several types of frames according to what sensory type of student they are intended for and how detailed they are.

Layer: the smallest element of instruction representing the individual stages of instruction. There are two large groups of layers in the TAE – instructional and testing. In adaptive testing, the focus is on the latter group.

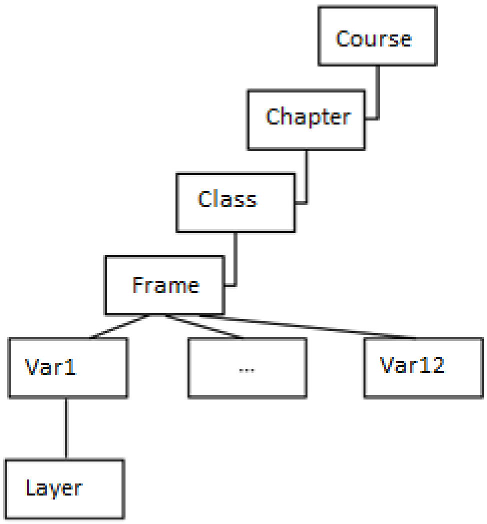

Fig. 3: Adaptive LMS

Types of Test Assignments

In the testing layer there are three types of test assignments:

Questions (Q): assignments aimed at the theory – remembering definitions, theorems, sentences.

Tasks (T): typical school assignments aimed at the application of theories, mostly without practical application.

Practical tasks (X): connecting the assignment to real life situations.

To prevent repetition, guessing the correct answer and to be adaptive, the set of test assignments should be large. Therefore, for each type (Q, T, X) and level of difficulty the author should create a **group** of test assignments. The following strategy has been proposed for suitable alteration of assignments in a group:

- In each group the author presets a set of assignments the students need to take. Those are **compulsory** (C). The remaining assignments are **optional** (O). As far as the C assignments are concerned, the student needs to answer them correctly at least once. As far the O assignments are concerned, those are equivalent assignments which do not differ much from one another (assignments with different formulations, different operators, numerical change, etc.). The O assignments are used to avoid displaying the correctly answered assignments when the student revisits the same curriculum.

- The system keeps records of each student's ***statuses*** – a strategy of assigning all test assignments (C, O). The C assignments are assigned first followed by the O assignments. The assignment ***statuses*** are as follows:
    1) O unanswered,
    2) O answered incorrectly one time,
    3) C unanswered,
    4) C answered incorrectly one time,
    5) O answered incorrectly several times,
    6) C answered incorrectly several times,
    7) O answered correctly,
    8) C answered correctly.

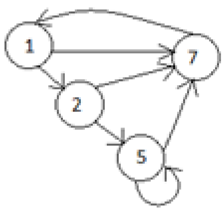

Fig. 4: Status transition in C assignments

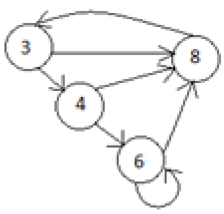

Fig. 5: Status transition in O assignments

- To make the testing adaptive, the testing assignments need to be distinguished according to the level of difficulty, making it possible to select a suitable variant. These are levels of difficulty (the author chooses the number of levels; we chose 5, Level 1 being the most difficult).

Types of Test Answers

Technically, various types of answers can be created. Each assignment can have one or more correct answers. The Barborka LMS currently contains two types of answers – ***closed*** and ***open***. In closed answers, the student ticks the correct answer. In open answers, the student needs to form the correct answer (also the assignments with more than one correct answer). The Barborka LMS currently contains the following types:

Closed answers	
Closed answers with one correct answer	– no change of sequence
Closed answers with one correct answer	– change of sequence
Closed answers with more than one correct answer	– no change of sequence
Closed answers with more than one correct answer	– change of sequence

Tab. 1: Closed answers

Open answers
Number
Set of numbers separated by commas; sequence is not important
Vector of numbers separated by commas, sequence is important
Word without diacritical marks = string of characters with commas and spaces
Set of words without diacritical marks separated by commas
Vector of words without diacritical marks separated by commas
Word with diacritical marks = string of characters with commas and spaces
Set of words with diacritical marks separated by commas
Vector of words with diacritical marks separated by commas

Tab. 2: Open Answers

Types of Reactions to Test Answers

As has been mentioned above, adaptive testing can be applied mainly in the fixation and self-testing stages (Figure 1). The aim of the fixation stage is for the user to remember the curriculum, be able to use it in further study and not to be discouraged by incorrect answers. That is why in this stage they should be able to answer more than once. The LMS's ***reactions*** to their answers also help the student. Based on the number of incorrect answers to the same question, the reactions are as follows:

a) Correct answer – ***system message***: answer is correct.

b) First incorrect answer – ***system message***: answer is incorrect.

c) Second incorrect answer – ***Reaction***: notifies of expected errors, displays a small "help".

d) Third incorrect answer – ***Reference***: refers to a layer or study material (e.g. in PDF form) containing the respective curriculum or demonstration, which may help the student solve the task.

e) Fourth incorrect answer – ***Help***: one of the possible solving processes with the correct result.

Rules

When there are this many possibilities, there also need to be certain if-then-type rules determining the way the system works and assigns different types of assignments based on the user's success rate or different reactions based on the user's answers. Before the rules can be created, the following data need to be formulated:

SUsp – *user's success rate* in the interval from 0 to 100.

OBod – *level of difficulty* in the interval from 1 to n.

Bzmen – *change of success rate after a correct answer and first incorrect answer*.

Bopak – *change of success rate after repeated incorrect answers*.

The relation between SUsp and OBod has been preset to n of intervals of the X = 100/n size; meaning that ⟨0,X-1⟩,⟨X,2*X-1⟩, ⟨2*X, 3*X -1⟩, …, ⟨(n-1)*X,100⟩, Bzmen =X/2, Bopak =1.

- Rules determining the relation between SUsp and OBod:
  - If the SUsp value is $\in \langle 0, X-1 \rangle$, then display a task from Obod = 1.
  - If the SUsp value is $\in \langle X, 2*X-1 \rangle$, then display a task from Obod = 2.
  - …
  - If the SUsp value is $\in \langle (n-1)*X, 100 \rangle$, then display a task from Obod = n.
- Rules determining the SUsp value for a correct and first incorrect answer:
  - If the answer is correct, then SUsp = SUsp + Bzmen.
  - If the answer is incorrect, then SUsp = SUsp – Bzmen.
- Rules determining the SUsp value for repeated incorrect answers:
  - If the answer is incorrect two times, then SUsp = SUsp – Bzmen – Bopak.
  - If the answer is incorrect three times, then SUsp = SUsp – Bzmen – Bopak – Bopak.
  - If the answer is incorrect four times, then SUsp = SUsp – Bzmen – Bopak – Bopak – Bopak.
- Rules determining the reaction of the system to a correct answer:
  - If the answer is correct, publish a system message on the correctness of the answer.
- Rules determining the reaction of the system to repeated incorrect answers:
  - If the answer is incorrect one time, publish a system message on the incorrectness of the answer.
  - If the answer is incorrect two times, then:
    - Publish Reaction; if it is not available, omit it and continue to Reference.
  - If the answer is incorrect three times, then:

        - Display Reference; if it is not available, omit it and continue to Help.
    - If the answer is incorrect four times, then:
        - Display Help; if it is not available, omit it and display only the correct result.
- Rules determining transition between statuses for C:
    - If the task is in Status 1 and the answer is correct, then proceed to Status 7, otherwise to Status 2.
    - If the task is in Status 2 and the answer is correct, then proceed to Status 7, otherwise to Status 5.
    - If the task is in Status 5 and the answer is correct, then proceed to Status 7, otherwise to Status 5.
    - If the task is in Status 7 and there is not an answer with a status lower than 7, then proceed to Status 1.
- Rules determining transition between statuses for O:
    - If the task is in Status 3 and the answer is correct, then proceed to Status 8, otherwise to Status 4.
    - If the task is in Status 4 and the answer is correct, then proceed to Status 8, otherwise to Status 6.
    - If the task is in Status 6 and the answer is correct, then proceed to Status 8, otherwise to Status 6.
    - If the task is in Status 8 and there is not an answer with a status lower than 8, then proceed to Status 3.

Discussion and Conclusion

The Barborka adaptive LMS with adaptive assignment of test tasks was tested on the sample of 53 9th grade elementary school students – the stage was "*fixation of what the student has learned*" and the subject was Mathematics. The tasks were based on the following thematic areas: Number and variable; Terms and formulas; Data, graphs, and tables; Functions; Plane geometry; Space geometry.

First, the students took an entry test which contained tasks of different levels of difficulty based on the abovementioned thematic areas.

Then, they spent several classes working in the Barborka system, in the "*fixation of what the student has learned*" mode. All of the tasks in this mode were in compliance with the abovementioned principles: they were of different types – Q, T, X, they were divided into C and O and into 5 difficulty levels; test answers, too, were of different natures – closed and open; for each assignment reactions to possible answers were created – Reaction, Reference, Help; the if-then-type rules were applied (however, neither *statuses* nor *rules determining transition between statuses for C and O* were part of adaptive testing).

Finally, the students took the final test which consisted of the tasks equivalent to those in the entry test.

Please note that this paper is not aimed at the course of the actual testing, but that it aims to introduce the principles of adaptive testing and ponder possibilities that may present themselves or those arising from the results. That is why the actual testing is mentioned only briefly; it is, however, described in detail in the paper *“Adaptive Testing in Practice”* (Prextová, 2014).

The analysis of the entire testing revealed the following:

The tested students' final test results were better than their entry test results.

The final test results of the students with the average grade in Mathematics of 3-4 were better than their entry test results.

There was not a significant difference between the entry and final test results of the students with the average grade in Mathematics of 1-2.

Having observed and interviewed the tested students and their teachers, we arrived at the following results:

- The tested students appreciated that they could submit their answer more than once. They stated that the uncertainty resulting from their limited knowledge of Mathematics often led to their being absent-minded, nervous, incorrect understanding of the task, choosing the incorrect answer by mistake, etc.
- They also appreciated the PDF materials (Reference) which helped them find the information needed to solve the task. The teachers also appreciated the PDF materials as they could not be in two places at once.
- The students also liked that when they had difficulty solving the task, they could see the entire solving process and the correct result (as – again – the teacher cannot be in two places at once).
- The teachers also appreciated the students' motivation to improve. The students were told that the testing was adaptive and that the tasks were being presented to them on the basis of their answers. Ambition and determination to surpass the better classmates were important factors. The students knew that the easy tasks were always going to be followed by the more difficult ones. It was interesting to see that, as the time passed, everyone started to work alone, did not let anyone bother them, was making notes and was trying to find another solution than the presented one.
- The elements of gamification can be seen – the students do not get badges or points, but collect more and more difficult tasks and examples.

It needs to be determined if, or to what degree, this improvement was influenced by the adaptive system since it can be assumed that the final test results will always be better than the entry test results. However, our research results show that the implementation of the adaptive system could be purposeful as it motivates the students to improve. Even the teacher knows that this system can be used not only in instruction, but can also be a part of students' homework.

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STUDENT EDUCATIONAL PORTALS

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In their bachelor's and master's theses, the students at the Department of Information and Communication Technologies of the University of Ostrava have created successful and efficient web portals. Each portal is aimed at a different topic: raster graphics (Adobe Photoshop), digital video processing, processing and use of sound on a computer or history. The portals are primarily aimed at the education support for the students of the University of Ostrava. Some of them, however, can be used in elementary schools and high schools. Educational portals are based on modern technologies such as HTML, CSS, PHP, MySQL and content management systems (WordPress).

There are a number of modern and technologically advanced tools for creating educational objects. In recent years, there has been a shift from simple computer presentations and HTML-based statistical websites to dynamic websites into which educational objects and multimedia content can be implemented. The tools for the creation of educational objects make the content dynamic, interactive and multimedia. Websites can also help test the acquired knowledge and improve user communication.

Using modern technologies, the students at the Department of Information and Communication Technologies create educational objects and educational web portals which are then used both at the department and other educational institutions.

Creation of Web Portals

Creation of educational portals requires expertise in the multimedia creation area, the HTML and PHP languages, databases and the use of CSS (cascading style sheets). The portals contain not only the educational content in the form of information, but also multimedia objects such as flash animations, video tutorials and audio samples. Interactive objects, multimedia videos, video programs, etc. can be embedded on websites, improving transparency and understanding of the educational content. Moreover, they can draw the user's attention and motivate them. As tests are an integral part of portals and are used for revision of the acquired knowledge, a test created in PHP or java script can be a part of such websites. Communication tools for users can also be created. The most common form of communication is a forum where each user can post their problems and opinions.

ADDIE Model

When creating web portals, rules based on the tested system design models need to be followed. Out of the variety of models, the ADDIE model, which simply and concisely describes the creation of educational tools, programs, e-courses, etc., is the most popular. It describes the 5 phases of development (Pavlíček, 2003):

1) Analysis – in this phase the main problem is identified. Questions are asked, the problem is introduced, an analysis of needs is conducted, the target group of the project is determined and the main educational goals are specified. This analysis allows for the creation of a tool that can help users achieve the required educational outcomes.
2) Design – the educational outcomes are formulated on the basis of set goals. Based on those outcomes, the content of the study material and the content structure are specified. Software tools for the creation of study materials are determined. The evaluation system and graphical environment of the educational tool are designed. The outcome is a prototype of the educational tool.
3) Development – the actual creation of the content and educational objects based on the prototype created in the Design phase. Using selected software applications, the following individual educational objects are created: educational texts, demonstrations, interactive educational objects, revision tests, etc. However, various problems might occur, which is why the created objects need to be tested and evaluated in order to eliminate all the errors.
4) Implementation – the created educational tool is implemented into the actual education process. In this phase it is important to verify the functionality of the object.
5) Evaluation – the quality and errors of the educational tool are determined. The tool is evaluated continuously during all the phases and then again after it has been implemented into instruction by collecting data from users, providing feedback which can lead to the elimination of the errors.

Examples of Educational Portals

"Editing in Adobe Premiere Pro" (Vlček, 2013)

Educational web portal for working with Adobe Premiere Pro CS5.5. 4 hours of high quality narrated video tutorials are an integral part of the educational portal. The video tutorials cover the entire process of digital video editing from import to timeline editing, addition of effects, working with sound to export to file or optical disc compilation. The video tutorials are designed to simulate the actual editing process. It is the first extensive educational portal to contain educational video tutorials in Czech. It was primarily designed as a study aid for the instruction of courses aimed at digital video editing at the Department of Information and Communication Technologies of the University of Ostrava.

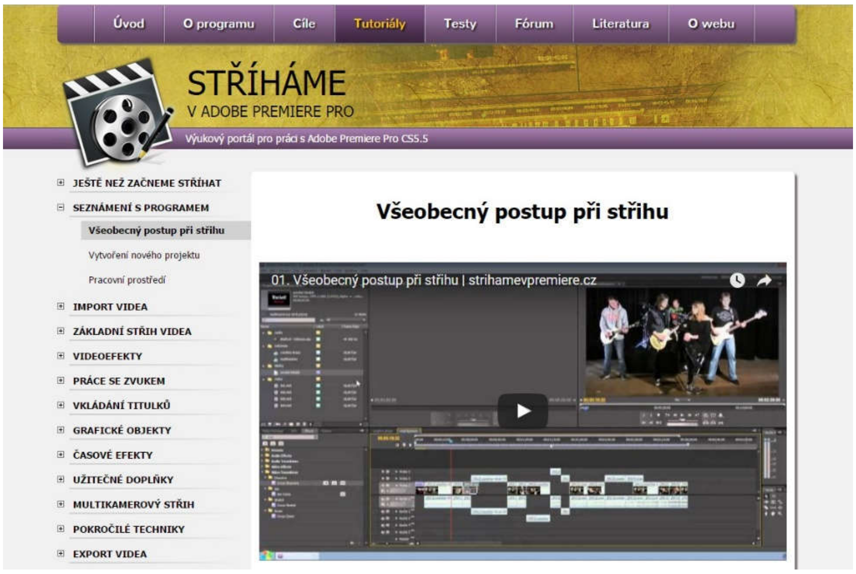

Fig. 1: Editing in Adobe Premiere Pro

The video tutorials are extensive and understandable enough, with graphic processing, transparency and easy navigation being other advantages.

Based on a questionnaire research and posts on a discussion forum, other video tutorials on the following topics have been created: advanced working with sound – adding an audio effect to the entire audio track, connecting the editing room with Adobe Audition, mixing audio channels into the 5.1 surround sound, anonymization of face (advertising, license plates) and voice.

As the educational web portal has been met with a positive response from the general public, its development will continue. The portal is available at: http://strihamevpremiere.cz/.

"Educational Portal for Adobe Photoshop CS5" (Wiejacki, 2014)

A web portal aimed at photo editing in Photoshop CS5. It contains 42 video tutorials (4 hours). The tutorials include instruction manuals for both beginners and experienced users. It contains the basics such as distribution of panels or tools as well as advanced functions such as selections, layers, masks and retouching. The portal has become the first high quality educational portal that explains and shows the user how particular things work (something text content cannot do). It was primarily designed as a study aid for the instruction of courses aimed at photography and raster graphics at the Department of Information and Communication Technologies of the University of Ostrava.

Fig. 2: Adobe Photoshop CS5

The portal is available at the public server: http://upravujemevephotoshopu.cz and has been included in the instruction of courses aimed at photography at the University of Ostrava. It contains tests which can help students test their knowledge about the Adobe Photoshop program.

"Sound and Computer" (Pastyřík, 2013)

Fig. 3: Sound and Computer

Within the scope of a bachelor's thesis a web portal was created which is now used in the instruction of the Sound and Computer course at the Department of the Information and Communication Technologies of the University of Ostrava.

The portal has made the course coherent by providing unified information on sound editing on a computer. The entire curriculum is divided into 10 chapters which contain information about the physical nature of sound and music acoustics, ways of sound recording, converting sound into digital form, hardware requirements of computers concerning sound editing (sound cards, headphones, microphones), sound formats, ways of sound editing on a computer, creation of MIDI tracks, creation of surround sound and the software used by DJs. The portal also contains multimedia elements created in the Flash application aimed at practicing and revising the curriculum and practical examples created in the Wink program. Moreover, there is a final test through which the students can test their knowledge of the curriculum. The educational web portal has been met with a positive response from the general public. As a result, besides the University of Ostrava, it is now used in the instruction of informatics in high schools. It is available at the university server: http://hucak.osu.cz/zvukapocitac/.

"World War I" (Šubrt, 2014)

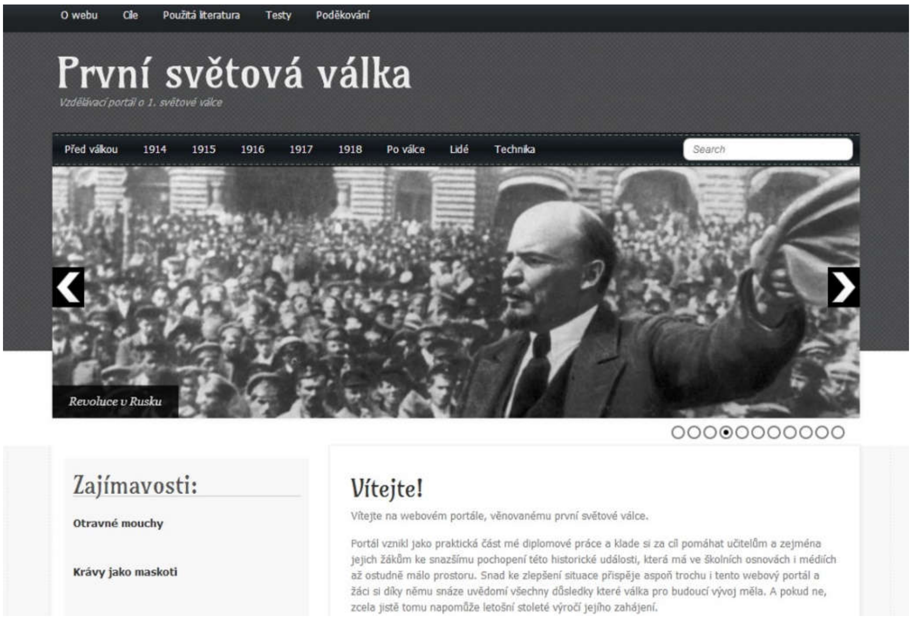

Fig. 4: World War I

A portal about World War I primarily designed for elementary school students. Texts in this portal have been designed to be understandable for elementary school students. Aside from the main topics, the portal also contains subtopics related to the war – weapons, technology, portraits of main figures and other interesting facts. Moreover, it contains texts enabling students to test their knowledge, photographs, statistical graphs and animations. The students can also comment on the individual articles.

The web portal has been used and evaluated by a number of teachers and updated based on the questionnaire research results. It is available at the university server: http://hucak.osu.cz/ww1. It has been tried out by history teachers at 19 elementary schools and has been met with a positive response. A new version of the portal, which will be launched soon, is now being developed.

Conclusion

Modern web technologies provide a plethora of possibilities in developing educational tools. In their theses and dissertations, the students at the Department of Information and Communication Technologies use those technologies to create educational web portals aimed at educating various target groups such as the University of Ostrava students, elementary school and high school students, but also those eager to learn in the fields covered by the web portals.

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