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The Diversified World of Information Technology in Education

Dear readers,

We are glad that we have managed to gather quality papers that will hopefully be useful in your work and studies. The topics of submitted papers again prove that the world of information and communication technologies is exceedingly varied. Not only would it be difficult for us to find an area where ICT has not yet penetrated, but also in each of these areas we continually witness the finding of new ways of using ICT in education.

The authors of the first paper called *ICT in Technical Subjects* have noted that although information and communication technologies have penetrated almost all areas of education, science or control systems, they cannot completely replace practical knowledge and working with real models. Despite these limits, the possibilities of using ICT in the areas mentioned above are many. Among other things the paper emphasizes the importance of interdisciplinary links and students' ability to transfer knowledge from one subject into other areas.

Museums and educational exhibitions play an important role in the process of lifelong learning. The second paper called *Categorization of Museum Visitors as Part of a System for a Personalized Museum Tour* is therefore focused on using information and communication technologies in museum didactics. In order to achieve the greatest educational benefit for the visitors of the museum tour or the educational exhibition, it is advisable to tailor the tour route through this institution, as well as the depth, comprehensibility, significance and formal appearance of presented information about exhibits for the individual visitors or the target groups. The personalization of the museum tour or the educational exhibition in the presented concept is provided by a virtual guide which uses expert systems and a thorough categorization of visitors.

The third paper called *Creation of Educational Video Tutorials and Their Use in Education* provides interesting and useful information about a very effective and therefore increasingly popular teaching material – a video tutorial. However, creating these video tutorials is not easy. The author of the paper describes step by step the whole process of creating video tutorials, as it is taught to the students of the Department of Information and Communication Technology of the Pedagogical Faculty at the University of Ostrava. The author also illustrates the possibilities of using video tutorials in teaching special needs students or teaching foreign students.

The fourth paper called *The Development of Computer Competencies Using Artificial Intelligence* presents possibilities of using artificial intelligence in order to raise the educational process to a higher level. First, the paper gives an overview of the basic information concerning *development of cognitive research on feed-forward neural networks (perceptrons) and teaching support systems*. Next, the complete teaching system is described. The system is based on the original GLM module with elements of artificial intelligence. On the basis of research the results of traditional instruction were compared to the results of

individual instruction using the suggested methodology. Finally, the benefits of the proposed system and its possible extensions are discussed.

The fifth and the last paper called *Information System "Diagnostic" as a Tool of Action Research* concerns the demanding requirements the schools currently have to contend with. The internal transformation of schools can not be done haphazardly or only intuitively, but must be based on thorough analysis of internal data. As shown in this paper, this data may be obtained using the action research method with established information system called Diagnostic. Long-term acquisition, analysis and use of internal data should help the school become the so-called learning organization that is able to respond to external changes and constantly improve its quality.

The appendix of the journal discusses the beneficial symbiosis of information and media literacy at the Department of Information and Communication Technology of the Pedagogical Faculty at the University of Ostrava. It is becoming increasingly apparent that students who have developed competencies in one area, have a head start in developing their literacy in another area, and vice versa. That is why we would like to propose the field of media communication and literacy as a subsequent thematic field for the authors of future papers submitted to our ICTE Journal. Thank you in advance for your submissions.

I wish you interesting reading on behalf of the editorial staff,

Pavel Kapoun,
Executive Editor

ICT in Technical Subjects

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Abstract

ICT have currently spread almost into all areas of human interests. These technologies accompany us during our rest and entertainment and enable fast and easy communication across vast distances. Moreover, they are used in education and science and control systems around us allowing easier design and construction of these systems. However, they cannot be taken as the only one perfect and best technology. Our research and experience in education of technical subjects shows that they cannot replace the work with real systems and models. In fact, no simulation or animation, even the most perfect one, can fully replace reality. Nevertheless, reality properly completed with animations or simulations offers many possibilities that were previously unthinkable. It is very important in education to show proper interdisciplinary relationships which are the true image of the real world. Also, it is essential for pupils and students to acquaint themselves with the practical problems from their practice. They have accustomed to computer design and project and assembly documentation and they understand technical documentation. Further, they have realized that these are direct images of real systems and they have learned to create and use them. At our department, we have focused on those issues. Students profit from acquired knowledge and skills in one subject that can be used in other subjects. This contribution aims to summarize up to now experience and show some practical results of research that have been conducted.

Keywords

external system, ICT; technical subjects, 3D, 2D, interactive animations

Introduction

It is well known that ICT in education has replaced education aids and practical activities with real systems. However, the situation in technical fields is critical. Our research and experience show that not only pupils of primary schools but also a large number of technical university students do not have good craftsmanship. In fact, a social prestige of crafts is extremely low and it results in a very little interest in them. Knowledge can be stored in books and other media but experience and skills cannot be preserved like that. They are handed down from a master to

an apprentice and this transmission takes from several years to decades depending on the field. Unfortunately, masters able to pass experience are slowly disappearing. In general, demands of technical fields require a high level of quality secondary and tertiary technical education, which seems to be a global problem as shown in a report for President Obama (Holdren, 2010) where recommendations to change education in the United States are. Nowadays, mutual natural authority based on skills, not only for pupils in primary schools, does not practically exist. In today's society more and more emphasis is put on the idea of freedom and democracy and the authority together with the discipline are considered inadmissible (Vališová, 1999). At the same time, to educate an individual does not mean to take him the opportunity to be himself or to restrict his abilities and to operate in an authoritarian way. In our society, freedom and authority are not mutually exclusive opposites but complementary aspects of formative action (Vališová, 2005). In such a social climate it is very difficult to educate young people and motivate them to diligence, consistency, ability to solve problems or to cooperation and consideration.

Our research and experience with technical courses at basic schools show that practical activities naturally create space for cooperation. During them, a natural authority is created based on handicraft or technical skills. It can often happen that students with worse results but with skilful hands and technical thinking can be an authority for other pupils. Generally, practical work requires patience and the ability to face difficulties when obtaining skills and abilities. It is the dependence of the current generation on ICT that can be used in a positive way to bring young people back to the practical work, and to suppress the negative impact of ICT and improve the employability.

Creation of technical documentation drawings, diagrams and their use

Basics of education for the design and production of technical documentation have been developed in primary schools and subsequently technical schools and technical universities. Creativity and imagination are the basic requirements related to the construction and design of products and technical devices (Driver, 1994). Thus, preparation of a technically oriented young person should include: the basics of technical graphics, practical activities and work with the material, installation and maintenance, self-control, quality, health and safety at work (Kočí, 1994).

Technical documentation is crucial in the fields of mechanical engineering, electrical engineering and electronics, civil engineering and architecture. The basis is the technical documentation or a draft, a scheme of circuit board in electrical engineering and electronics or an assembly plan. Technical documentation currently includes everything from technical standards to design using computer technology – CAD (Svoboda, 2011). The area of primary education needs to focus on the basics of technical documentation and its creation, reading and use within the various practical activities.

Technical drawings used to create technical documentation and ICT are linked over CAD. The issue of CAD is currently represented by two main fields of use (Freedom, 2011):

- 2D CAD;

- 3D CAD.
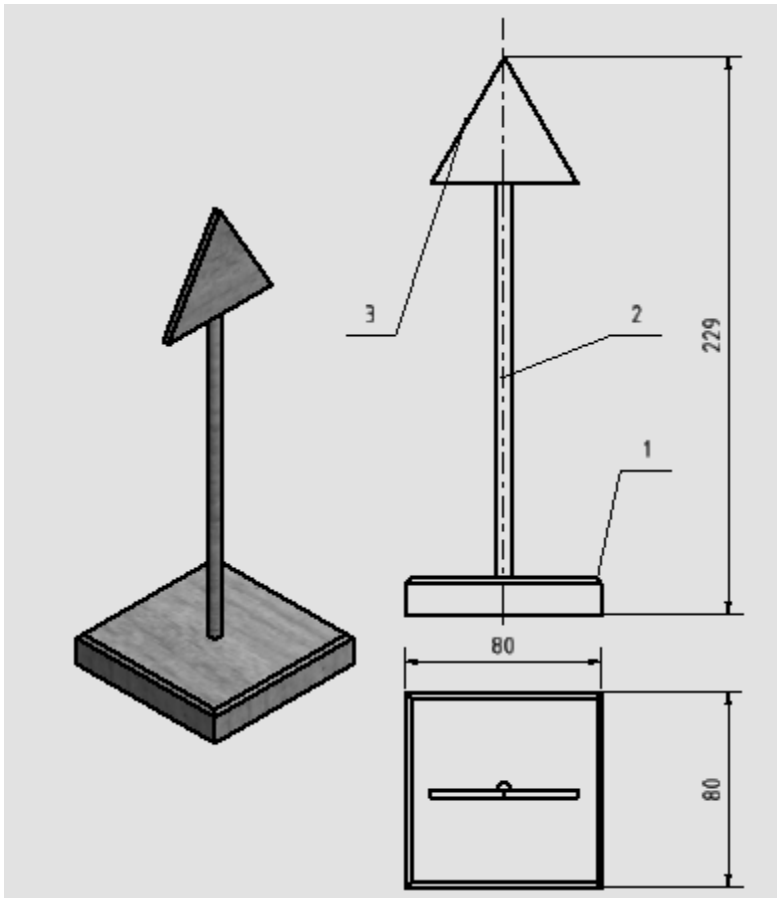
Fig. 1: Design of a simple road sign – Autodesk Inventor

In practice, modern methods of 3D design are promoted at universities and secondary schools and they are based on the parametric modelling - 3D CAD (Svoboda, 2011). The core of this design is the creation of a 3D model of an object (component) on the computer screen. The model is mathematically described by the variables and parameters. In the process of construction, these parameters can be flexibly changed with the immediate effect on the subsequently created technical documentation (Svoboda, 2011). The indisputable advantages include the fact that the transfer of 3D objects into technical documentation provides the program itself and the creation of technical documentation thus becomes more creative (Hodis, 2012).

Primary schools are mainly focused on simplicity and mastery of basic manufacturing operations such as sawing, filing, etc. When making a draft, it is therefore important to pay attention to its visualization (Hodis, 2012). This can be very effectively done with 3D CAD solutions - Autodesk Inventor. An example of using this design system to create a simple product for a primary school is in Figure 1.

ICT are linked with the creation of technical documentation over CAD in the design of schemes in electrical engineering and electronics. Specialized software such as AutoCAD, progeCAD (Figure 2) or Eagle is suitable for schemes or PCB design (Eagle).
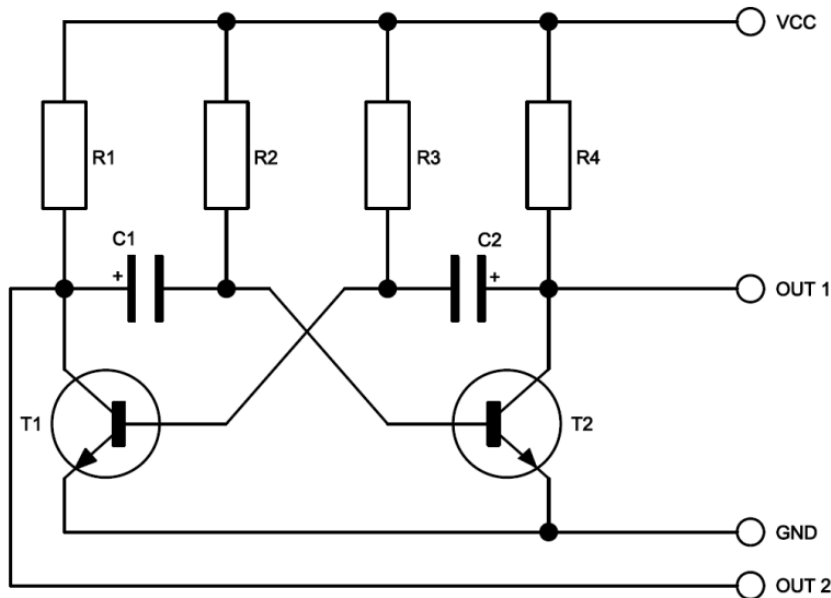

Fig. 2: Scheme of multivibrator – progeCAD

Mastering the basics of technical documentation is an important condition for the use of basic graphic communication in technical fields. The creation of technical documentation and diagrams is linked with ICT and is currently ensured by using specialized software - CAD. New CAD systems are prospective graphical software for creation of technical documentation. It is especially 3D design based on the parametric modelling - 3D CAD which is an area with a great potential that leads to visualization of the proposed design solution. The essence of this design is the creation of a 3D model of the object on the computer screen. The undeniable advantages include the fact that the transfer of 3D objects into technical documentation provides the core of the program itself. In fact, the work with these new systems is becoming a creative activity and it is much more attractive than the older method of 2D imaging. However, 2D imaging method with CAD is still irreplaceable in the concept of the graphical display and especially in the schemes creation in electrical engineering and electronics.

3D models, animations and interactive simulations

Use of e-learning and multimedia study supports is growing not only in technical fields. Benefits can be seen not only in distance education, but also in the support of full-time education. The importance of multimedia and their dynamic elements (animations, graphics, videos, interactive features, audio, online applications, etc.) rises. Multimedial study materials

provides a more effective preservation of knowledge of taught study matter (Klimeš, Svoboda, 2009) because of better clarity and possibility to involve more senses.

The use of 3D graphics and demands for it has significantly increased in recent years. This happens due to the increasing power of computers and accessibility of 3D modelling and animation applications. The best-known application for creating 3D models and animations are Maya, 3ds Max, Cinema 4D (figure 3), Blender and others. In terms of using 3D applications in the school environment, we conducted a comparison of two commercial and one "open source" product (Maya, Cinema 4D and Blender). Due to the low cost of school licenses (Cinema 4D Academy Program), easy control, Czech localization and availability of materials for self-study, currently the best product for the use in the school environment is Maxon Cinema 4D (Babb, 2004).

There are new and new areas where 3D graphics can be used – for example movies and television, computer games, multimedia, 3D GUI applications on the Internet, e-learning and multimedial textbooks with visualizations of objects, processes and principles. In the field of technology, 3D can be used engineering or architecture, where we can visualize models of buildings or devices, their design and transfer into the technical documentation.

We can use the term CGI (computer generated imagery) for the image created on the computer using graphics software. CGI is often used in the field of 3D graphics (Derakhshani, 2006), but the output can also be a 2D image (render).

The creation of 3D graphics is very similar to the creation of vector graphics. In the case of 3D graphics, the vector graphics is extended to the third dimension (coordinates X, Y and Z).

The model is then created from polygons (defined by points and lines). A polygon is composed of at least three vertexes and form a triangle or a polygon (n> 2, n ∈ N). By combining multiple polygons, we create the surface of the modelled objects using the selected modelling techniques. After modelling the object, we apply materials and textures, lighting and animations. The we can render the scene, which means converting the scene into a 2D bitmap as a single image or image sequence (jpeg, tiff, avi, mov, ...). This procedure is the middle phase of a three-phase process consisting of preproduction, production and postproduction (Baaba, 2004). Production of CGI can be summarized in the following steps (Derakhshani, 2006):

- modelling;
- shading and texturing;
- animation;
- lighting;
- rendering.

It should be noted that the classic 3D applications (such as Cinema 4D) are not the only possible way to create a 3D model. Another way, frequently used in engineering, is volume rendering. Unlike "classic" 3D graphics, where polygons are formed in the process of coverage to a 2D image consisted of pixels, volume rendering works with the so-called voxels (volume element).

The data sources can be various types of measurements or scanning (CT, MR…). 3D data are stored and then it is possible to re-create the image.

When we are animating 3D models, we are not limited only to keying of basic parameters (position, size…), but we can animate any parameter. In addition, using tools such as Xpresso, we are able to influence the behaviour (animation) one object by the behaviour/state of another object. If we include the dynamics of solid and soft bodies, or particle effects, we expand the animation possibilities by a variety of possibilities usable for modelling of physical properties in technology.
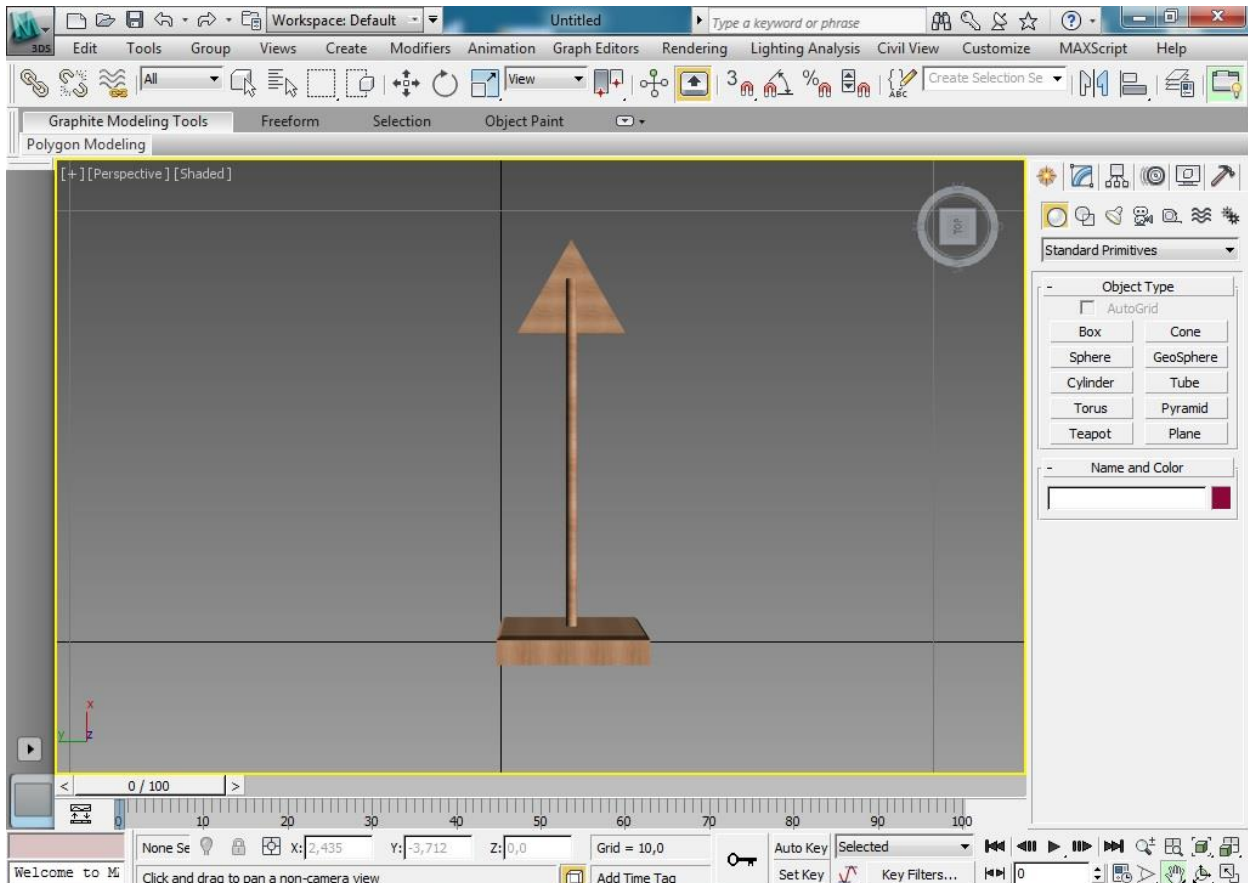
Fig. 3: Example of a 3D model of a technical product

The use of 3D graphics in education of technical subjects helps to develop the perception of principles of the world around us. Thanks to the clarity of 3D graphics, models and animations, pupils and students are more aware of the laws of physics and the interaction between bodies. They perceive different behaviours of materials, lights, shadows, geometry objects and other aspects. By simple rendering of image sequences, we can create an illustrative animation. If we need interactive simulations, we are able to export for the web environment in VRML format, or use other technologies (such as Adobe Flash) and thus widen the interactivity of models suitable for education in technical fields.

Interactive whiteboards in education

Interactive whiteboards can be currently considered a standard among education devices that schools normally have. With them, the teacher can easily create an active and creative environment. In fact, the hardware or software of an interactive whiteboard does not matter because the current boards are practically comparable. Furthermore, larger software differences only provide a different level of user comfort, which is an important fact to consider when choosing an interactive whiteboard, but it is not a prerequisite for the creation of the aforementioned creative and active environment in the classroom. Thus, board itself is not a guarantee of interactive education. However, it enables extension of the standard teacher – student and student – teacher interaction. As for student – interactive whiteboards and interactive whiteboard – teacher see Fig. 4.
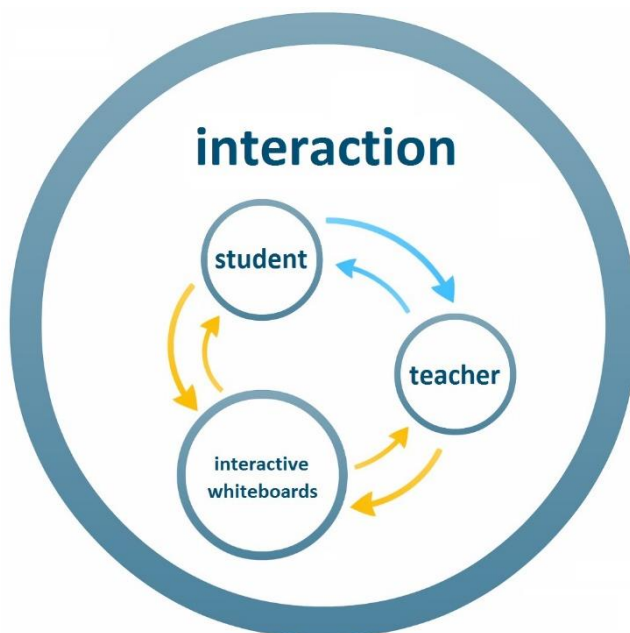
Fig. 4: Interaction between participants in the educational process

It is therefore essential to change the attitude of teachers towards students. Experts (Fidedor, 2007) agree that quality interactive education lies in the involvement of pupils directly in the process of education so that they become part of it. As reported (Rack, 2007), an interactive whiteboard is not a punishment for teachers but a great help during a lesson. Yet many teachers hold the opinion that the energy spent with the creation of interactive materials using a new technology is not directly proportional to the increased efficiency of education. However, working with an interactive whiteboard does not necessarily mean hours spent on creating materials. An interactive whiteboard can be used as a classic board and also have the comfort in the form of tools and software applications of the interactive whiteboard. An example of such use is shown in Figure 5, where a teacher of technical education illustrated an interconnection of modules of robotic kit H&S electronic systems through block diagram.

Pupils can also elaborate other suggestions for robotic system activities on the board. Due to the automatic recording of each page, a few suggestions became available and can be worked with.
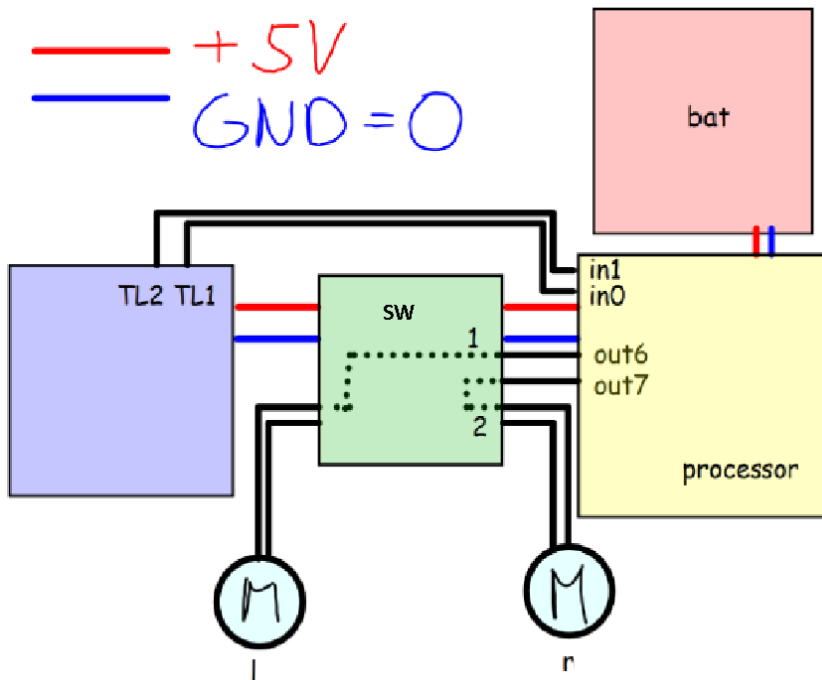
Fig. 5: The use of an interactive whiteboard as a classic board

Another option for the creation of interactive materials is the use of PowerPoint presentations. Currently, many teachers have plenty of PowerPoint presentations that were created in the past for the explanation of a new subject matter. One of the ways to integrate these materials into new interactive materials is a transfer using OpenOffice Impress into the SWF format, which can be easily inserted into most of the programs provided with interactive whiteboards (Stojanová, 2008). This way, it is possible to insert several pages into one interactive page (Figure 6).
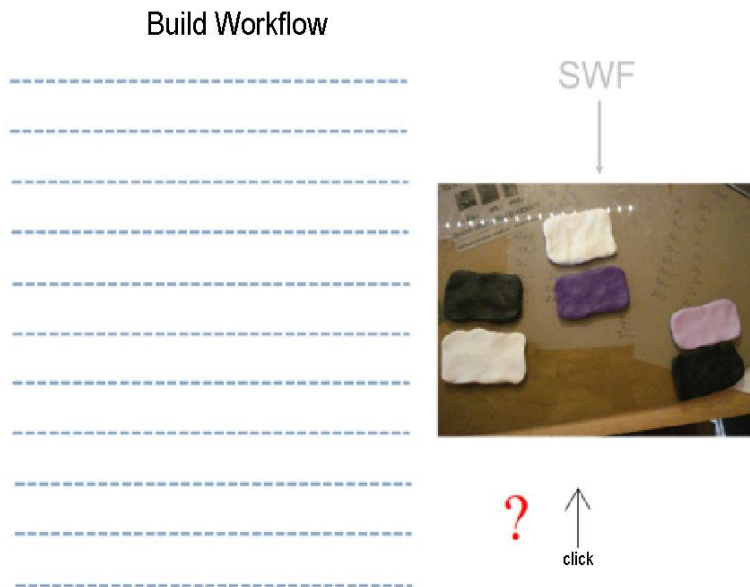
Fig. 6: Integrating PowerPoint presentations into interactive materials

The above examples can be useful especially for beginners that are already familiar with working with basic tools but have not created their own interactive materials yet and would like to start using interactive whiteboards. As Stojanová remarks, it is all about people. The implementation of changes is a long-time and difficult process. Eventually they will become a normal part of our lives and nobody even think that it should be otherwise.

Use of external systems connected with interactive animations

Other important areas in technical fields where ICT are used is programming of drivers and firmware for various devices, programming of systems operating in real-time, such as robotic systems, PLC control systems of technological processes, intelligent homes or industrial robots. These areas are very interesting and require entirely different programming approach than what we know from programming of desktop applications. For this reason, it is necessary to teach subjects related to these fields in a different way since they also require a different way of thinking. As our researches suggest, it is optimal to begin education these subjects in the third year of primary schools. This requires the maximal pupil motivation and direct connection of external systems with interactive study supports.

Thanks to Adobe Flash, it is possible to directly connect interactive multimedia study supports with external systems. A system which enables the creation of dynamic study supports with internal intelligence directly connected with external system has been developed at our department. This system is called MyIMLE (My Interactive Multimedia Learning Environment) and allows connecting interactive multimedia animations running in web browsers with desktop applications running on client computers and connected to external systems. There is also no need using servers as in the case of remote laboratories.
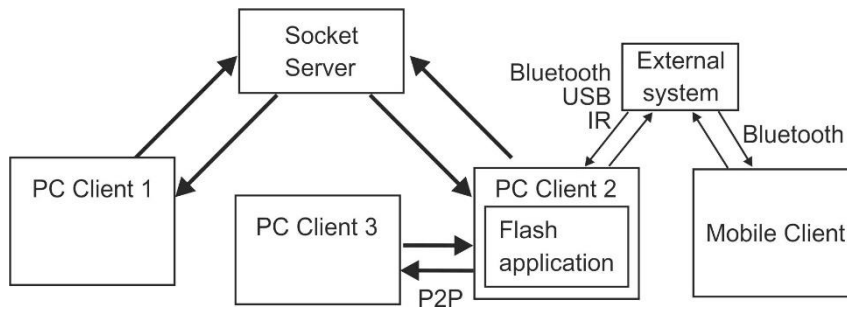
Fig. 7: Demonstration of the possibility of connecting client computers with an external system

Figure 7 shows the most common connection possibilities of client computers to the computer where is running a Flash application directly connected to an external system. The Flash applications can be executed from a Web site, or can be run as a desktop application (Adobe AIR, ZINC, Flash EXE, etc.). Even these applications can mutually communicate.

We have been searching for several years in order to find a suitable device operating in real-time for education of programming. Based on various tests and analyses "H&S electronic systems" were designed. The development of these systems is still in progress, but there are currently available basic electronic modules for custom construction of external devices and robotic systems, which can be used also for educational purposes. In the education of robot design, we use a robotic kit H&S that can be used even in the third year of primary schools. The core of the kit is processor board PICAXE 20M2. Programming of the board is realized using flowcharts. We use a professional programming editor that is free for educational purposes.

The robotic kit can be extended by using new modules and the programming of the processor board can be realized in Assembler. The education can gradually continue from primary schools, over secondary schools, to universities.

Fig. 8: Example of a wireless control of a robot from a Flash animation

If we need to use a robotic kit together with MyIMLE system, we use Hrb1662802 module that communicates with Flash animations by speed 115200 Bd via USB, TCP IP (Virtual COM port), or Bluetooth. A simple class Robot1662802 for Flash is available for this purpose. The module controlled from this class enables to control both motors of the robot, wheel synchronization, PWM wheel speed control and motion by a set distance. In addition, t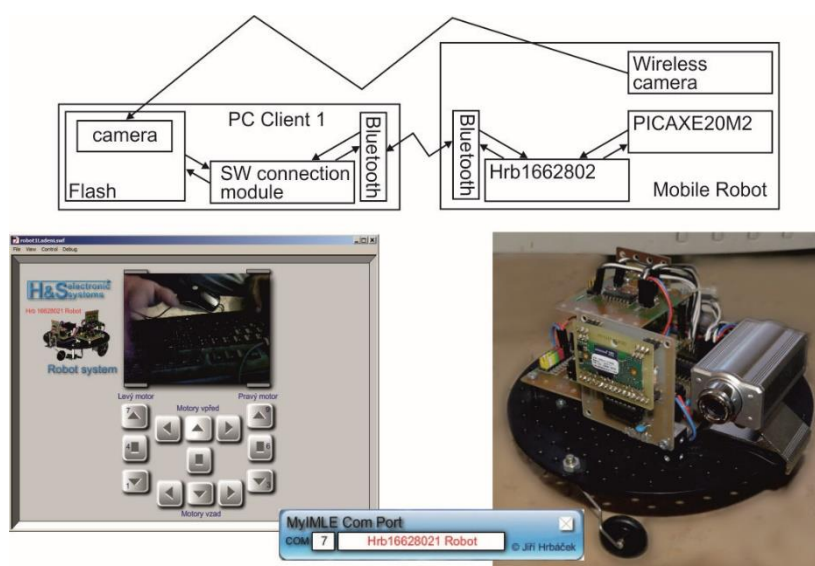he module has four other IO pins, through which it is possible to communicate with the board PICAXE20M2 to create a multiprocessor system control. An example of such a robotic system with a wireless USB camera is shown in Figure 8.

In the education of creation of interactive Flash animations in OOP, students learn to create intelligent graphics and to use already existing classes. There are several classes available for external systems connectable to MyIMLE that allow, for example, as was already mentioned, to control a robot or other models, to create cheap measurement system or adjustable sources (modules containing a 10-bit AD converters with conversion time 25μs or 10-bit PWM sources with a period of up to 20 kHz, etc.). External systems (HW modules) can be also used with another control programs, for example based on Java, etc.

The great advantage of the above mentioned systems is that even common users without any previous experiences are able to create simple applications. On the other hand, advanced users can use these systems in special applications.

Conclusion

New information technologies have spread into the all fields of science, technology and our lives. One of the important parts in technical fields is Computer Aided Design (CAD), which shifts towards parametric modelling. This method of creating technical documentation is very interesting and suggestive for students. Together with 3D graphics, animation and interactive education, we have a powerful tool for visualization in other study subjects and visualization of technical devices. Moreover, together with electronics and robotics, we are able to link the virtual world with the real world. By combining all of these areas, we gain a complex concept. We are currently verifying our conception by using surveys and interviewing students.

Information and communication technologies have brought many positive aspects into our lives, but they have brought negatives as well. History already showed that whenever a new technology enabling unprecedented possibilities appeared, we attributed it more importance than it deserved. It is wise to examine such technologies and use them, but we can't forget the technologies used before, as it happened when computers appeared. Now we have come so far that we are not able to manage the euphoria of their possibilities and gave them the place they actually deserve. We hope that the contribution showed some possibilities and connections of ICT and technical fields and we believe that the usefulness of ICT will increase, if we use it together with real systems or if we use them together with practical activities.

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CATEGORIZATION OF MUSEUM VISITORS AS PART OF SYSTEM FOR PERSONALIZED MUSEUM TOUR

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Abstract

In the past few years, the process of lifelong learning has become more important. A tour of an educational exhibition is an interesting and attractive activity for a person receiving an education. A museum, art gallery, zoological or botanical garden or even a technological park can all be perceived as an educational exhibition. If we want the exhibition tour to provide an educational benefit to the visitor, we need to offer him adequate information about individual exhibits. The exhibition has to be personalized, that is, tailored for the various kinds of visitors. This paper deals with the issue of categorizing museum visitors using ICT, specifically an expert system which is a part of a "virtual guide". Based on an initial analysis of a visitor, the virtual guide proposes a tour through the exhibition so that it brings the visitor the maximum educational benefit while at the same time offers information about the displayed exhibits in such a way that is most interesting and comprehensible.

Keywords

information and communication technologies (ICT), museum, virtual museum (VM), expert system, virtual guide, tour route personalization, visitor, exhibit

Introduction

A museum is an institution that conserves a collection of artefacts and other objects of scientific, artistic, cultural, or historical importance and makes them available for public viewing through exhibits that may be permanent or temporary (Alexander, 2008).

ICOM (International Council of Museums, established 1946, based in Paris, an international professional organization with the status of UNESCO consultant) defines a museum as "a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment". The goal of the museum is to present a given topic in an interesting and engaging way. In order

to do so, it maximizes the use of its exhibits and available technology. Likewise, it is important for the presented exhibition to have an educational function.

To achieve that function, the exhibition content has to be presented in a way that is interesting and comprehensible for the potential visitor. The range of museum visitors is wide and so it is necessary to customize the tour to some extent. The standard way to do this is a differentiation of informative texts, either as various legends to the exhibits or as printed textual guides. Another step is a personalized tour with a live guide or the introduction of audio guides, used mostly by foreign visitors. With the availability of modern information and communications technologies (ICT) museums enter a new era and the topic of personalization (customization to a particular visitor) is being discussed more often. Among the most common ICT means used in museums in the Czech Republic are information kiosks, topical interactive games, personal guides in communication devices (tablets, smartphones, communicators) or robotic guides.

Virtual museums are a new domain. Thanks to the Internet, a virtual museum allows the visitor to tour the exhibition right from the comfort of his home. From the beginning, there was interest in adapting such a tour to the particular visitor. Thus, the term *virtual guide* came into existence. A virtual guide is software which strives to give the visitor a tour through the virtual exhibition according to his requirements.

Yet another step is the logical interconnection of the real and virtual museum in one unit, the so-called *augmented museum*. In this case it does not matter whether the visitor is physically present in the museum or is there only virtually.

As a part of a project, we wish to create a virtual guide through an exhibition. It is to be software that is to guide the visitor through the exhibition based on the characteristics given by the user when entering the museum. The virtual guide should present not only suitable exhibits, but also appropriate information related to them. The emphases is placed on the educational benefit of the tour.

It is crucial for the system to "know" the exhibition visitor. This requires an existence of an application which will be able to characterize the visitor and choose an optimal tour route as well as the content of the tour.

Resources

In order to create a useful and effective museum exhibition, all its creators, designers and curators have to be well acquainted with the target group. Without understanding the target audience the exhibition cannot succeed because it will not be able to communicate with and foster the interest of visitors. The spectrum of museum visitors is very diverse and there is no general and universal classification. Visitors, however, have some common features upon which we can build our categorization:

- **socio-demographic characteristics**: age, sex, occupation, education, the type of community the resident is from, local or non-local residents;

- **museological characteristics:** motivation for the visit (professional, informational), knowledge of the topic, potential of the tour to engage;

- **range characteristics:** individual visitor, (various types of) groups of museum visitors, frequency of visits, timescale of museum visit;

- **psychological or physiological characteristics:** reception, intelligential, memory, imaginative, visual, auditive, motoric.

It can be stated that every significant author writing about personalization of museum exhibition created his/her own classification system of visitors.

Eilean Hooper-Greenhill identifies target groups which include (Hooper-Greenhill, 1999):

- families;

- school parties;

- other organized educational groups;

- leisure learners;

- tourists;

- the elderly;

- people with visual, auditory, mobility or learning disabilities.

She then suggests a partition of museum resources, to target, attract and entertain these different groups.

Dean generalizes museum visitors in three broad and much simpler categories (Dean, 1994).

- **Casual visitors**: people who move through a gallery quickly and who do not become heavily involved in what they see.

- **Cursory visitors** show instead a more genuine interest in the museum experience and collections.

- **Study visitors**: A minority of visitors who thoroughly examine exhibitions with much more detail and attention. They are learners who will spend an abundance of time in galleries, read the text and labels, and closely examine the objects.

Serrell (1996) also divides visitors into three types:

- **the transient;**

- **the sampler;**

- **the methodological viewers.**

She notes that currently museum evaluators are using terms like "streakers, studiers, browsers, grazers and discoverers" to characterize museum visitors' styles of looking and exhibits. But she concludes that this type of categorization is not useful for summative evaluation, suggesting that it is a subjective method of classification, and that it is not fruitful to try and create exhibitions that serve these different styles of visiting. She suggests instead that a more objective means of classification needs to be found, such as the average time spent in the exhibition space.

Based on visitors behavior in physically enclosed space, Veron and Levasseur identified four different visiting styles using metaphors form animal motion behaviors (Veron, 1991):

- **The ant visitor,** who spends a long time observing all exhibits and moves close to the walls and the exhibits avoiding empty space.

- **The fish visitor,** who walks mostly through empty space making just a few stops and sees most of the exhibits but for a short time.

- **The grasshopper visitor,** who sees only exhibits he/she is interested in. He/she walks through empty space and stays for a long time only in front of selected exhibits.

- **The butterfly visitor**, who frequently changes the direction of the tour route, usually avoiding empty space. He/she sees almost all exhibits, but times vary between exhibits.

Umiker-Sebeok presented four major visitor types with respect to their interpretation of the exhibition space (Umiker-Sebeok, 1994):

- **The Pragmatic** is interpreting the exhibition as a classroom or workshop and is interested in "useful" information.

- **The Critical** is interpreting the exhibition as a museum and is interested in the aesthetics of displays, the structure of the collection and the classification of exhibits.

- **The Utopian** is interpreting the exhibition as an encounter session and his/her main goal is the social interaction.

- **The Diversionary** is seeing the exhibition as an amusement park and his/her goal is to have fun during the visit.

McCarthy (McCarthy, 2006) determines these categories based on learning styles:

- **Imaginative** – learns by listening and sharing and prefers interpretation that encourages social interaction.

- **Analytical** – prefers interpretation that provides facts and sequential ideas.

- **Common sense** – likes to try out theories and discover things for themselves.

- **Experiential** – learns by imaginative trial and error.

Also Gardner (Gardner, 1996) uses learning styles:

- **linguistic** – written material;

- **logical-mathematical** – diagrams, schemes;

- **spatial** – maps;

- **musical** – audio, music;

- **bodily** – manipulation;

- **interpersonal** – social context;

- **intrapersonal** – alone.

These are some examples of classifications that were considered when creating the "virtual guide" system. Of course, there are many different ways of categorization of visitors, but none

of them were suitable. By comparing the categories listed above we created our own categories of visitors.

Categories of visitors

For the first phase of this project we decided to divide the museum visitors based on these three criteria: age, social integration and expertise (the extent of knowledge from the field presented in the exhibition).

Context	Category				
Social integration	Individual	Homogeneous couple	Inhomogeneous couple	Homogeneous group	Inhomogeneous group – family
Age	3–6 years	6–12 years	12–18 years	18–65 years	over 65 years
Expertise	Layman	Expert			

Tab. 1: The original categories of visitors

In theory such division presents 50 variations when creating the algorithm for the guide. To create so many various "paths" seems very complicated, nevertheless not all combinations are probable or plausible. Furthermore, in the first phase we want to focus on individual visitors only. We presume that each visitor will have his/her own guide, which opens another area for further research. A group of visitors does have slightly dissimilar behaviour and exhibition requirements than an individual. Moreover, an exhibition algorithm to suit couples of diverse ages (for example grandfather and grandson, mother and child) should be calculated in the near future.

Besides that, another important variable is the visitor's purpose of the exhibition visit. For that reason, it is necessary to create yet another category The purpose of the visit. This purpose influences the number as well as the type of viewed exhibits, which not only further affect the length of the tour, but also the form and the content of presented exhibits.

The purpose of the visit
Quick overview – inciting the interest, motivation (RP)
Fundamental knowledge (ZP)
In depth research (HS)

Tab. 2: The purpose of the visit

During further development, we decided to choose the fuzzy expert system as the core of the "virtual guide". This means, that the individual categories of visitors are not firmly set, but rather serve as inputs of the fuzzy system. From the original categories, these three remain:

- the age of the visitor;

- familiarity with exposition topic (expertise);

- the purpose of the visit.

The concept of the expert system

The planned expert system for categorization of visitors is one of the modules of the virtual guide. The modular structure of the system ensures flexibility and will allow future interconnection to other museum systems, especially to the already existing database of the exhibits. At the beginning of creating the concept of the virtual guide system, We were concerned with its openness. The whole system should be able to function in a virtual as well as in the real environment where the range of museum exhibitions is extensive. (The term museum can be understood as, for example, a zoological or botanical garden, art gallery or even a technological park.) It can even serve as a simulation tool in the design stage of a new exhibition.
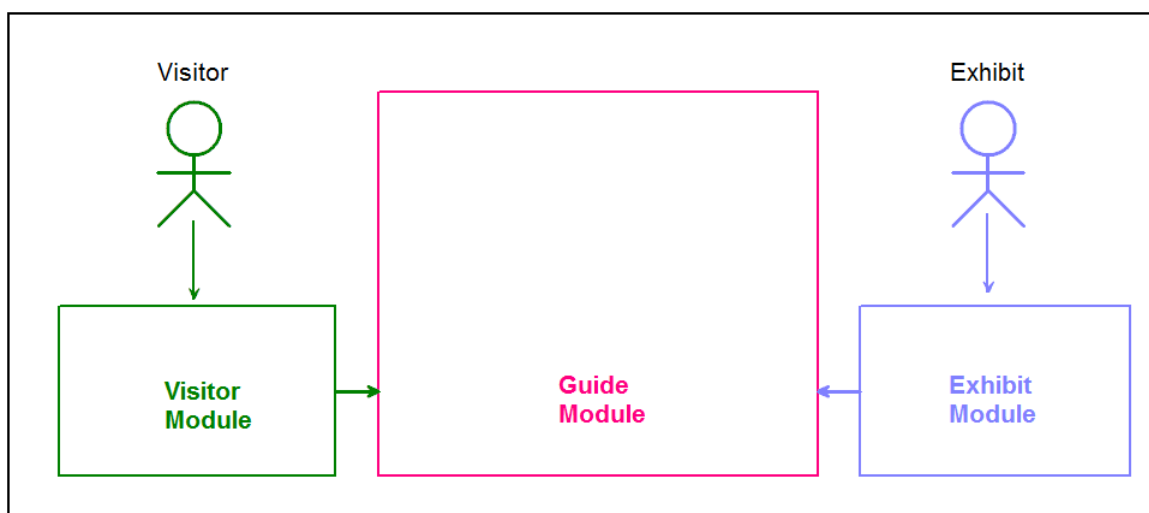
Fig. 1: The virtual guide system

The whole system consists of three modules: Besides the Visitor module, there is Exhibit module (It is a database system of exhibits. The exhibit is represented by its form – physical manifestation and content – information about the exhibit.) and Guide module, which chooses the best tour route and level of presented information to the visitor based on the categorization of that visitor and available information about exhibits.

Visitor module:

The visitor module serves as an interface between the system and the visitor. The task of the module is to obtain basic information for the guide module of the fuzzy expert system. From the selected categories of visitors, names and linguistic value identifiers of intended linguistic variables are chosen:

- Age of the visitor (VEK)   Youth (NIZ) – adult (STR) – senior (VYS)

- Visitor's expertise (ZNA)   Low (NIZ) – intermediate (STR) – high (HLU)

- Purpose of the visit (ZAM)   Quick tour (RP) – standard tour (ST) – detailed tour (PP)

The advantage of such a fuzzy expert system is that it does not require exact answers from visitors, therefore the categories are not firmly defined. For example, to the question "How deep is your knowledge of the exposition topic?" a visitor can reply "Rather low" or "Higher than average".

Exhibit module:

This is a database of exhibits. Each exhibit is categorized and includes three information layers representing three levels of the visitor's knowledge of the exhibition topic. The categories are the type of exhibit and significance within the exhibition.

Guide module:

This module is represented by a fuzzy expert system which, based on the classification of a visitor, determines the weight of a type of an exhibit. The exhibits with the highest weight are then selected for the tour. Based on the weight, other exhibits are then sorted into the groups of recommended, additional and not recommended exhibits. A key exhibit is automatically included in the tour and its weight is not taken into account. At the same time, exhibits are assigned appropriate information layers corresponding with the type of visitor.

A tour route adjusted in such a way is then presented to the visitor along with personalized information about the currently viewed exhibit.

Implementation

1. phase – creation and debugging:

- Creation of virtual museum web pages.

- Creation of individual system modules. All modules are placed on the same server as a virtual museum.

- The expert system of Visitor module acquires information through a simple form that the visitor fills out when entering the museum pages. The output of this module will be used in the Guide module.

- Filling the virtual museum database of exhibits – Exhibit module. The creation of individual information layers needs to be done with the help of an educational specialist so that each information layer is appropriate for its audience.

- Based on information acquired from the Visitor module and using data from the Exhibit module, the expert system suggests an appropriate tour route. During the tour the visitor can change the proposed tour as well as the level of exhibit information layer. His route will be recorded for possible later editing of the rules of passage.

- In order to obtain relevant data, it is necessary in this phase to have many various visitors take a tour through the virtual museum.

- When leaving the web page of the virtual museum, the visitor can leave feedback in the presented form. This will be added to the data about his tour route and will serve to eventual improvements of the system.
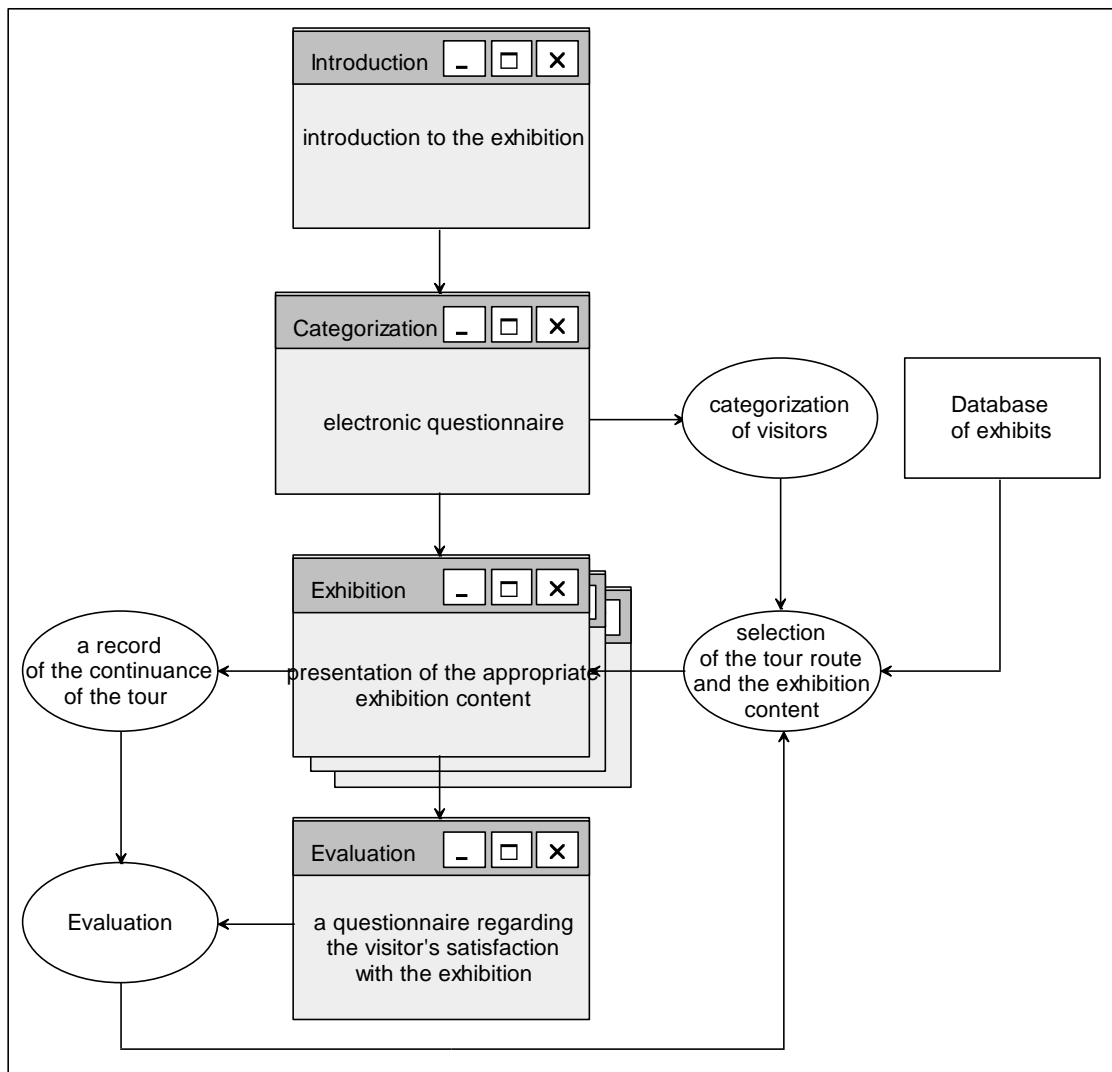
Fig. 2: A scheme of the system in the 1. phase of development

2. phase – testing the educational function

- Guide module adjustment based on real data gathered from the records of visitors tour routes.

- Potential modification of virtual guide web design based on the visitors' reactions.

- Testing of educational functionality of the system on two groups. The first group will be 1st grade students of a primary school, the second group will be students of a secondary school. Part of the students will use the services of the virtual guide, while the others will go through the virtual museum by themselves. After the tour, the degree of knowledge acquired by each group will be compared.

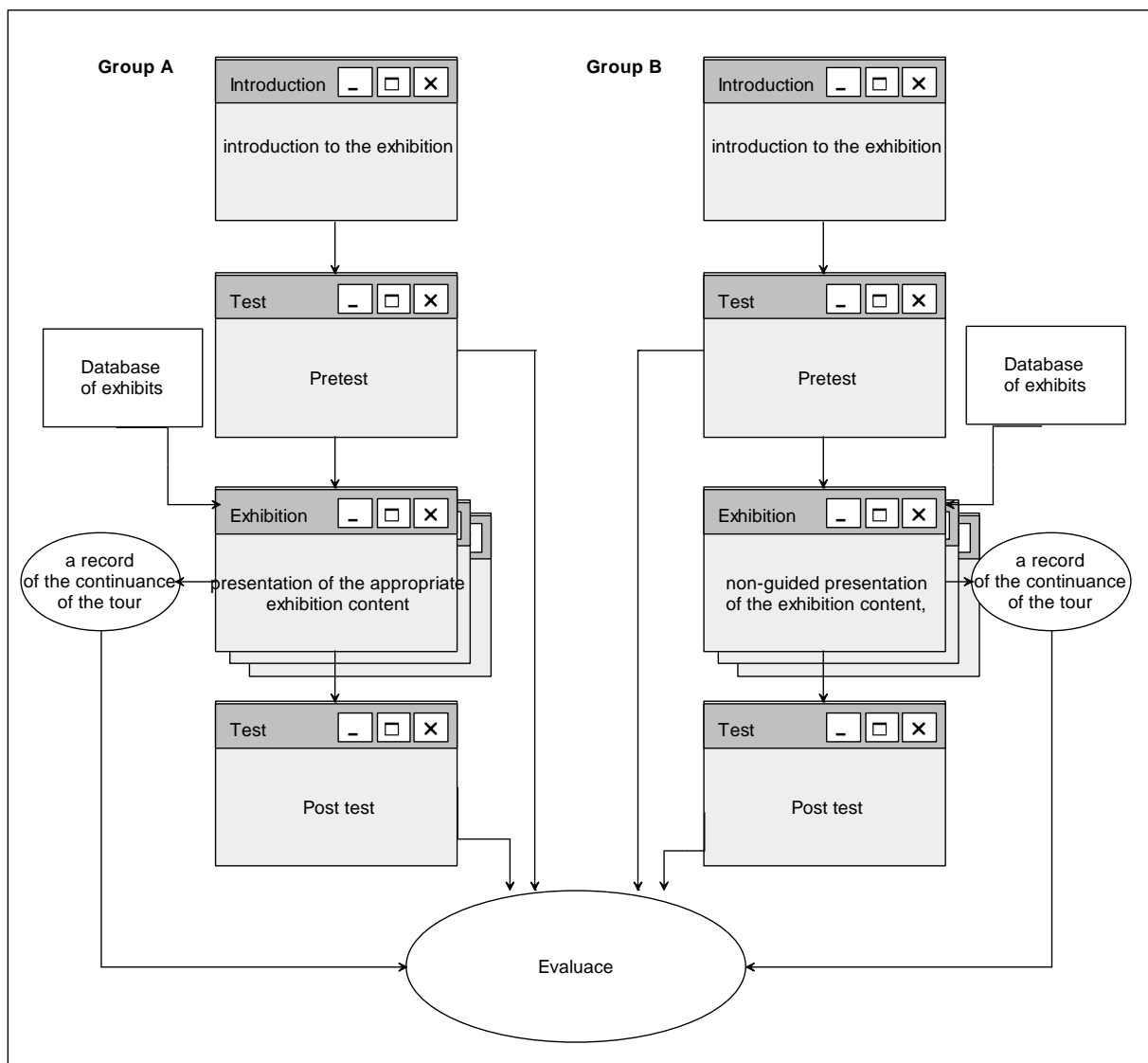**Fig. 3:** The scheme of the system in the 2. phase of development

3. phase – implementation in a real exhibition

- Adjustments for implementation in the real exhibition. Filling the database of exhibits with new records and the creation of new information layers. Also the Guide module has to be modified in order to correspond with new conditions.

- The whole system will run on the museum's central server. When entering the museum exhibition the visitor will download an application to his smartphone. For those who do not own a smartphone, a lending service will be provided. After running the application, the user will have to answer questions in order to be placed in the right category. His answers will be transferred to the server and the user will receive a map with a plan of the tour route on his smartphone. The application will direct the user through the exhibition to the appropriate exhibit. When at the exhibit, the visitor will place his device on the NFC panel or will download the displayed QR code and the appropriate information layer of the exhibit will be displayed on his device screen. After he is done viewing the information layer, the application will direct him to another exhibit.

- The visitor will still be able to change the tour route as well as the information layer of the exhibit.

Conclusion

One of the museum's mission is to educate its visitors. One way to accomplish this mission is to offer an individual approach to the visitor. Different visitors require different information. Modern ICT offers tools that enable the creation of personalized tours. The adaptive guide system is one of those tools. It is vital to choose an appropriate categorization of visitors for such system. However, as there is no universal classification system, it is necessary to develop my own and verify it in practice. The expert system will then take care of the visitor category determination and its output will be used by the Virtual guide as a source for selecting the appropriate tour route. When the expert system is finished, it will be tested and debugged in the virtual museum. After its educational function is verified, it will be implemented in real museum exhibition, where it will work as an application for a smartphone. In the future We plan to expand the categorization of visitors to groups as well, so that the system is more complex and allows working with various groups of visitors.

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CREATION OF EDUCATIONAL VIDEO TUTORIALS AND THEIR USE IN EDUCATION

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Abstract

Educational video tutorials are currently modern teaching resources. They are primarily used as a guide when working with various software applications. The tutorials can be produced in high definition, including narration and subtitles. However, creating such a video tutorial is not easy. Students at the Department of Information and Communication Technologies are learning to create these video tutorials. The basis of a tutorial is the creation of a script. The next step is a high quality screen capture, sound recording and subtitle creation. The tutorial can be accompanied by several different audio tracks and subtitles in different languages. Such video tutorial can be then used by foreign students or hearing-impaired students. The tutorial is then exported into a modern format that ensures high image quality and can be played on most devices for video playback. At the Department of Information and Communication Technologies the tutorials are being created mainly for Informatics courses where students work in different and often special software applications.

Keywords

video, codec, video tutorial, screen capture, container

Introduction

The application of modern information technologies in education has risen increasingly. The use of educational video tutorials is an attractive form of education in ICT. The video tutorial, for example, teaches to work effectively with the software application or an educational program. Well-prepared tutorial, which is accompanied by an audio commentary or subtitles, is the most effective e-learning teaching resource in teaching students to work with software applications (Pavlíček, 2003). With the development of computer technology and consumer electronics one can create educational video tutorials in high resolution, with audio commentary and subtitles in different languages. The created video tutorial can be played on a computer, on

a modern TV via USB port or directly from the Internet in all sorts of devices, such as computers, netbooks, tablets, smart phones and smart TVs.(Bijnens, 2003)

Custom work lies in the screen capture, where all the action on the screen and the mouse movement in particular, are saved in the video file. This process is challenging in both the technical (quality recording software, a powerful computer, suitable codec), and content aspects (to properly carry out educational activities according to quality scripts). Often, both the content and technical aspects of the video tutorial are of a low level and therefore the educational video tutorial is useless.

The finished and edited video tutorial is to be supplemented with audio commentary. Without audio commentary only watching the screen is often not easy to understand. And the commentary can be performed in various languages. During playback, it is easy to switch between different audio tracks. Because a video tutorial can be used for hearing-impaired students, or it can be viewed on a computer that does not have speakers or headphones, it is possible to add subtitles. If there is a pre-built script that contains all the voice commentary, it is not difficult to save the text as subtitles, and again this can be done in different languages.

To create these video tutorials one can use special commercial software, but also a freeware application. Emphasis must be placed on both the technical aspects and the quality of the content. Students at the Department of Information and Communication Technologies learn to create such video tutorials, and their work is often used when completing the practical part of their bachelor's or master's work. The created video tutorials are then used in the teaching of Informatics courses at the Department. Currently, video tutorials for students with special needs are being developed.

Creation of Educational Video Tutorials

It is not a matter of a few minutes to create a high-quality video tutorial. It is a complex process in which a number of different software applications are used. The creator of a tutorial should be very well versed in the field in which he or she produces the video tutorial. On the Internet, especially on YouTube, we can find an enormous number of created video tutorials, but only some of them are created by an author who has appropriate technical equipment and is an expert in the field in which a tutorial is created. Such video tutorials have shortcomings in various areas of production, such as:

- image quality – low resolution video, low quality video due to the usage of the wrong codec, mouse cursor that is difficult to see, mouse movements that are too quick,

- sound quality – usage of a poor-quality microphone, recording in high noise, poor recording sound intensity – too weak or overexcited sound,

- content aspect – fragmented tutorial with non-continuous record, confused mouse movements and mouse clicks, incomprehensible and vaguely described problem without the use of scripts, key search words, slip of the tongue, repeating words and phrases, incomplete or inaccurate information, creation without thorough prior preparation.

To avoid these shortcomings, a thorough preparation is essential before the creation of a tutorial. It is important to think about the content in advance. The description of working with advanced software is often a content of a tutorial, and therefore it must be divided into several individual parts. A tutorial that is too long and contains a lot of new information can be difficult to understand. In this case, it is vital to accurately lay out the overall structure and content of the individual parts with a logical sequence. It is important to maintain this structure, because it happens often that the various functions of the described software applications are closely linked. The creator of a tutorial can forget easily, and then he starts to enrich the content with additional functions or features, gets lost in the topic, and finds himself explaining a completely different issue than he originally intended.

Before the creation itself, it is common to prepare all the video tutorials being created with their titles and especially with their brief content. If text subtitles will be included in the tutorial, it is advisable to prepare all the texts in advance and then they will be transformed to the subtitles. To create subtitles by the transcription of the spoken word is a much more complex process.

As during the creation of the video tutorial, we are working with the software that processes certain data and imports files Therefore, it is necessary to save all needed files into a folder and set up a path to them in the application being described before the screen recording itself. While recording the tutorial, it often happens that the author is searching the whole hard drive for a certain file he or she wants to open, the result of which are confused mouse movements and scanning his or her computer for an inordinate amount of time.

Script Development

The first step before creating a video tutorial is a script development. There are several ways to create a tutorial and this is also linked to the form of the script. The script may be only made of keywords or phrases; the activities that will be recorded in the video are described in a bulleted list. This is a brief outline that provides the creators with focus reminders in order to prevent deviation from the topic of the tutorial.

The keywords and phrase entries are useful when the video is being recorded along with audio commentary. As for additional subtitles, the subsequent transcription of spoken words is necessary for the subtitles to be created. Subsequent audio commentary in different languages also presents a problem. It is possible to add the audio commentary later using the already created subtitles.

Another option is to create a script that will contain the complete audio commentary. These comments are usually created by a separate recording of a text being read. The advantage is that it is not necessary to watch the video during the audio recording, because the timing of individual sentences is set during editing. The advantage of a script such as this is the easy creation of subtitles and simple recording of audio commentary in another language. The complete script is not suitable when the video is being recorded along with the audio. The author of the tutorial would be more devoted to reading the text than what is happening on the screen and the content aspect of the video would be degraded.

Video Recording

It is necessary to select the resolution of a video tutorial or the area being recorded before the video recording itself. If the tutorial was played only on a computer, the video player can handle any resolution without any problems. Because the tutorial is primarily intended to be placed on the web or played in different devices (tablets, mobile phones, television), it is essential to keep the standards used in digital video (Beránek, 2003).

Current standards are high-resolution HD (1280×720) and fullHD (1920×1080). The advantages of the HD option are lower requirements for computer performance while video recording (the computer must have sufficient power for video recording and work seamlessly with any application that is being described in the tutorial). Some applications have a variety of functions, buttons, their working environment is complex, and therefore HD resolution is usually not sufficient because the entire application does not even fit in the working window in HD (1280×720). Therefore, it is necessary to use fullHD resolution. Most computer monitors at this time are using fullHD resolution.

A wide variety of applications that are used for screen capture is available on the Internet. Those are both commercial and freeware products. Among the most famous freeware applications is CamStudio with excellent functional features. In commercial applications, Camtasia Studio is among the best ones as it includes a custom video editing room, own codecs for video recording and sophisticated work environment with an intuitive interface.

CamStudio

It is an excellent freeware application. It enables any settings of the recorded area from the custom setting in pixels, to the capture of the whole screen. Other features include:

- to highlight the mouse cursor in the recorded video;

- to record sound from microphone while capturing the screen;

- the choice of codec for video compression;

- the possibility of setting frame rate video.

- the export to AVI (with selecting the codec) or export to the SVF (flash animation).

The disadvantage of this application is that its own codec (Lossless Codec v1.5) offers excellent picture quality, but some additional editing applications (e.g, Adobe Premiere Pro) are unable to work with this codec. The selection of another codec (such as XviD) brings greater requirements for computer performance, because this codec uses high compression and is designed more for the finalization of video after editing. And choosing other codecs can greatly affect and primarily degrade the quality of the resulting video. It is important to be careful with codec (XviD, etc.) adjustment for the highest video quality and lowest compression ratio. Working window CamStudio is shown in Figure 1.

Fig. 1: Working Window of CamStudio Application

Despite some shortcomings, the CamStudio application can be used to create video tutorials and it also brings excellent visual results. However, the application is only for screen capture. It is necessary to subsequently edit the recorded video in one of the video editing rooms.

Camtasia Studio

Camtasia Studio is professional software for screen capture. Although it is a commercial product, it is possible to use the 30 day trial version that has no functional limitations. The application also contains its own video editing room and therefore it is possible to edit the recorded videos instantly, edit them, add the subtitles, and link them with the spoken audio commentaries. For recording, the application uses its own codec with the excellent image quality. Recorded video tutorial can also be exported to a standard video format and be edited in another video editing room. Basic working window of this application is shown in Figure 2.
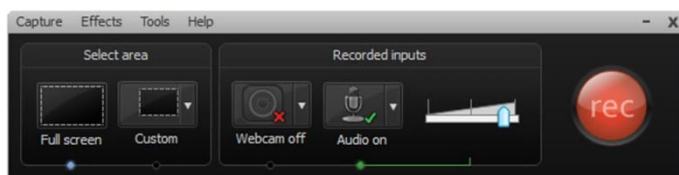
Fig. 2: Working Window of Camtasia Studio Application

The application enables the final edited video and sound to be export in several ways:

- a standalone video file;

- export to Flash player;

- export videos directly to YouTube.

Sound Recording

When a high-quality video tutorial is accompanied by poor audio commentary, it degrades the entire video tutorial. However, a sound recording is often underestimated and its poor quality in the tutorial is very common (Kopecký, 2008).

In terms of the technical aspects of a sound recording, the key element is to use a quality microphone. Cheap microphones or microphones integrated in laptops are not built for a quality sound recording. Therefore, it is necessary to use a good quality microphone. High-quality sound recording can be achieved with a quality microphone connected to the microphone input

of the computer. Consequently, it is possible to edit the record and remove noise. Another solution is to rent a studio condenser microphone. This is then connected with the microphone input in the computer, because such microphones cannot be connected directly to the computer, and on top of that they require their own special power. In this case, it is necessary to use an A/D audio converter connected via USB port (e.g. M-AUDIO Fast Track) or a mixing console that connects to the computer via line input (laptops usually do not have this input).

Before recording the audio, it is necessary to set the audio format (e.g. MPEG Layer-3 with attributes of 44.1 kHz, 320 kbps CBR). It is also necessary to set the proper intensity of the recorded sound so that it is not too weak or overexcited. Further, it is necessary to take into account the level of noise, which increases with the higher volume of input on the sound card in the computer. To avoid emphasizing of strong consonants "p", "b" and sibilants "z", "s", it is vital to use a pop-filter.

In terms of the content aspect of a sound recording, understandable speech is vital. It is important to use short sentences, because long sentences may be incomprehensible. An important element is the intonation. Too monotonous voice can be boring, while exaggerated intonation distracts from the action on the screen.

For simple video tutorials, it is possible to record audio directly during video recording as applications for screen capture enable this feature. Any slip and errors in the commentary must be cut out along with the video. For more complex and more comprehensive tutorials, it is a must to record the audio comment separately with the possibility of re-recording and subsequent editing of bad passages.

The creator of a tutorial does not necessarily need to be the one who narrates the audio commentary. It is usually better to find a person with a pleasantly modulated voice, with good pronunciation and rhetorical skills. Comments can be prepared by the script and narrated without watching the recorded video. During video editing, the individual narrated sentences are assigned to the scenes in the video.

Audio commentary can be done in different languages and stored separately as mp3 files. Subsequently, all audio tracks in different languages will be encapsulated with the video and subtitles into one file.

Edit and Export

The recorded video requires editing and adding of subtitles, transitions, and audio commentary. If the Camtasia Studio application is used, it is possible to edit the video completely in the editing room that is included in this application. In case of the CamStudio application being used, it is necessary to use a different editing application. One can use Windows Movie Maker, which is free and is part of the Windows operating system, but for HD video processing, an additional installation of a special plug-in is necessary.

During video editing, the following operations are carried out:

- editing of bad scenes;
- adding subtitles at the beginning and end of the video tutorial;

- adding audio commentaries (if the sound was recorded separately);

- adding video transitions (usually only a blend into the black screen is used).

After the video editing is finished, export needs to be done. An H.264 codec is commonly used in high resolution HD video or fullHD. Because it is a video that does not contain dynamic scenes, bitrate of 2 Mbps is sufficient. The resulting file will have the MP4 extension. If the editing system does not support this format, it is possible to select a different format and then convert the video in one of the many freeware applications for video conversion (Dancyger, 2007, Wallace, 2013).

Subtitles Creation

It is suitable to add subtitles to the finished video tutorial. The subtitles can be in any language and it will be possible to turn them off at any time during playback. Such video tutorial can be then watched by foreign students or students with impaired hearing. For these students, the subtitles will replace the audio commentary.

Because the narration was created by the script, this script can be used to insert individual sentences into a special application for creating subtitles. Only timing has to be assigned to the subtitles. A freeware application called Subtitle Workshop can be used for the creation of subtitles.

The application can open the created video. Individual subtitles will be copied by rows into the working window. When playing videos and listening to the narration, the beginning and end of each subtitle is created with the mouse in real time. When playing the video next time, it is possible to put the finishing touches and time the subtitles exactly. The resulting subtitles are exported to a file with the SRT extension. It is a universal subtitle format, which usual video players do not have any problems with.

In the same way, one can create subtitles in foreign languages such as English or in other languages. All sets of subtitles will be encapsulated together with video and audio into one file.

Encapsulation

Since the created video tutorial may contain also a number of audio tracks and subtitles for the foreign-language versions, it is suitable to encapsulate all files into one file. Video player then starts the first audio track and first subtitles simultaneously with the video. During playback, it is possible to freely switch the audio tracks and subtitles.

The modern Matroska container is suitable to use for encapsulation. The resulting file will have the MKV extension. A convenient freeware application for encapsulation is MKVToolnix. Working with this program is intuitive. The working window is shown in Figure 3.
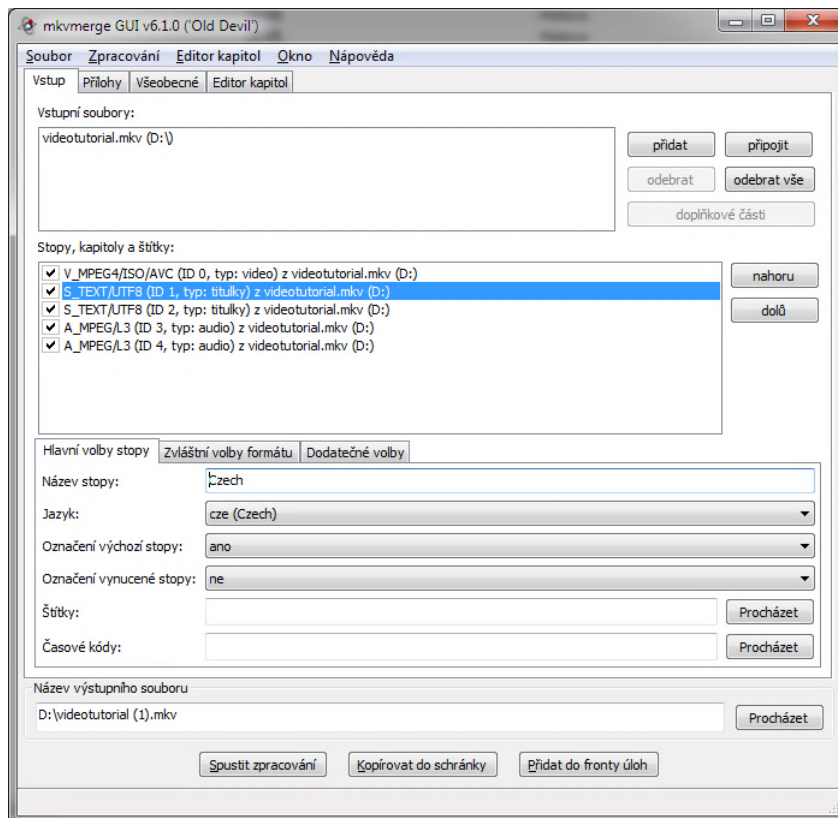
Fig. 3: Working Window of Subtitle MKVToolnix Application

The subtitle settings are important because the language needs to be set (e.g. Czech) to ensure the use of the appropriate character set in order for the subtitles to be displayed properly. "Add" button adds our own video tutorial and then the individual audio tracks and subtitles. "Start processing" button then encapsulates all the added files into one with the MKV extension. Into this file, one can later add additional audio tracks or subtitles, or remove some if necessary. The video file can be played on a computer, tablet, in a cell phone or on TV if they support HD video and playback of MKV files.

When playing the video on a computer, it is appropriate to use, for example, a portable version of the VLC Media Player that can be used without installation, is free and has the support of switching audio tracks and subtitles in various languages.

Video tutorial can also be placed on the website or on YouTube.

The Most Common Deficiencies

This chapter describes the most common deficiencies which students make when creating video tutorials.

Visual deficiencies

- Low video resolution – currently is considered standard HD resolution (1280 × 720 pixels).

- Low bitrate – related to the low resolution video – text is difficult to read.

- Screen capture is acquired at high resolution (1920 × 1080 pixels), but subsequently reduced to 1280 × 720 pixels. Readability is poor.

- Low frame rate – usually 15 to 30 frames per second is sufficient. Lower frame rate leads to jerky movements of the cursor.

- Fast cursor movements – during fast movements of cursor, viewer loses track of what is happening in the recording

- Confused cursor movements – the creator does not know where to find a particular function, the cursor moves too fast.

Sound deficiencies

- Cheap microphone – a microphone does not provides a sound quality as the more expensive models. Usually associated with high level of noise in the audio.

- Inadequate volume - the creator of the tutorial speaks into the microphone from a great distance or he is too close to microphone (overdrive volume).

- Variable volume – creator of tutorials is moving away or towards from the microphone and the voice is variably too quiet or too loud.

- Loud breaths or munching tongue – very distracting.

- Too frequent repetition of certain words - if not pre-prepared scenario, the creator often uses certain words to fill the silence (perhaps we will see... Perhaps about ... Perhaps ... Maybe ...).

- Loud thinking accompanied by the sound of "eeee" (now is how you how… eee... We can... Eeee...)

- Unbalanced volume of the microphone and application – volume of sound from application is too loud and it is hard to understand to creator´s voice and vice versa.

- Slips of the tongue and repetition of sentences – mostly due to lack of preparation.

Content deficiencies

- Sudden changes in topics, lack of continuity.

- Information is given in fragments.

- Too lengthy explanations of simple functions.

- Incomplete or false information – mostly by young creator who teach them self and still not fully understand how it works.

- Creator cannot include the described functionality (or part of the process) to the real workflow.

- Creator is not able to clearly and unambiguously describe the problem in simple sentence.

- Creator often neglected preparatory stage – with the preparatory phase, the creator can avoid most of the problems described above.

Use of Video Tutorials in Education

Students at the Department of Information and Communication technologies will become acquainted with educational video tutorials during their studies and they will also master the technique required for their creation. They are then expected to create such tutorials as part of various projects and concluding essays. These tutorials are then used as teaching tools in Informatics courses to work with different and often special applications for which there are no educational materials.

One of the specialized courses is called Digital Video where students learn to work with Adobe Premiere Pro – the professional video cutting room. This application is only available in English version and there are no official educational materials in Czech. Therefore, educational video tutorials have been created that completely cover the working process in the above mentioned cutting room, including the use of its advanced functions. Total time of video tutorials is approximately 6 hours. Tutorials are primarily meant for students of combined studies but because of their content and technical qualities they are used also by full-time students.

Another specialized course is called Digital Photography. In this course students learn to work with the Adobe Photoshop application. Although this application has its full Czech version, some work techniques and processes are so complex that video tutorials are a fundamental part of education – mainly for students of combined studies who do not have enough chances to work with this application.

Students with Special Needs

Currently, educational video tutorials for the Audiovisual Means 1 course are being created as part of the project of the Department of Social Pedagogy. Their content covers the syllabus of the course (computer graphics, computer sound, digital video). This course is meant for full-time students at the Pedagogical Faculty of University of Ostrava. Because the tutorials will be used also by students with special needs, in this case hearing-impaired students, they contain Czech subtitles.

The created video tutorials have two parts. In the first part, educational presentations with audio commentary and subtitles are created. These presentations cover the theoretical part of the course. In the second part, video instructions for working with different applications, which also contain audio commentary and subtitles, are created. These video instructions cover the practical part of the course.

Foreign Students

The Audiovisual Means 1 course is also taught in English and foreign students frequently sign up for it. Therefore, the translation of Czech subtitles into English is scheduled to provide foreign students with better education related opportunities.

As part of the Department's plan to add more courses taught in English, the creation of English subtitles for other, earlier created video tutorials, is planned. This applies mainly to the Digital Video and Digital Photography courses.

Conclusion

T Educational tutorials are a popular form of learning to work with software applications. The Internet is flooded with a large variety of video tutorials for all possible applications. Unfortunately, most of these tutorials are of a very poor quality and they are created not only in amateur conditions, but also by authors who ignore both the quality and the technical or content aspect.

Students of the Department of Information and Communication Technologies learn to create high-quality video tutorials during their studies. They often create them within their bachelor's or master's theses. In the course of their studies, they are introduced to a variety of technical and software features and they learn to use them effectively and apply them in their work.

At the Department of Information and Communication Technologies educational video tutorials are used in the Digital Video and Digital Photography courses. In these courses special applications such as Adobe Premiere Pro and Adobe Photoshop are used. It is difficult for students of combined studies to learn to work with these applications when they do not have a quality educational material at their disposal (in this case the created video tutorials).

In the final stage, high-quality video tutorials with sound are created, which are subsequently used in the classroom at the Department, and also in elementary and secondary schools, where students apply them.

For foreign students, the created video tutorials can be easily accompanied by audio commentary or subtitles in a foreign language. The Department plans creating English subtitles for several courses where video tutorials are applied. Consequently, the Department will be able to widen the number of courses taught in English for foreign students.

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THE DEVELOPMENT OF COMPUTER COMPETENCIES USING ARTIFICIAL INTELLIGENCE

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Abstract

The paper informs about possibilities how to improve educational process with the help of artificial intelligence. Theoretical part provides an overview of the development of cognitive research on feed-forward neural networks (perceptrons) and teaching support systems. It expresses the preconditions, expected results, concepts, objectives, hypotheses and research methods of the thesis. The practical part describes the construction of a complete teaching system based on the original GLM (Grudzień Learning Module). This module, which contains elements of artificial intelligence, served to achieve the main objective of the experiment and to compare the effects of conventional teaching and individualized instruction based on the proposed methodology. Further part of the paper describes the course of the experiment, pedagogical discussion of results, conclusions and observations. The benefits of the scientific results of the experiment, expandability of the system and subsequent works are mentioned as well.

Keywords

professional competencies, computer competencies, neural networks, eLearning project, expert systems, artificial intelligence

Introduction

The research problem

I am a teacher of vocational subjects and science in Zespół Szkół Ekonomiczno-Gastronomicznych in Cieszyn. In my daily work with students, I am concentrated on activities that can improve the speed of acquisition of teaching materials and improve students' knowledge. This objective can be reached by specially prepared ways as eLearning courses aimed at individualization of instruction.

Educational systems found in literature are either commercial solution that are too expensive to be implemented in schools, or devoted to teaching a particular subject. I have not found a system that was so versatile that it can be adapted to the taught subjects.

In the article, I propose teaching with the use of copyright the GLM module, which uses part of the artificial intelligence to select the appropriate learning path (learning trajectory) for a student. The module is so flexible that it can be adapted to teach each subject. Together with the module, a complete management system of teaching equipment computer technology in the field of informatics techniques is prepared.

Objectives of the work

The aim of the research is the development and testing of new author's module, which uses neural networks and expert system for individual teaching of students (Grudzień, 2010a; Grudzień, 2010b; Grudzień, Smirnova-Tribul'skaja, 2012).

The second objective was to develop a scientifically substantiated eLearning system of vocational education course *Computer technology equipment* in the teaching of computer technician using artificial intelligence techniques. This system is coherent with the program of instruction 312[01]/T/SP MENiS/2004.06.14 announced by the Polish Ministry of Education as the framework program of teaching computer technology.

The expected result of the work is to improve the learning process of obtaining better results in the professional courses of computer technology equipment. It is assumed that in the final test, students using the proposed system will have better results than those who did not use this system.

Methods of work

Research methods included the following elements:

1) analysis of scientific – methodological and psychological-pedagogical literature related to e-learning teaching;

2) analysis of school curricula of vocational subjects in the field of informatics techniques;

3) analysis and testing of eLearning teaching in selected courses;

4) analysis of students' work, analysis of questionnaires, observations and comments;

5) comprehensive diagnosis and monitoring of students gain knowledge through mathematical and statistical methods;

6) conducting pedagogical experiment and presentation of results using mathematical and statistical methods.

The current status of solving issues

Development of cognitive methods

The following theories are methodological basis of the research: pedagogical – in the field of education development by Davydov's and Jelkonin's, creating mental frameworks Galperin's, differentiation of the current development zone and the nearest development zone of Vygotsky and Laurie, and the principle of unity of the psyche, consciousness and activity Vygotsky, Leontiew and Rubinstein.

According to research (Kostjuk, 1988; Ljublinskaja, 1971; Menchinskaja, 1989), intellectual development of external and internal factors can be defined. External factor may be the number of teaching hours or their regularity. Internal factors can be independence and flexibility of learning or individual qualitative characteristics of intelligence. Other works (Kabanova-Meller, 1981; Kruteckij, 1968) mention the influence of already acquired knowledge to further education.

Jel'konin (Jel'konin, 1989) and Davydov (Davydov, 1986) have demonstrated that intellectual development is dependent on the environment and the content of teaching. The same was confirmed by Pellegrino (Pellegrino, Chudowsky & Glaser, 2001), which recommended the use of such methods, which affect the increase in the level of knowledge of students.

Intellectual activity is closely related to certain properties of the nervous system. These properties are responsible for the learning skills of the individuals (Jegorova, 1973; Lejtes, 1971; Lubovskij, 1989). According to experimental research (Kalmykova, 1979; Menhinskaja, 1989), there are cases that all differences of students' knowledge levels are not possible to equalize, even with proper educational environment.

To determine the difficulty in learning, a good diagnostic tool is necessary. For this purpose were used quantitative indicators based on measuring the number of tasks carried out in the time unit (Zykova, Marcinovskaja et al. 1980). As an alternative, Eysenck (Eysenck, 1992) suggested measuring IQ to determine the speed of the functioning of mental processes.

While looking for the most reliable indicators of intellectual development, not only quantitative indicators were used. The emergence of new mental structures can be studied as a result of the learning process (Fidman, 1977). The research by Nepomnjashhaja (Nepomnjashhaja, 1983) shows that individual intelligence is variable and its components depend on the teaching methods.

Teaching should be done in an optimal manner so that the best possible use of the student's potential. This requires individualization of teaching methods and the choice of appropriate sensitivity to student teaching methods (Pen'kov, 1989). If we define all the knowledge and skills that a student can use alone as an area of current development, and the intrinsic relationship between education and development as the next area of development (Vergeles, 1972), we can try to define the teaching route. This route should be such that while the extension of the current development is to expand the range of tasks that can be performed under the supervision of student's teachers and in collaboration with more skillful peers (Davydov, 1986).

Modern approaches to education require the use of new techniques and technology of effective teaching. In secondary schools, there are new didactic and methodological challenges caused by computerization of teaching (Kapounová, Pavlíček, 2003; Smyrnova-Trybulska, 2009).

Groundbreaking research on the development of the intellect components based on comprehensive utilization of informatics techniques in teaching mathematics was done in Ukraine (Smirnova, 1996) and its sequel is one of the objectives of this research work.

Unidirectional neural networks (perceptrons)

As a resource of modelling and neural bases of calculations, the article by McCulloch and Pitts (McCulloch, Pitts, 1943) should be considered, where the first model of artificial neuron was described. Work by Minsky (Minsky, 1963; Minsky, 1967) allowed to accept the proposition that the threshold network constructed from artificial neurons can be considered as machines with a certain number of states, and that these networks are able to perform universal computation.

Parallel to the threshold logic, the theory of continuous systems using differential equations to describe the activity in neural mass was developed. This work was carried by Buerle (Buerle, 1956) and Wilson and Cowan (Wilson, Cowan, 1973).

Rosenblatt team, who focused on networks called perceptrons, dealt with finding the weights for specific computational tasks. Neurons were organized into layers with unidirectional connections. In these works, it was shown that the algorithm of learning network (iterative algorithm changes in weights so that the network performed the required computational tasks) is convergent. Additional research on the networks called Adaline was conducted and discovered by Widrow and Hoff (Widrow & Hoff, 1960).

The book *Perceptrons* (Minsky & Papert, 1969) provided stagnation in neural network research. The authors demonstrated that a simple perceptron networks are not able to learn problem solving linearly inseparable. This situation lasted until finding the back propagation algorithm discovered independently by Werbos (Werbos, 1974), Williams (Williams, 1987) and Parker (Parker, 1985; Parker, 1987) and LeCun (LeCun, 1985).

Modification of network learning algorithms, which are designed to accelerate this process are described by Hertz, Krogh and Palmer (Hertz, Krogh & Palmer, 1991).

A broad assessment of various types of networks, including feedback (Hopfield, Hamming, Elman, RTRN, BAM) and self-organizing networks with competitors (ART, radial, probabilistic) are presented by Cichosz (Cichosz, 2000), Tadeusiewicz (Tadeusiewicz, 1993), Rutkowski (Rutkowski, 2005) and Osowski (Osowski, 1996).

Learning support systems

First steps associated with the use of intelligent machines can be attributed to Pressey (Pressey, 1926), who used the machine instruction tests with multiple choice answers. But at that time, the level of technology did not allow the functioning to implement in accordance with the teaching theory.

Along with the expansion of the first computers, the first systems to enhancing learning appeared (Bloom, 1956; Carroll, 1963; Skinner, 1957). At first, they based on the theory of programmed instruction (PI programmed instructions).The system determined entry skills and competencies defining the output of the student. The student's individual problems led to teaching scheme and tested their knowledge. In the case of incorrect answers, there were presented and treated right solutions of teaching other content (Bunderson & Olsen, 1983). As the developed system of PI, systems called CAI (computer aided instructions) or CBT (computer based training) emerged. CAI systems based on Skinner's theory of stimulus response. The next stage of development systems strengthening education systems was ICAI (intelligent computer assisted instruction).

The next step in the evolution of enhancing teaching systems is ITS (intelligent tutoring systems). These include: knowledge of the field (expert model), knowledge of the student (the student model) and knowledge of teaching methods (tutor model). Moreover, they also require that these systems led to diagnose student's errors and prevent them (Kyllonen, Christal & Shute, 1989).

Another type of training systems are based on the reasoning of the cases - case based reasoning (CBR) (Schank, 1982; Kolodner, 1988). Unlike the ACT model systems, which in some cases give very detailed description of the problems of the student, CBR systems are content with a certain approach and focus on the main issues.

Since the 1980s, the simulation tools of various kinds, containing different types of artificial intelligence have been developed.

Along with the emergence of broadband access to the Internet has opened opportunities to work in Virtual Reality environments. This environment is a platform in which, except for maybe the implementation of all the above teaching methods are easy to implement social element of teaching - cooperation and exchange of experience among course participants.

Main topics of the latest research are located around the following questions:

- systems based on network usage (Israel & Aiken, 2007; Conejo et al., 2004);

- systems focusing on the interaction between users (Rosatelli & Self, 2004; Walker et al., 2004);

- systems using the new student model, such as Bayesian model (Vu Minh et al., 2010; Chao-Lin, 2008);

- modelling of teaching (Aleven et al., 2009);

- open learner model (Bull & Kay, 2007);

- ill-defined domains (Lynch et al., 2009).

Practical part

The construction and method of module operation

The teaching in this work by the proposed algorithm works in steps:

1) preparation of learning objects in accordance with the standards and requirements of the Framework educational program;

2) pre-setting system;

3) collection of psychological data about the student, in this case the intelligence structure test;

4) enabling the access to the course to students (teaching with support);

5) collecting data about each student (results of tests, questionnaires , etc.);

6) intelligent system improvement based on data from previous phases;

7) return to step 3.

The algorithm works is an endless cycle, which means continuous improvement of the system based on data from other students.

The proposed management system of teaching is consistent with the model of the Intelligent Tutoring System, which consists of 4 parts: the student model, expert module, tutorial module and a graphical user interface.

In the proposed solution author's teaching management module GLM comprises tutorial module and a part of a graphical user's interface. Teaching management module GLM consists of two parts: Web GLM, which shows the proposed trajectory for student learning and GLM.exe, which learns neural network and generates PHP code for web parts GLM.

The expert module containing learning objects, tests, surveys and the remainder of the graphical user interface is supported LMS Moodle. Student's model data from the intelligence structure test.

Preliminary work of GLM module

Before beginning of teaching users system administrator creates in module GLM.exe ordered set of neural networks. These networks are unidirectional networks based on the perceptrons with a sigmoid activation function. The number of neural networks is equal to the number of learning objects contained in the built up part of the course. Networks are numbered from 0 to n. In each neural network is contained as many neurons as there are networks (and learning objects). Each neuron receives a number which corresponds to the learning object (a number of associated neural network). The weights of the network are configured in such a way that, when any of the input data, the most stimulated neuron is a neuron of a number one greater than the number of the current network. (This setting is intended to provide user's guidance through all learning objects).

Gradually, using already created data and GLM.exe module, part of Web GLM containing in its code the copy of the previously established networks is automatically formed. Web GLM is located on the server supporting the learning management system. This solution was adopted for technical reasons. Preparatory works are completed.

The module work cycle

Subsequently, the approach to the next stage of the work that is already part of the cycle. For proper execution, modules GLM are necessary components of the intelligence structure test (IST). After psychological tests, carried out by authorized and trained psychologist, a student will receive a code. The code consists of nine letters of the Latin alphabet, which corresponds to the results of the intelligence structure test.

It is worth noting two parts of the algorithm – part I designed for the student to teaching conduction and data collection, and part II, where it comes to an intelligent, automated improvement of the module GLM operation.

Improving the operation of GLM module relies on advancing its ability to create individual learning trajectories for a particular student.

In each section, there are visible cycles – these have an important function in data collection for the training set and neural network teaching in GLM module.

After starting the system the user enters the coded IST results in the form. This data is sent to Web GLM module that checks the correctness and decodes. The decoded data Web GLM directs to the first neural network (numbered 0), associated with the first learning objects (also with the number 0). The start of the network is recorded by Web GLM. The user can see a link to a learning object associated with the network. Neurons generate answers to the mains input. Web searches GLM neuron with the greatest stimulation and reads the identifier. If this identifier is zero, Web GLM completes the creation of the result page for the user. Otherwise it is running in another network with the same number of neurons identifier (in this case 1). Starting next network causes the further reference to the learning object, and so on. This cycle is repeated. Learning trajectory is generated containing links to learning objects user.

The user, in addition to information about the proposed learning trajectories, has access to all learning objects. GLM module gives the student a proposal for the selection of the current optimal learning trajectories.

After studying learning objects (through trajectory designed by GLM module or not), the user accesses the tests. If the test failed, the user is returning back to the study materials. This cycle is repeated until it reaches the level of correct answers provided by the system's administrator.

Upon successful completion of the test (or tests), the student is asked to determine what learning objects and in what order they should be in learning trajectory and which are unnecessary.

On the basis of a questionnaire, the learning set record of the neural network which will be continued to speak as a student learning trajectory record (SLTR) is created. SLTR contains user's intellectual structure test data and the proposed educational path.

SLTR are written as a training file of GLM.exe module. After collecting adequate data amount (the system administrator subjectively evaluates it) it begins the process of modifying the learning trajectory by neural networks learning.

For each stage of learning, each SLTR is transformed into the learning record of selected neural networks. The record, which learns network, includes input data and expected output data from the selected network. The selected networks are neural networks associated with learning objects with numbers presented in the learning trajectory.

Input data for each learning record in each neural network (record of the training set) are the intelligence structure test results. Estimated output data for a particular network include: value one for neuron number identical with the number of the next learning object located in SLTR and a value of zero for the remaining neurons.

After preparing and loading training set, neural networks start learning, which takes place under supervision (supervised learning). Teaching process continues until they reach the neural network error responses smaller than the set in the parameters of learning or to exceed the maximum number of stages of learning set by the system's administrator.

The most important element, module GLM, is a part associated with the modification of neural networks. In this area, it follows the weighting change caused by networks teaching.

GLM module is taught on the basis of data derived from intelligence structure tests and questionnaires completed by the student. The result of this teaching method is the ability of GLM module to create better learning trajectories for students.

After completion of all networks, learning for different input data may be subjected of maximum stimulation different neurons, when these do not have the number of further learning objects. For new users, the learning trajectories become dependent on the input data, i.e. the intelligence structure test results.

Stimulation of other neurons causes changes in the sequence of induced neural networks and consequently changes the learning trajectory. Trained neural networks are retained for future education.

This means that the outcome of learning neural networks (in other words, changes of weights) is improved by learning trajectory for other students with similar intelligence structure test results.

The next step is to create a modified version of Web GLM containing a neural network with the updated weights and place it on a production server. It is the end of the cycle.

Work algorithm of the system is returned to the place of gathering user data. Another student, awarding the same or similar data user (IST) receives generated and modified learning trajectory. This learning trajectory is already better adapted to the needs and abilities of the student.

As in the previous case, the student has access to all learning objects, but the learning trajectory designed by GLM module is already approaching the optimal trajectory.

Comparing the learning trajectories generated by neural networks at the beginning and during the learning process of the module, the differences are easily perceived. After each new student acceding to the learning, module improves its ability to create learning trajectories.
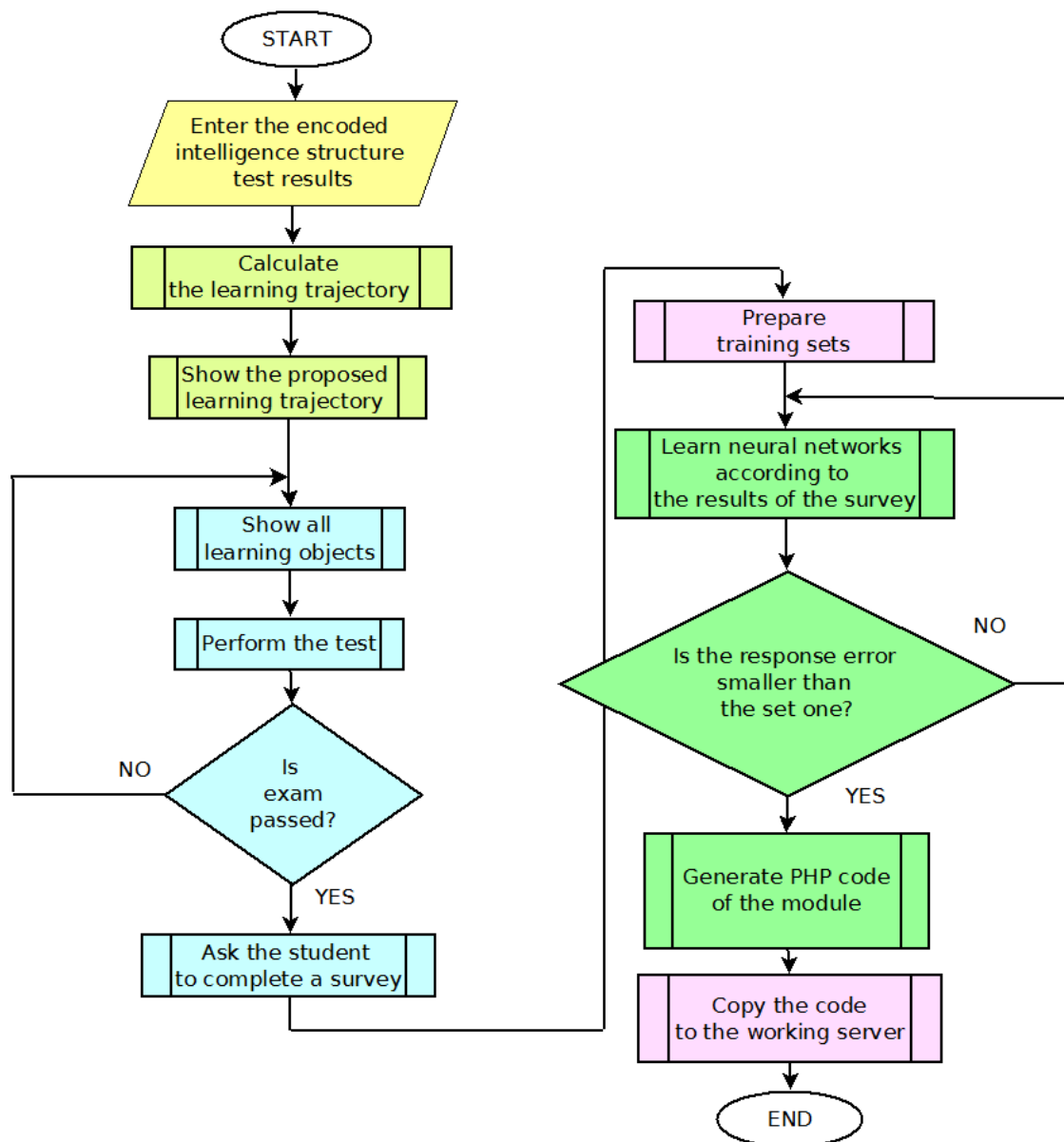
Fig. 1: Detailed algorithm of the whole system of teaching management for individual student.

Summary

The main experiment

The research sample consisted of 116 pupils were divided into two groups - experimental (56 students) and control (60 students). Teaching of the computer science in the experimental group was conducted through e-learning course, which was prepared on the basis of the development of experimental teaching methodology. In the control group, the training took place on the basis of conventional (traditional) methods of teaching.

The object of investigation was the question of knowledge of numerical systems which are often the subject of computer technology equipment (CTE): theoretical issues, logic gates, combinational circuits, multiplexers and demultiplexers, asynchronous sequential circuits, synchronous sequential circuits, generators and special circuits. The test included questions of various types: multiple choice test, single choice test, true/false answers, short answers, numerical and calculation answers. For both groups were made following the pre-test before beginning the experiment: intelligence structure test examining the components of intellect and test determines the level of professional skills of students before the courses start.

Immediately after the experiment was carried out, the test to check the level of professional skills of students and the knowledge of the area were covered in the course. The results achieved in the test were processed using statistical software R.

Methods of processing and method of solution

The course of the research was to test the hypothesis that using the proposed eLearning system to teaching vocational subjects will increase the professional competence of students compared with students who work with conventional methods of learning The null hypothesis set following: there is no difference between students who work with the proposed eLearning system of teaching, compared with students who work with conventional methods of teaching.

The results and discussion of the main experiment

The results of the two groups pre-test – the control and experimental – are at the most competency tests in the range of 0 % to 20 %. The test results of Kolgomorov-Smirnov and Wilcoxon do not allow to reject the null hypothesis. Also degree of central tendency is similar. From a statistical point of view, not the premise for the claim that the two groups represent different populations. This assertion is correct, when we analyse individual tests, as well as the overall result of the pre-test both groups.

Completely different results of tests performed during the experiment. Taking into account the results throughout the course, large differences in their distribution can be observed. Although both groups have unimodal distribution, scores of the control group are negatively skewed, and the results of the experimental group positively skewed. Distribution of the experimental group is more flat compared with the distribution of the control group. Extremely low p values of Kolgomorov-Smirnov test and Wilcoxon test confirm observations based on histograms. Based on the statistical rights, calculated p values and adopted significance level α ($\alpha = 0.05$), the null hypothesis is rejected and the alternative hypothesis is accepted on the difference distribution.

The values of central tendency measures clearly show better results of students who learned of the proposed methodology using GLM module. Accepted scientific hypothesis about improvement the quality of teaching is confirmed on the basis of research results.

Statistical method	Control group	Experimental group
The arithmetic average	23	48
Median	25	50
Standard deviation	13	21
Bilateral criterion of Kolmogorov -Smirnov test	D = 0.6643 , p- value = 1.581 -11	
Bilateral criterion of Wilocoxon test	W = 538 , p- value = 2.831 -10	

Tab. 1: The results of the statistical calculations of experimental group and control one.
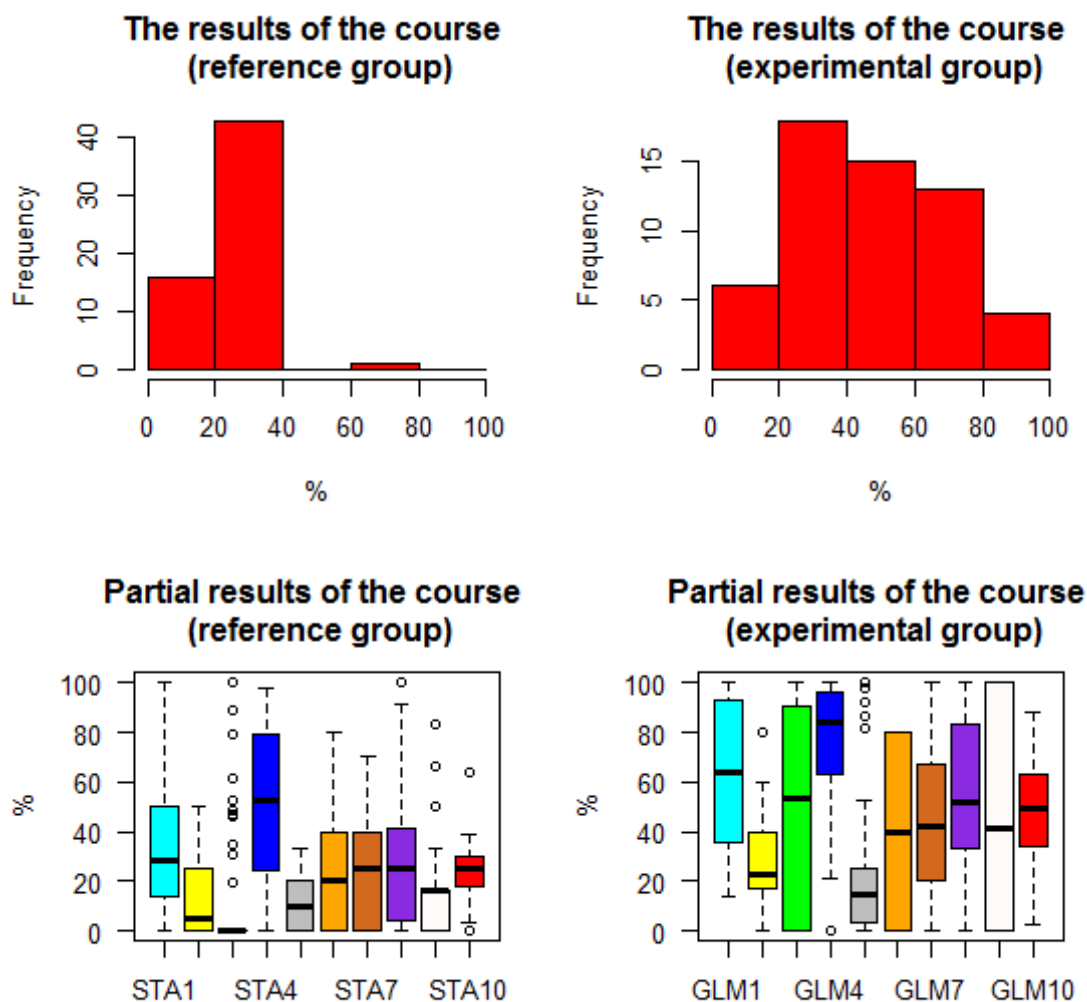

Fig. 2: The test results of the course - histograms and box plots.

Conclusions and recommendations of further research of work

Learning trajectories generated by the module gradually improve themselves by the impact of neural networks learning, which are an integral part of the module. The experiment leads to the following conclusions:

- based on the statistical results, adopted a significance level of $\alpha = 0.05$ and test results of Kolgomorov-Smirnov and Wilcoxon it is confirmed that using the GLM module has an influence on the distribution shape of the competence tests results of the participants of the computer technology equipment course;

- based on the analysis of the characteristics of central tendency measures competency tests it is confirmed that using GLM module enhances students' competencies in this course.

Observations and conclusions gained during the implementation of pedagogical experiment in this study yielded a number of questions that may be the topic of further research. Among other possible areas of theoretical research include:

- verification of the permanence of knowledge in groups taught by the conventional method as the optimization of learning trajectories,

- carrying out similar research in other disciplines – natural and humanistic sciences;

- work precisely determining how they affect learning trajectories of human cognitive sphere;

- anticipation of expertise competency tests based on psychological tests;

- extraction of logical rules from the network, e.g. to determine how learning objects are characteristic to a particular student;

- verifying whether the distribution of learning outcomes is the Poisson distribution of students, which would suggest a low occurrence of the phenomenon of student self-education;

- verifying whether the type of statistical distribution of competency test results changes at different student motivating system;

- perform neurocognitive research on the influence optimal trajectory learning the work of various regions of the human brain.

There is also plenty of practical improvement of the system of teaching functioning using GLM that includes artificial neural networks. Enumerated should be:

- automatic data collection, especially with regard to student learning trajectories.

Learning trajectories generated by the module to gradually improve the impact of learning neural networks, which are an integral part of the module:

- implementing the extended monitoring of user activity;

- adaptation of the whole course mobile devices, especially mobile phones;

- changing the activation function of the neuron and its learning method to speed up the functioning of the learning process of neural networks;

- changing the type of neural networks, such as the self-organizing ones;

- extraction of logical rules from the network to create rapidly working expert system.

Further work will be continued.

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INFORMATION SYSTEM "DIAGNOSTIC" AS A TOOL OF ACTION RESEARCH

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Abstract

In order for schools to be able to manage the demanding tasks that are imposed on them today, they must be ready for internal transformation. This transformation cannot be driven by chance or intuition, or managed from the outside, but has to be executed on the basis of exact internal data. This data can be obtained through the methods of action research carried out at schools, with the help of the prepared information system called Diagnostic. Using long-term data gathering and processing, as well as other activities, school can become a learning organisation, which can adequately react to the changing external conditions, and constantly improve its quality.

Keywords

school quality, action research, longitudinal research, organisational learning, IS Diagnostic

Introduction

Schools today face the constant stream of new problems and ambitious challenges, which create extreme pressure on their transformation. Schools are expected to act towards their own development. They are often affected by educational politics, educational research and professional public discussions – that is, by activities that might provide short-term, even random, goals and solutions. But school development cannot be driven by chance or even intuition. Long-term and systematic steps need to be taken when developing the professional skills of teachers and school management representatives; detailed reflections, evaluations and presentations of the importance of individual phenomena and processes are needed, in order to show how these work in reality and what results they bring. It is important to emphasise the importance of internal school development, of proactive school behaviour, and of the *organisational learning* of schools. One of the possibilities to meet these requirements is the *action research*, supported by suitable *information system* for obtaining, storing and processing data.

The aim of this report is directed by the intention to complementarily examine the phenomenon of school quality and its development using the processes of action research that is supported by an information system. We present theoretical/research groundwork for the quality of school as an educational organisation, in which we refer to the systems of quality indicators that were elaborated by J. Sanders and E. Davidson (2003) under the applied model of school evaluation. We further draw on the findings by the OECD/CERI (1995) experts and R. R. Verduga and M. Schneider (2005). The connection to the construct of teacher quality and the possibilities of evaluating this quality in relation to the process of pupil learning is also inspiring.

In connection with the school quality concept, this article further covers the approaches to the action research that is carried out in pedagogical practice. We work with the approaches by J. McNiff (2002); J. Hendl (2005), A. McIntyre (2008), J. McNiff and J. Whitehead (2009). We discuss the methodological characteristics of the action research, its procedural demands, and mostly the intervention-based and applicable character of gathered information; the analysis and evaluation of the data demand the arrangement of supportive information system. In the end, we introduce a draft of the information system Diagnostic, which constitutes a crucial technological support for monitoring and evaluating school quality.

School quality and its management using the longitudinal research design

In general, we can agree on the important factors of the effort to evaluate schools in their aggregate quality and in all their pedagogical and educational services they provide. Schools play significant role in nurturing the national cultural heritage as well as the personal development of their pupils and students. But to actually choose the criteria that would represent this quality[1], to determine their right mix as well as to scale the individual criteria in terms of their importance, to create their clear and easily comprehensible characterisation; here the agreement is not that easy to reach. One of the many remaining questions asks whether the quality of school and teachers can significantly influence the learning of pupils, the quality of their results and their further life fulfilment, if we take into account the role of various socio-cultural backgrounds of their families, or the role of their personalities and developmental characteristics. The effort to create a universal model of good school is complicated by at least one other factor – a certain point of view, or a question: *"quality for who?"* How to specify the desirable and expected level through the different views of pupils, parents, teachers, headmasters, inspectors, school authorities, sponsors?

Nowadays the traditional belief that only the results of pupils can be used as a significant indicator of school's quality is being abandoned. A more complex notion of quality is being adopted and we try to specify the features that characterise good school of high quality, creating a basis for school management and development. To learn about and deeply understand the complex structure of school is the prerequisite for discovering, naming and solving the problems that are part of this intricate living system. School therefore resembles *"a living*

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[1] When evaluating certain pedagogical phenomenon, we want to find out if and how much it is in correspondence with the criteria and indicators that determine whether the phenomenon can be marked as "of high quality". *Quality* defined in this way represents the optimal, desirable level, certain degree of perfection, and thus becomes a normative category; the examined phenomenon is compared with this normative category.

organism, in which every element assures its healthy state and modification of each element affects the function of the whole" (translated from Walterová, 1994, p. 8).

The basis of quality management and development is grounded in the more or less elaborately structured body of indicators as specific and qualifiable characteristics of selected phenomena and processes happening in the school environment. The indicators have descriptive character and give school actors (pupils, teachers, parents) but also evaluators and self-evaluators the possibility to *"stimulate productive thinking and discussion on the needs of changes and on the course of school development"* (Sanders, Davidson, 2003, p. 810). However, Sanders and Davidson (2003) also warn about certain risks in using this approach and recommend a certain caution when using it. They especially point out the problems when creating national standards that contain a general delimitation of the indicators, which do not take into account the specifics of individual schools, such as personality characteristics of their pupils, or the resources school has at its disposal. In order for the system of indicators characterising the desired quality of school to work properly, it has to meet several requirements. First of all, it has to be complex enough to enable a full assessment of school in the whole wide range of services the school provides, and be potentially convenient for each individual school and all the participants. Among other requirements is the option for every school to choose from the available set of indicators and create its own specific profile of quality. Furthermore, it is desirable to consider any system of indicators as an open one; one that can be changed, if necessary, and its creation should be cooperative and based on consensus, especially when considering the sensitive, and in the Czech Republic unknown, process of self-evaluation. At the same time, however, it is necessary to agree on and specify the indicators clearly and at the beginning of any evaluating processes (more in Seberová, Malčík, 2010).

Material end Methods

Action research – concept and groundwork

Action research was defined in the middle of the 20th century by a social psychologist Kurt Lewin. One of the key premises of action research is its direct participation in solving problems that emerge during teaching. It has an influencing character, because its results shape the reality of the given professional area, and among its main goals is to identify, in as much detail and complexity as possible, all the processes of a given practice and their contexts, and therefore be able to postulate and propose wide range of inspiring solutions. Action research in the field of teaching practice is defined as a process in which teachers/practitioners and other actors of school life carefully and systematically examine their own pedagogical practice and phenomena and processes connected with teaching and learning by using the strategies, methods and techniques of pedagogical research. These are the attributes that should be generally observed (Walterová, 1995; O'Brien, 1998; Ferrance, 2000; McNiff, 2002; Nezvalová, 2002; Hendl, 2005):

- The research is aimed at problems that are identified by the participants themselves; the real environment is reflected - in all its complexity (complexity of views on the impact of conditions and forms of social action); teacher's own teaching is examined;

- The research is a process of learning and change, teacher's own teaching is the object of the research, the effectiveness is improved through interiorisation of the needs of specific interventions, changes can be implemented that are improving the quality of pedagogical practice;

- The research is carried out by professional as well as unprofessional researchers, who are therefore both subjects and objects of the research; the participants have an equivalent position, they cooperate and they also participate in evaluating and interpreting the results;

- If teachers cooperate as a research team, a way to transfer tacit knowledge opens up and school becomes a learning organisation, which consequently enables the growth of professional self-confidence as well as the prestige of the teaching profession;

- The research results are published for the needs of all groups of participants.

The methodological speciality of the action research is the permanent spiral cycling process of several phases: *1. Reflection – identifying problems, issues, major and initial ideas, or the needed changes; 2. Collecting data and information (consulting literature, choosing the method of data gathering and analysis, planning and executing the research); 3. Analysis and interpretation of findings, suggestions for changes and corrective measures; 4. Action – implementation of changes; 5. Reflection – evaluation of the plan of changes and its modification.* The cycle comes to end and it is followed by the phase 1 again: gathering and analysing data to evaluate the effects of implemented changes, identifying problems, … (Lewin, 1948 in Smith, 2007; Ferrance, 2000; Hendl, 2005). The following diagram clearly shows the cycle of individual phases:
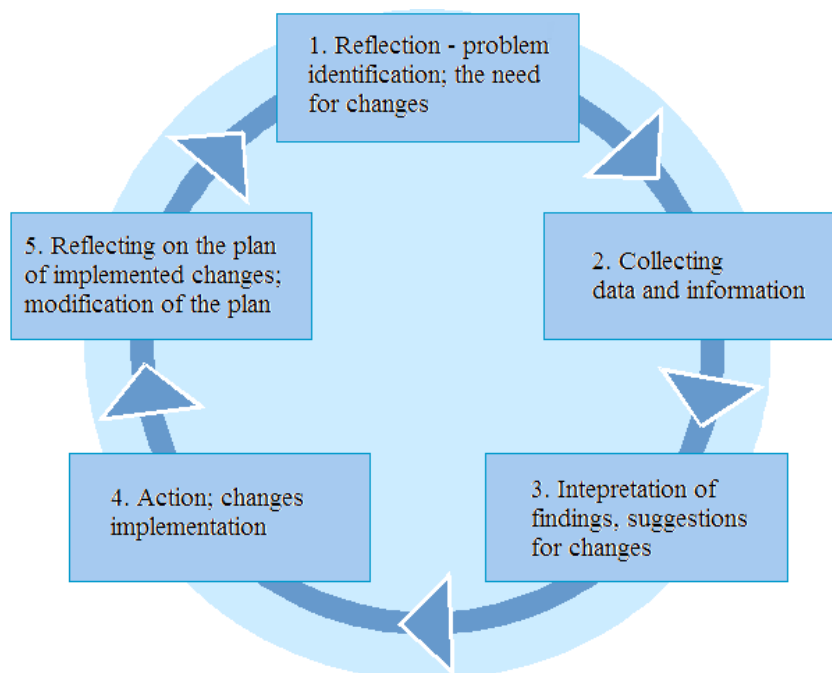

Fig. 1: Diagram: The action research process phases

Results and Discussion

Information system "Diagnostic" and its application in the longitudinal monitoring of school quality

The information system Diagnostic has been developed to support the monitoring and evaluation of school quality as the key feedback for all the participants of the educational process. The information system Diagnostic is a web-based application that stems from the EFQM Excellence Model[®2] and the Model for School Quality Improvement.[3] During its use, school self-evaluate their own educational reality in the following basic areas- Education conditions; Course of education; School culture; School management; Education results; School results in relation with the education conditions and financial resources.
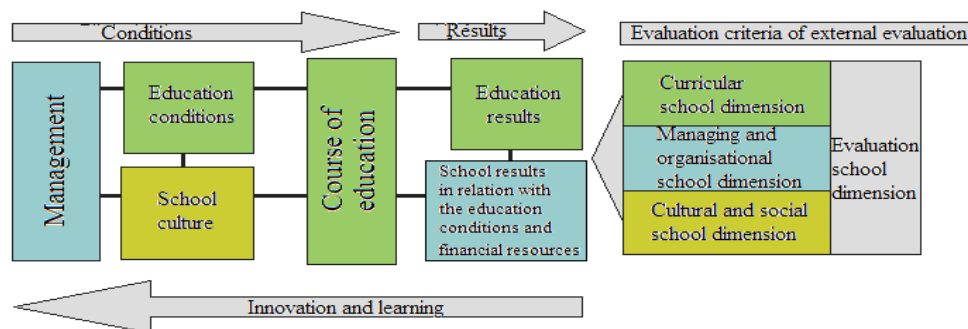

Fig. 2: Block diagram of school dimension evaluation related to the dimensions of school educational reality (based on EFQM®, modified by M. M.)

The Figure no. 2 shows the schematics of developing system of relations between the areas and dimensions of good school. The self-evaluation is always checked by an external evaluation, where the individual school dimensions are evaluated in accordance with pre-formulated evaluation criteria, as indicated by the left-pointing arrow in the block diagram. The left part of the closed diagram represents the school's self-evaluation carried out in the areas as defined by the Ministry of Education, Youth and Sports law no. 15/2005 and inspired by the EFQM[®]. The right part of the closed diagram represents the external evaluation, containing three dimensions – curricular, managing and organisational, and cultural and social. All these dimensions are empowered by the *evaluative* dimension, because all the elements of individual dimensions can be and should be subjected to the action research.

The information system Diagnostic stems from the basic requirements of working with information, i.e. to provide enough relevant and correct information, at the right time to the right users.

Among other functions, the IS Diagnostic allows to:

- Apply internal and external diagnostic tools on the education reality of schools (techniques of action research);

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[2] The EFQM Excellence Model[®] is a customer-oriented system for quality management.
[3] The Model for School Quality Improvement was developed in the Association for School Quality [Společnost pro kvalitu školy, o. s.] (Malčík, Hudec, 2010).

- Continually store the gathered data from the action research – the managed process of self-evaluation – for further use, mainly in the long-term evaluation;

- Analyse data in compliance with the law no. 101/2000 on personal data protection; enable school benchmarking;

- Assign outputs from diagnostic tools, i.e. information from a carried out action research, to individual dimensions/sub-dimensions;

- Insert suggestions for modifications; as the basis for the Plan of School Further Development;

- Monitor and compare the development of various areas/sub-areas in the self-evaluation of certain school in time.

Each and every sub-area of the school education reality is periodically evaluated in accordance with the methodology for school quality improvement; the evaluation of each area is calculated by the following formula:

$$O_k = 0,4 * \frac{\sum_{i=1}^{l} r_i}{l} + 0,3 * \frac{\sum_{i=1}^{l} o_i}{l} + 0,2 * \frac{\sum_{i=!}^{l} n_i}{l} + 0,1 \frac{\sum_{i=1}^{l} t_i}{l}, \qquad (1)$$

Where O_k is the result of the evaluation of k-area; l is the number of sub-areas of k-area; r_i is the value of the real evaluation of i-sub-area; o_i is the value of the verification possibility evaluation of i-sub-area; n_i is the value of evaluation of suggestions of i-sub-area; and t_i is the evaluation of trends of i-sub-area. $O_k \in \langle 1,4 \rangle$. Weighted values are setted according to Information system adjusting.

The output of the information system is the evaluation of individual areas and sub-areas, comparison with other evaluated schools of the same type, pre-generated report of the school self-evaluation and the option of a long-term monitoring of selected indicators, showing trends and predictions.

If we take $k=6$ and so we realize school evaluation in six selected areas, school output could look like this $School = \{1,5;2,3;3,5;2,4;3,1;2,8\}$.

The information system Diagnostic is currently used by about 400 Czech primary and secondary schools and first outcomes and outputs appeared.

School quality improvement

It is more and more difficult to define all the characteristics and attributes that quality schools should have today. Society constantly succumbs to new socio-cultural, political and economic changes; new developments in technology and science bring an ever-growing amount of easily reached information, they enable more and bigger "possibilities" for man. We can communicate easily with transoceanic countries and at the same time be unable to come to understanding with people around us. What is the task of schools in contemporary society? Which quality is

the most important? Which quality should schools strive for in order to prepare today's children for tomorrow's problems?

Processes connected with school quality management, and its further development, are a long-term issue. Their longitudinal character predestines them to be realised in a long time span of several years or even decades. If the longitudinal research on school quality state and management is to be systematic, orderly and methodologically correct, so that its findings are valid and reliable, it has to be grounded in a specific research design. With its practical, intervention-driven focus, the action research suits these requirements very well, supported by a suitable information system for obtaining, storing and processing the data.

Experts agree that the action research carried out by teachers is not mere uncovering of problems and looking for what is wrong and unsuitable, but finding knowledge that enables qualitative growth. Action research is not only about discovering and understanding why we make certain decisions or implement certain strategies, but more about thinking what can be done better and what can be changed to facilitate learning of pupils (Ferrance, 2000; McIntyre, 2008; McNiff, Whitehead, 2009, Kostolányová, Šarmanová, Takácz, 2012).

When carrying out action researches, it is important to take into account the conditions of the actual environments as they influence the course of the researches. Equally important and desirable, however, is to help schools in carrying out such demanding and professionally specific activities. One of the helping hands is certainly offered by supportive information systems that facilitate the gathering, analysis and interpretation of the longitudinally handled data and information. The information system Diagnostic presented in this paper also enables to adhere to the methodological specifics of the action research in school environment. It brings up-to-date analysed and evaluated data, thus ensuring that the data can be used to continually help the decision-making during the course of the research, and that the partial results are put into practise and the effects of the proposed changes and interventions can be immediately and constantly monitored.

More than ever, school has to prepare its pupils for an unknown tomorrow. For that reason, more than ever before, school must become a learning organisation (Collinson, Cook, 2007, Senge, 2001), it must monitor its quality and be ready for a change that comes from within and that is a reaction to the objective understanding of the described educational reality at school. As stated for instance Lankshear, Knobel, (2004), these requirements evidently comply action research strategy especially in qualitative-quantitative research designs. In order to succeed in this demanding task, school needs wide information support. Although it is standard that schools today use information systems to manage their operational and economic activities, it is not usual for them to use information systems to manage the quality of their main processes (Seberova, Malcik, 2010). And school quality management cannot be done only on the basis of documentation, however well compiled; it is necessary to notice and analyse, as objectively as possible, the individual domains of school educational reality, with the possibility to run benchmarking and further analyses. These requirements are met by the developed Diagnostic information system that builds upon the Model for School Quality Improvement that utilises, in a sense, the simplified model of action research.

Conclusion

In recent years, schools have been facing new challenges and demanding tasks that call for their internal transformation accompanied by systematic self-reflection. In order for school to be able to cope with these tasks, it must not rely only on solutions and help from the outside, but has to be prepared to carry out long-term and methodologically relevant processes of gathering and assessing exact data and information from within. This data can be obtained through the methods of action research, carried out at schools by teachers and headmasters, using the help of the prepared information system Diagnostic. Using long-term data gathering, processing and assessing and other systematic and managed activities of self-evaluation, school can become a learning organisation, which can adequately react to the changing external conditions, and at the same time meet the increasing requirements for quality.

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Information and Media Education
Two Sides of the Same Coin

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Introduction

We are overwhelmed by information and media content which places increasing demands on our information and media competency. To rely on knowledge gained through self-learning in the area of information and media education may prove to be insufficient. Already primary and secondary school students are learning how to use information resources and media efficiently (Altmanová et al., 2010; RVP, 2013). The quality of information and media education in schools depends largely on the qualification and motivation of teachers. The Department of Information and Communication Technologies (ICT) of the Pedagogical Faculty of the University of Ostrava has devoted many years to the preparation of future teachers for both information and media education (Dpt. of ICT, 2013). Students of a single field acquire information about information science as well as media studies. This approach proves to be a great advantage since information and media education can be perceived as two sides of the same coin. The author examines functional, information and media literacy and describes how students majoring in the field of Information Technology in Education acquire competency in these areas.

Functional literacy

Even though the results of international surveys (OECD PIAAC, 2013) did not confirm the thesis of the dramatic decline of the Czech educational system, it would not be prudent to abandon efforts to increase the functional literacy of both children and adults. Among other reasons, because functional literacy is the basis of information and media literacy.

According to the definition of the United Nations Educational, Scientific and Cultural Organization (UNESCO, 1978) "*a person is functionally literate who can engage in all those activities in which literacy is required for effective functioning of his group and community and also for enabling him to continue to use reading, writing and calculation for his own and the community's development.*"

Functional literacy consists of several components (Dombrovska, 2004), which can be represented by the following diagram:
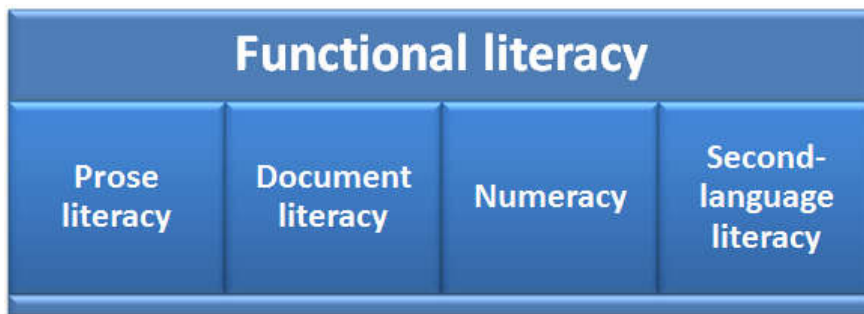

Fig. 1: Functional literacy consist of prose literacy, document literacy, numeracy and second-language literacy

More precise content and meaning of the individual components of functional literacy is given in the following list of characteristics:

- Prose literacy is the knowledge and skills needed to understand and use information in continuous texts, such as news and current affairs articles in newspapers and magazines.

- Document literacy includes the knowledge and skills needed to find and use information in different types of discontinuous or short, but richly structured documents, such as forms, transportation schedules, maps, instruction manuals, figures or charts.

- Numeracy is represented by the knowledge and skills necessary for carrying out operations with figures found in texts and documents, such as tables, graphs, bills or purchase orders in e-shops catalogs.

- Second-language literacy means the ability to communicate in a foreign language.

Functional literacy includes not only the ability to interpret, but also the ability to retrieve information from various resources and assess its quality and relevance, the ability to classify, categorize and store the information so that it is seamlessly available for later use, and last but not least the ability to clearly and convincingly present it to others.

Information literacy

Information literacy can again be simply illustrated by the following diagram:

Fig. 2: Information literacy consists of functional literacy and ICT

Information literacy can be characterized in detail by the following list of applicable knowledge, skills and abilities:

- the ability to identify a person's own information needs;

- the ability to obtain information and assess their relevance;

- the ability to store and again find the stored information;

- the ability to effectively and ethically use information;

- the ability to use information for the creation and sharing of knowledge;

- the skill to use ICT to work with information.

Information literacy cannot be reduced only to the skill of operating a computer. ICT literacy is only one of the components of information literacy. Among other things, this means that an information literate person is able to utilize the entire portfolio of information institutions and resources. Thus, not only can he/she use the Internet, but can also take advantage of libraries, media centers, archives, museums, as well as personal contacts, lectures, seminars, workshops or scientific meetings. Among the major information institutions and resources that an information literate person actively uses to his/her advantage are also (mass) media, both print (newspapers, magazines) and broadcast (radio and television). In such cases the information and media literacy blend together, which can be seen as two sides of the same coin.

Media literacy

Although information and media literacy are close to each other and overlap in many areas, they are not completely interchangeable. Media do not provide only hard data and factual information. As described in the functionalist theory of media (McQuail, 2009), media are one of the subsystems of the social system and perform several functions here:

- information, i.e. providing information about events, but also about the existing relations of power, facilitating adaptation and promoting innovation;

- correlation, i.e. explaining and commenting on the meaning of events, supporting established authority and social standards;

- continuity, i.e. supporting prevailing cultural patterns, but also finding new directions in the development of culture;

- entertainment, i.e. amusement, diversion and relaxation, reducing social tension;

- mobilization, i.e. lobbying for socially important goals, but also commercial promotion.

Complete media literacy is not just defense against harmful influences of media, but also the ability to use media actively to our own advantage, understanding the patterns of media and their part in a life of a person and society. A teacher who includes media education in his syllabus should strive to train his/her students to become an active and critical audience. Such an audience has the following characteristics:

- chooses what to monitor, and how much attention to devote to it;

- wants to meet its needs;

- acts deliberately;

- actively interprets offered messages;

- is resistant to tampering;

- is critical not only to individual communicated messages, but also to the media communication as a whole.

Currently a person does not have to be only a recipient of media content, but can himself create such content and through social media, such as blogs, Twitter, social networks, Wikipedia or YouTube can share it with others. If a teacher expands media education to include creative and production activities (class or school magazine or blog, school broadcasting, school YouTube channel), students will gain a better understanding of the patterns and operation of media because they will know them from the "inside".

The study of media and journalism

Department of ICT of the Pedagogical Faculty of the University of Ostrava offers a wide range of courses that are focused on the development of information and media competencies of students, and not only the students from the field of Information Technology in Education. Many of these courses are available to students of different fields, even from different faculties. The two main courses offered by ICT department are Basics of Media Communication and Basics of Journalism.

Students who complete the course Basics of Media Communication acquire skills for informed, active and critical work with media and their use in teaching. The individual sections of the course are focused on the process and models of communication in media and in education, history of media and media communication, media technology, functioning of

media organizations, influence and effects of media and their use in education. Students produce and present term papers which contain a detailed and critical analysis of the influence of media and the work of journalists and the possibilities of using media communication in education.

The students of this course present a specific concept of how to use articles or columns in newspapers and magazines or radio and television programs in the teaching of a selected subject. Among the concepts is a recurring use of television travelogues and historical programs in teaching geography and history, as well as language courses or a wide range of nature documentaries. The benefit of incorporating media into teaching is that students will realize that media do not have to serve as entertainment only, but also as self-education in an enjoyable way.

Students who pass the second main media course Basics of Journalism acquire skills for the production of news and current affairs articles and team work in creating school newspapers and magazines. Individual sections of the course focus on the relationship between journalism and society, the work of journalists, sources of journalistic information, selection of a subject and information retrieval, journalistic creation, editing and presentation. Students perform an information retrieval, write a news or current affairs article, and in a group, participate in the work of editors in creating a newspaper or magazine.

Cooperation in creating and editting a student newspaper, which is managed and organized by the students themselves, proved to be very positive. Students are highly motivated, perform extra tasks and have excellent results. In today's virtual world of electronic media and the Internet, a print form of the newspaper was chosen on purpose (including their own graphic design), which proved to be even more interesting and fun for the students. One of the graduates of the course is currently writing a thesis which aims to propose a methodology on how to incorporate creative and production activities of students into media education in primary schools.

Conclusion

Media education in primary and secondary schools is mostly taught as a cross-disciplinary topic. That is, various parts of media education are included differently into subjects like Czech or Civics. Students majoring in Information Technology in Education at the Department of ICT of the Pedagogical Faculty of the University of Ostrava acquire skills for teaching media education. The combination of information literacy and media education proved very effective. As it turns out, an information literate person also has a better understanding of media and can use them actively to his/her own advantage and vice versa. A person who is media literate can use media sources for acquiring, analysis and interpretation of information as well as his/her own self-education. A person's own creation is considered the hypothetical peak. Students who are developing their information and media competencies concurrently, are able to contribute to a scientific journal, as well as write a current affairs or popular science article for a school newspaper or other media. The goal of

the Department of ICT is for the pedagogy students, when they become teachers, to help their students develop the same broad scale of competencies.

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