

ICTE Journal

Volume 1

2012/1

International Journal of Information and
Communication Technologies in Education

editorial

WHY THIS NEW JOURNAL

Pavel Kapoun 3

articles

PILOT PROJECT OF M-LEARNING

Tomáš Zeman, Jaromír Hrad, Marek Nevosad 4

THE APPLICATION OF MULTIMEDIA AT THE LECTURE-EXPERIMENTAL TOURS
AT SECONDARY SCHOOLS

Oľga Holá 17

INQUIRY BASED LEARNING OF SELECTED COMPUTER SCIENCES CONCEPTS
AND PRINCIPLES

Ľubomír Šnajder, Ján Guniš 28

QUESTION OBJECTS – SOURCE OF ELECTRONIC QUESTIONS

Miroslav Hrubý 40

appendix

EDUCATIONAL ACTIVITIES AND CURRENT TRENDS IN SCIENCE AND
RESEARCH AT THE DEPARTMENT OF ICT (UNIVERSITY OF OSTRAVA)

Kateřina Kostolányová 50

ICTE Journal

International Journal of Information and Communication Technologies in Education

ISSN 1805-3726

Volume 1, 2012/1 (issued on 31 March 2012)

Editorial Board

Jana Kapounová (Chairperson), University of Ostrava, Czech Republic

Matilda Drozdová, University of Zilina, Slovakia

P. A. M. Kommers, University of Twente, Netherlands

David Leat, Newcastle University, United Kingdom

Mária Lucká, Trnava University in Trnava, Slovakia

Jiří Mareš, Charles University, Faculty of Medicine, Czech Republic

Eva Milková, University of Hradec Králové, Czech Republic

Tomáš Pitner, Masaryk University, Czech Republic

Maciej M. Sysło, Institute of Computer Science, University of Wrocław, Poland

Jana Šarmanová, VŠB-Technical University of Ostrava, Czech Republic

Milan Turčáni, Constantine the Philosopher University, Slovakia

Editorial Office

Kateřina Kostolányová (Editor-in Chief)

Pavel Kapoun (Executive Editor)

Lukáš Zoubek (Technical Support)

email: ictejournal@osu.cz

© 2012

University of Ostrava, Pedagogical Faculty

Department of Information and Communication Technologies

Fráni Šrámka 3, Ostrava-Mariánské Hory, Czech Republic

<http://periodika.osu.cz/ictejournal/>

Why this new journal

How to introduce the first issue of the new periodical named International Journal of Information and Communication Technologies in Education? You might be considering the same question we did while establishing this new journal: Why add another drop into today's information tsunami? It is because we believe that the field of ICT in education still has a number of current and discussable topics and questions that need their answers and inspiring ideas to be searched for and, most importantly, discovered.

The scope of this new journal is based on the seven following fields, which we believe are worth asking questions, discussing and finding answers to:

- 1) ICT integration in education;*
- 2) didactic principles of ICT supported instruction;*
- 3) learning applications, eLearning and examination with the use of ICT;*
- 4) computer based instruction in natural, technical and social sciences;*
- 5) virtual learning environment;*
- 6) educational technologies and new ways of their application;*
- 7) information and knowledge management.*

Whether the new journal is successful and of high quality will be decided not only by its professional profile, but mostly by the people who create it. Its editorial board, editors and reviewers come to mind, but first and foremost it is about the authors of quality articles. If our new journal peaks your interest with its professional orientation, you are very welcome to join the circle of its contributors. We are equally interested in the feedback from our readers. While positive reactions will please and encourage us, critical reactions will help us continuously improve the ICTE Journal.

*Pavel Kapoun
Executive Editor*



PILOT PROJECT OF M-LEARNING

Tomáš Zeman, Jaromír Hrad, Marek Nevosad

Department of Telecommunication Engineering, Faculty of Electrical Engineering
Czech Technical University in Prague, Technická 2, CZ-166 27 Praha 6, Czech Republic
{zeman,hrad,marek.nevosad}@fel.cvut.cz

Abstract

The article offers an insight into specific features of mobile e-learning (m-learning) in terms of technical implementation, available platforms and their related problems, and evaluates the practical experience. It also summarizes reasons for introduction of mobile learning and analyzes available options for its technical implementation. Specific example is used to demonstrate practical use of m-learning courses – learning of English language for a defined group of recipients within an international Leonardo da Vinci pilot project “M-Learning for the Young People (Students) at Risk Groups (MLARG)”. Substantial part of the text is dedicated to the analysis of typical functions available in an m-learning system and to the discussion about its advantages, disadvantages and limitations, mainly in relation to the properties and features of conventional e-learning environments. The expected development of m-learning technologies is outlined in the context of modern learning methods.

Keywords

communication technologies; education process; e-learning; m-learning; MLE-Moodle; online courses

Introduction

The contemporary world is characterized by new technologies emerging in the area of electronic communications (Vaněček, 2008). It is obvious that many (more or less successful) attempts to implement and use these technologies in education, especially in electronically supported distance learning (or e-learning) occur. The development focuses mainly on the user segment, i.e. mobile terminals for voice and data communication, and we can observe the convergence of two worlds that were originally very different – the world of computer technology and the world of telephony. The practical result of this process is that computers are becoming smaller and smaller (keeping or even increasing their performance), while the size of mobile terminals, resolution of their displays and their computational power are growing. Therefore it is logical that many scientists and teachers ponder the possibilities of such easily portable devices, especially in relation to the needs of e-learning.

Distance learning with the aid of mobile devices is referred to as m-learning. The definition of m-learning is straightforward: “Any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies” (O’Malley et al., 2005).

Suitable Content

When considering the introduction of m-learning, we should focus on the question whether the content to be provided is suitable for presentation on mobile devices.

Generally, it is advantageous if the “pocket” educational activities are not time-consuming and can be interrupted at any time without any complications. These activities include e.g. flashcards (for learning vocabulary), short tests or brief parts of explanations. On the other hand, this form is not recommended for demanding activities in terms of means needed for displaying the content, i.e. animations, complex tables, large images, or any content consuming substantial part of the transmission capacity, including those activities that require writing of long responses by the users (which usually takes much time and is not very comfortable with mobile devices).

Relevant Target Group

Structure of the target group should also be explored before the implementation. Every specific target group will use different hardware and different approach to learning with the help of modern technologies. We should take into consideration whether the users are willing to sacrifice the comfort of a large screen in favor of mobility. The willingness to use mobile devices can be characterized by the graph in Fig. 1. The first section (1) comprises those users who are fully capable of controlling the respective device (especially small children); they are followed (2) by older children who master the device itself, but for some reason they do not use data transmissions; the curve reaches its highest point for teenagers (3) and young adults (4). Midlife people (5) prefer comfortable displaying and control (of bigger devices) to the capabilities of mobile devices (perceived rather as a substitute in case of need). The last group (6) is formed by elderly people that may have substantial problems with small screen size and tiny control elements, and therefore they are likely to avoid such solution.

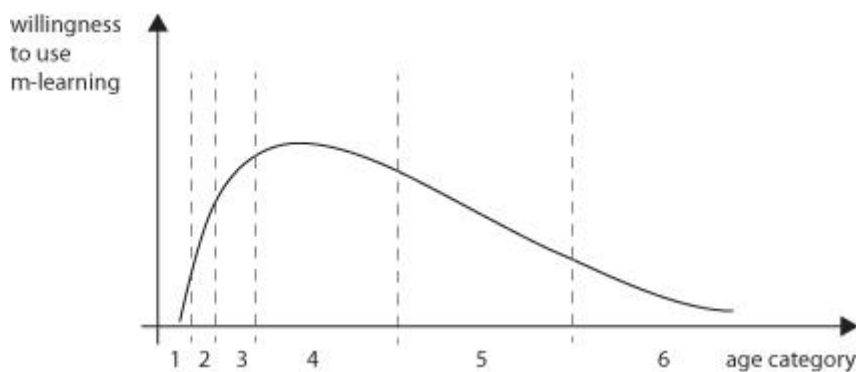


Fig 1. Attitudes changing with age

Education Objectives

Another important detail for implementation of a mobile learning system is the objective (i.e. what should be achieved) – the possibility of studying anytime and anywhere (with respect to the mobile device operation), or just a supplement to another type of education. Clarification of this objective is crucial for development of the learning content, as it must be optimized for the mobile terminal, which often brings on radical limitations that may be, after all, counterproductive in terms of efficient knowledge transfer.

Suitable Devices

The existence and availability of suitable terminal devices for the given target group is crucial for m-learning system implementation. Some parameters have to be based on a compromise. The elementary criteria include:

- large screen – offering comfortable reading and displaying of details;
- small dimensions – the device should be a “pocket” one;
- long operation on batteries;
- intuitive controls – e.g. touchscreens allow more precise navigation than a cursor controlled through keypad;
- data transmission – m-learning systems usually access the content stored on a remote server, using the client-server architecture. In such cases the satisfactory transmission capabilities of the terminal device are vital for proper function;
- appropriate software tools – hardware capabilities are just the first part, but software equipment is at least of the same importance (i.e. Internet browsers, multimedia players and their properties, etc.).

MLARG Project

Our department has been involved in the research and practical application of innovative pedagogical methods for many years, and therefore we eagerly accepted the offer to participate in a European lifelong learning / Leonardo da Vinci project “M-Learning for the Young People (Students) at Risk Groups (MLARG)” (<http://mlarg.boun.edu.tr>), coordinated by Bogazici University (Istanbul, Turkey), with partners in Italy, Slovakia and the Czech Republic. The aim of the project is to use mobile learning technologies to design language (English) teaching materials and methodology for young people (ages 16–17) with limited financial resources studying at vocational secondary schools. The main reasons for choosing mobile learning are the following:

- m-learning helps learners to develop positive attitudes towards literacy in both school subjects and technology;
- m-learning motivates learners to take part in activities in mobile medium of communication via multimedia tools, such as mediaBoard, portal page, and video clips;
- m-learning allows “personalized” learning “anywhere” at “anytime” for everyone with only a very basic equipment.

From the pedagogical and didactical viewpoint, the inclusion of mobile technologies is a new feature. Therefore it is necessary to design the technical implementation together with suitable procedures and methods that would make use of the specific properties of this solution; on the other hand, any procedures in which the use of mobile terminals would bring more difficulties than benefits (compared to traditional e-learning) should be limited or even eliminated.

Available Client Platforms

In principle, the application of m-learning can be based on either of the following technologies:

- Java application;
- Web browser.

Java application is a piece of software that is installed in a mobile terminal. The learning process uses an off-line approach and the method does not support full range of interactive elements. There is only limited communication with the server, and only the most important data is transmitted (usually in small batches), e.g. answers to test questions.

The principle of the “Web browser” approach is based on the traditional server-based solution. The complete learning system (specific type of learning management system (LMS)) is installed on a remote computer. Trainees access the services provided by the remote computer through a standard web browser installed in their mobile terminal device.

The latter (web browser) offers more advantageous, flexible and universal solution.

The advantage is that the look and/or content of the pages can be easily altered (on the server side) and there is no need to update the local software in the remote terminal (unlike the Java application). It should also be noted that the web pages work without limitations on different types of terminals (at present time, for example, it is relatively complicated to use Java applications on the iPhone platform, and different versions of Java introduce various unexpected problems as well).

The disadvantage is that the user interface may be slightly different for different types of browsers (similarly to non-mobile terminals). It may also be considered a specific disadvantage that this approach requires an on-line connection with higher volume of transmitted data (compared to the solution employing a Java application). Although caching in the memory of a mobile browser is possible, it is still necessary to transmit more data than the current operation requires. From the viewpoint of logic, the browsing through the learning content is entirely controlled by the server. For example, when the confirmation of a correct response in a test is transmitted towards the user, other content is always transmitted as well, e.g. change of a button pointing to the next question. In that case, the browser’s cache (in the mobile device) is used only for (e.g.) images or other related files (such as definitions of cascade styles).

Implementation

The selected technical implementation requires an LMS system installed on the server side, having the support for mobile devices already built-in, or employment of other learning system that allows such option to be added. For the purposes of the MLARG project we have chosen Moodle as the learning management system.

There were several reasons for this choice: we know the capabilities of Moodle LMS, its wide use, openness, favorable licensing conditions and the existing (and modifiable) support for displaying content on mobile terminals. The purpose was to preserve (to the largest possible extent) the option to study the learning content in the same GUI that is used on standard computers.

It is vital for the success of m-learning implementation to provide the users of the courses with a comfortable and friendly GUI. The original Moodle system is not suitable for devices with small displays. Therefore we have decided to use the MLE (Mobile Learning Engine) plug-in, which helps to optimize the learning content for presentation on mobile devices, organizing it into the format of relatively narrow columns.

As the recent version of MLE did not meet all requirements given by the nature of the considered courses with respect to the proper presentation of their content, we have started adequate modifications of the MLE source code, so that it becomes more compatible with the project objectives. In some details it was necessary to modify Moodle itself.

The implementation of the mobile solution is based on these key project objectives:

- a) motivation of students to learn through presentation of the learning content in an attractive form;
- b) the given topic, i.e. English language for professional schools in tourist industry.

Pilot Course

We have prepared an operable version of six exemplary courses. They are relatively short and their main purpose is to verify specific functions of MLE-Moodle as well as the m-learning methodology. The courses can be accessed at <http://mlarg.cvut.cz/mobile> (version optimized for mobile terminals) or <http://mlarg.cvut.cz/moodle> (PC-compatible version for reference purposes). The following topics of the courses are currently available:

- restaurant;
- tourist information office;
- check-In;
- at the travel agency;
- destinations;
- on the tour.

The target group involved in the pilot testing is composed of students at secondary schools specializing in tourist industry, and the particular objective is learning English language with the emphasis on specific situations and their corresponding vocabulary.

Implemented Functions

After logging in and entering the homepage of the courses, the system displays a screen containing the list of available courses and the upper navigation bar (see Fig. 2). The user interface and its functions are based on standard Moodle version, but some features are not available.

The overview of specific types of exercises can be seen in Fig. 3. The type “Listening for gist” consists of listening to an audio file, after which students pass a simple test (e.g. single-choice out of three options) verifying whether they have understood the meaning of the message. The “Listening for specific information” is a similar type of exercise, verifying whether the listeners also understand particular details of the message. In these tests students are usually given two attempts, and if both answers are wrong, then the correct response is eventually displayed.

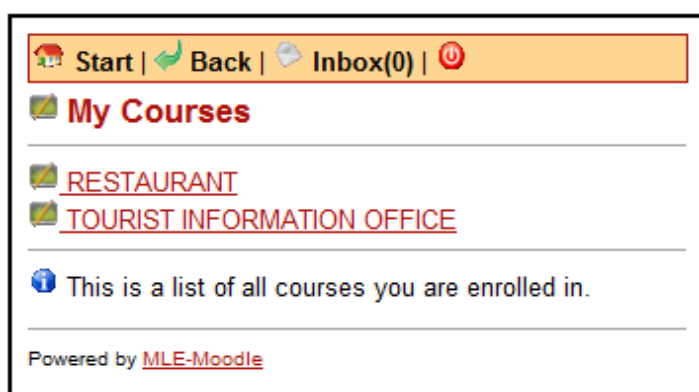
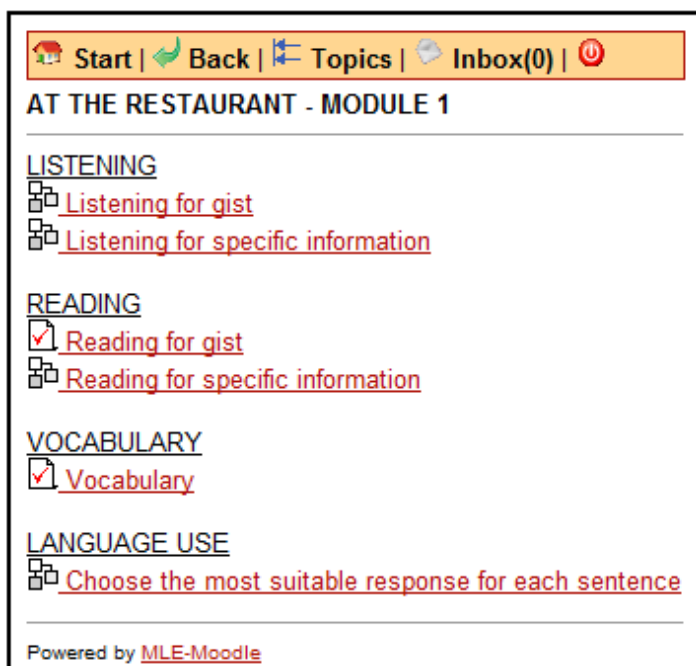


Fig 2. Initial page



Start | Back | Topics | Inbox(0) | [Power]

AT THE RESTAURANT - MODULE 1

LISTENING

- Listening for gist
- Listening for specific information

READING

- Reading for gist
- Reading for specific information

VOCABULARY

- Vocabulary

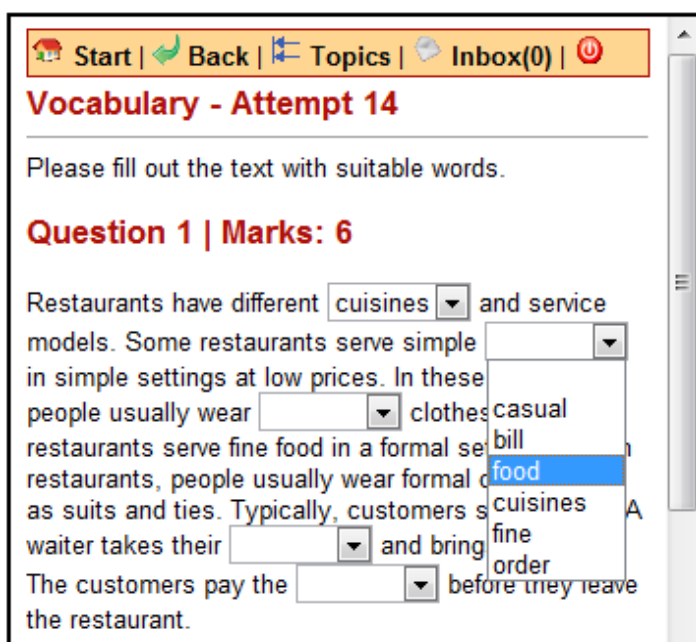
LANGUAGE USE

- Choose the most suitable response for each sentence

Powered by [MLE-Moodle](#)

Fig 3. List of exercises (various types)

The exercises of “Reading for gist” type are focused on the understanding of written texts. The question is in the textual form, and students are offered only one attempt to answer. “Reading for specific information”, similarly, focuses on searching for specific information in a text. Individual questions are displayed successively, and a wrong answer cannot be corrected. The total numbers of correct and wrong answers are summarized at the end.



Start | Back | Topics | Inbox(0) | [Power]

Vocabulary - Attempt 14

Please fill out the text with suitable words.

Question 1 | Marks: 6

Restaurants have different cuisines and service models. Some restaurants serve simple in simple settings at low prices. In these people usually wear casual clothes. In these restaurants serve fine food in a formal setting. In these restaurants, people usually wear formal clothes as suits and ties. Typically, customers usually order a waiter takes their fine order and bring the bill. The customers pay the bill before they leave the restaurant.

Fig 4. Specific type of exercise (“Vocabulary”)

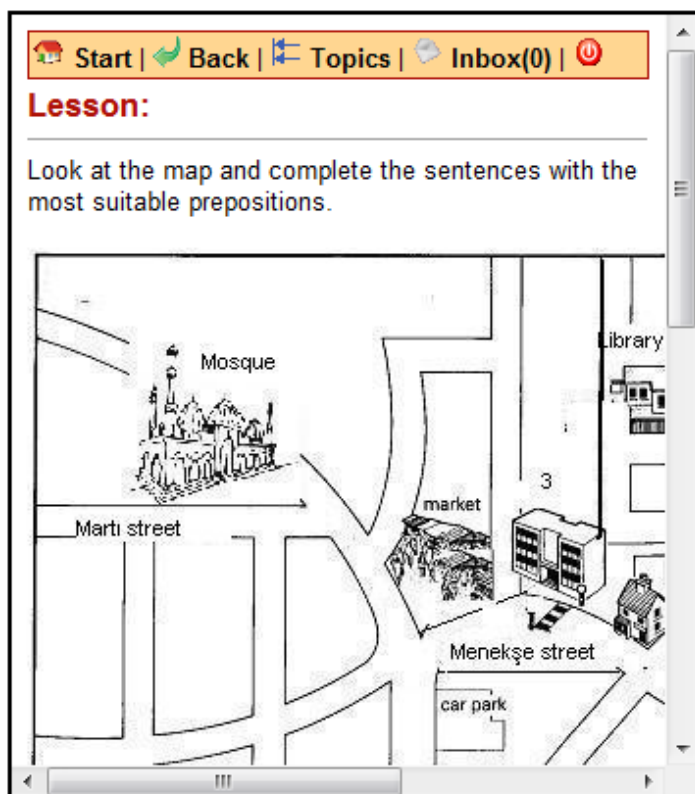


Fig 5. Displaying a large picture

The “Vocabulary” exercises (see Fig. 4) are, as we could expect, intended to practice the vocabulary. The individual tasks consist of sentence completing (choosing one option from a limited range of expressions) and of assigning corresponding words to pictures.

One of the major problems is the displaying and viewing of large images. As the display area is limited, there are basically two solutions coming into consideration:

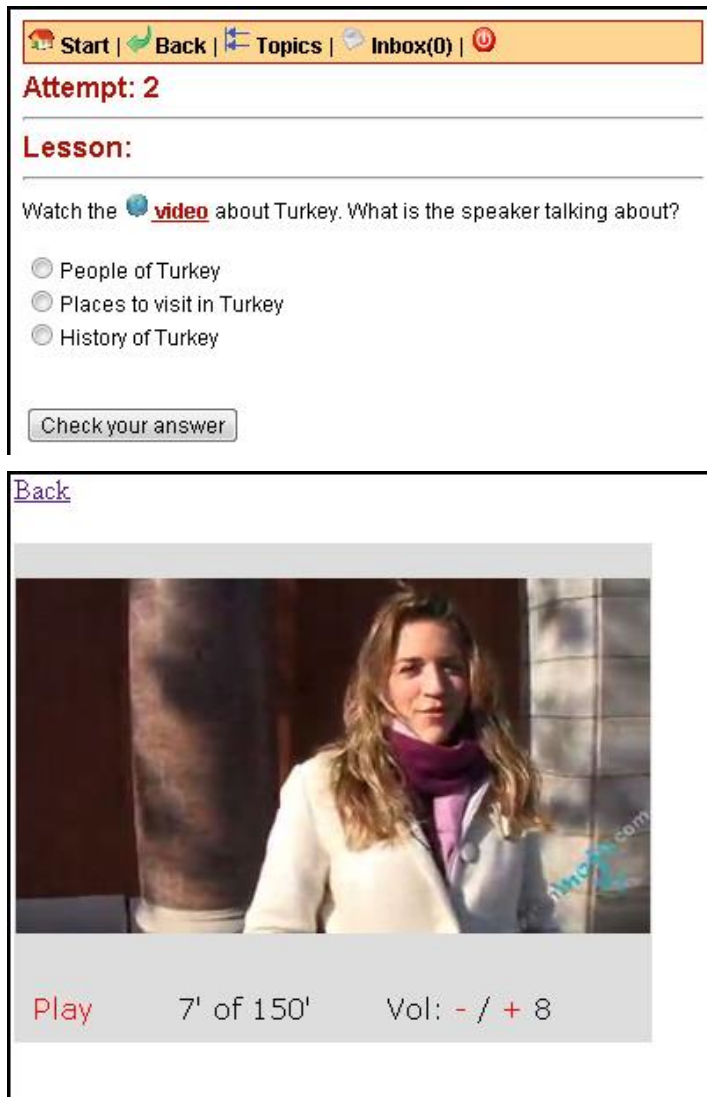
- Displaying of the entire image in a reduced size (which introduces the risk of poor readability due to its small dimensions), or
- Viewing by parts, changing the displayed area with the help of horizontal and vertical scrollbars (which might be difficult to get oriented in).

MLE-Moodle uses the latter option (scrollbars), as illustrated in Fig. 5. The picture is displayed in its original size, but users have to move over it. However, modern devices with multi-touch screens make resizing and moving very easy.

The last frequently used type of exercise is “Language use” – practicing understanding of the language. Different types of questions are available for testing. This type of exercise is included at the end of every module or lesson.

The developed learning content also includes videos (see Fig. 6). A specially prepared video server was implemented within the system. Video sequences are uploaded to the server and then automatically converted to a format suitable for mobile devices (we have chosen MPEG-4). With respect to the limitations of other supporting technologies (such as Adobe Flash) we have decided to use displaying through the HTML5 standard; however, this solution introduces a demand for an advanced web browser installed in a mobile terminal. Video can be played directly from the displayed web page, but in a mobile device a proprietary solution for video

playback is often implemented. When a request for video playback is indicated, the integrated playback method is used (e.g. pre-installed Real Player). In the same way we can encounter similar problems with the playback of external audio files. Also, incompatibility may occur between (usually user-installed) web browsers and integrated media players (for audio and/or video content).



The image shows two screenshots from a learning management system. The top screenshot displays a navigation bar with 'Start', 'Back', 'Topics', 'Inbox(0)', and a power icon. Below the bar, it indicates 'Attempt: 2' and 'Lesson:'. The main content area contains a question: 'Watch the [video](#) about Turkey. What is the speaker talking about?'. There are three radio button options: 'People of Turkey', 'Places to visit in Turkey', and 'History of Turkey'. A 'Check your answer' button is located at the bottom of the question area. The bottom screenshot shows a 'Back' link above a video player. The video player displays a woman speaking, with a 'Play' button, a progress indicator showing '7' of 150'', and volume controls set to 'Vol: - / + 8'.

Fig 6. Video playback

Two different types of learning activities were the most frequent ones in the course of MLARG learning content development – Lesson and Quiz. It was necessary to choose the type of activity also with respect to the required feedback.

Lessons were employed mainly for tasks with multiple attempts, with different feedback for each single attempt.

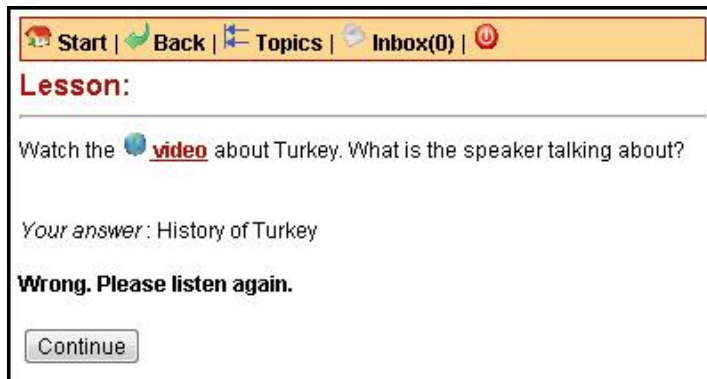


Fig 7. Feedback after the first attempt

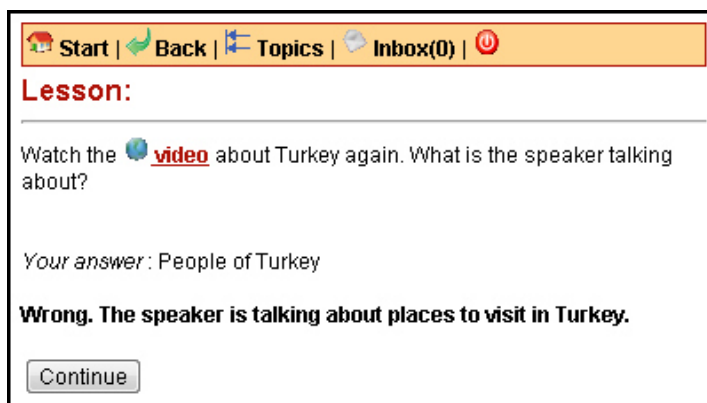


Fig 8. Feedback after the second attempt

If unified feedback was satisfactory – regardless of the number of attempts – we used the Quiz activity (see Fig. 9).

Start | Back | Topics | Inbox(0) | [Power]

Reading for gist - Attempt 60

Review of attempt 60

Started on:
Thursday, 22 December 2011, 05:57 PM

Completed on:
Thursday, 22 December 2011, 05:58 PM

Time taken:
43 secs

Please answer the questions and click on the submit button.

Question 1

Dining Style: Casual
Cuisine: Fish
Price: \$31 to \$50
Phone: (212) 847-3760
Hours of Operation: Lunch: Daily: 11:00am - 4:00pm, Brunch: Sunday: 10:30am - 2:00pm, Dinner: Nightly
Payment Options: MasterCard, Visa
Dress Code: Casual
Accepts Walk-Ins: Yes
Additional Details: Bar Dining, Full Bar, Non-Smoking Restaurant, Outdoor Dining, Weekend Brunch
Parking: Public Lot

Where do you think the information above is taken from?
Choose one answer.

a . a TV guide ❌

b . a web page ✅

c . a cookbook ❌

[Continue](#)

[Topics](#)

Fig 9. Unified feedback (Quiz)

Antalya (Wrong. The right answer is Mardin.) ❌ is an ancient Turkish city built of sandstone with many old buildings. The city is situated on a rocky hillside overlooking the Mediterranean Sea. It is famous for its historical architecture and is a popular tourist destination. The city has a rich history and is a great spot of interest. The weather is very hot and dry in the summer and cold and wet in the winter. Snowfall is quite common between the months of December and March, snowing for a week or two.

Correct Answer and Feedback [Close]

Correct answer: Mardin


Wrong. The right answer is Mardin.

Fig 10. Feedback in Cloze-type tasks as displayed in Moodle with implemented changes in the code


For a Cloze-type question (within a Quiz activity), traditional Moodle displays feedback using the technology for displaying an additional HTML element on a page, after moving the cursor to the user's response. This HTML technology is usually not supported by mobile web browsers. The solution was found through the modification of the MLE extension and of

Moodle itself; the feedback is displayed as an additional text following the user's response (see Fig. 10 and 11).

Antalya



Safranbolu



Antalya (Wrong. The right answer is Mardin.) ❌ is an ancient Turkish city built of sandstone with some interesting old buildings. The city is situated on a rocky mountain overlooking the plains of northern Syria and it is famous for its Arabic architecture. It has a lot of historical, cultural and architectural richness. A tourist can find many spots of interest. The weather is very hot and dry in the summer and cold and wet in the winter. Snowfall is quite common between the months of December and March, snowing for a week or two.

Incorrect

Marks for this submission: 0/1.

[Previous question](#)

[Next question](#)

[Continue](#)

[Topics](#)

Fig 11. Feedback in Cloze-type tasks as displayed on a mobile device

Platform-related Issues

As for the communication between students (and their teachers), usual tools common for Moodle system (chat, discussion forums, and direct messages) are available.

We have encountered some problems related with the presentation of multimedia content, caused by the wide variety of operating systems used in mobile terminals and by a different level of (different) web browsers integration.

For example, Android 2.2 operating system (Samsung Galaxy i9000 S) cannot play MP3 content delivered from Moodle server directly – the file must be first saved to the memory of the phone, and then opened by the associated application. On the contrary, in Symbian OS version 9.3 (Nokia E72) or 9.2 (Nokia E66) a link to such file works correctly – but only in the integrated web browser; the attempt to use Opera Mobile 10.1 (for Nokia E72) for direct opening of multimedia files was unsuccessful and, moreover, direct link to the MP3 file did not

help in this case. Windows Mobile 6.5 (HTC TouchPro 2) with Opera Mobile 9.7 browser did not have any problems and the link was working properly.

In Android operating system, the described problem is caused by passing the file to the web browser. The workaround in this case is to use a direct link to the MP3 file, outside the course (then it is interpreted correctly), or to set file downloading in Moodle so that the browser is sent data content respecting the specific features of these browsers and devices.

The initial page allows users to download Java MLE application. However, we consider this option to be just an alternative, as identical operation on different types of mobile terminals cannot be guaranteed. Moreover, the Java application also has occasional problems with access to multimedia content.

Feedback Evaluation

During the first phase of the pilot testing we have obtained a valuable feedback that may help us to make system improvements. Let's quote some most interesting comments.

“Around 15-20 minutes of instruction were sufficient to learn the system basics.”

“Studying the same content with a desktop computer would be more efficient.”

“There is no big difference studying on desktop or mobile phone.”

“Working on a small screen (4 inch) is a problem.”

“Devices like iPad (10 inch) would be much more effective.”

“My finger is so thick that I cannot easily activate the right button.”

“With an incorrect touch, I find myself out of the system.”

“My eyes get tired”, “Intensity of the screen light is dim.”

“A word puzzle may be helpful to teach vocabulary.”

From these responses we can see that users generally tend to compare m-learning with their experience from conventional platforms. Logically, they consider personal computer to be more comfortable in terms of ergonomics – specifically, displaying and control capabilities; nevertheless, some of them realize the advantages of mobility and welcome modern types of devices, such as tablets that offer larger screen with higher resolution than ordinary mobile phones or smartphones.

On the other hand, most of the users were satisfied and there were no explicit complaints about content quality or suitability, access to the server, or any difficulties concerning the usability of mobile learning platform. In other words, the system appears to be intuitive and well usable for the tested target group, and therefore it is reasonable to assume that other groups of users would have no substantial problems as well.

Conclusion

The completed pilot run of the courses should give the answer to the basic question: Is m-learning a suitable complement of the electronic form of education, or is it just a modish matter to be overcome and then abandoned? (Vaněček, 2006) Therefore the feedback obtained from the course participants and their willingness to use the individual learning objects on a regular basis (if any, to what extent) is crucial for the future employment of this technology in regular education.

We can envisage that the m-learning technologies will become useful mainly in those fields where the learning content can be presented in a visually simplified form (with the emphasis on reduced volume of textual information). Typical examples of applications include various drill learning methods (vocabulary, phrases, filling of correct words into sentences, applications supported by instructions spoken from a mobile device, single-choice from several options, etc.). On the other hand, we expect lower interest in m-learning applications that require reading of many texts, filling of numerous forms or frequent movements on the screen of a mobile terminal device, such as solving complicated tasks, assignments requiring schemes, diagrams, graphs or videos, tasks for which users need to compile context-based information from different sources, etc.

Acknowledgements

This article has originated thanks to the grant support obtained from the EC within Leonardo da Vinci project No. 2009-TR1-LEO05-08674 – M-Learning for the Young People (Students) at Risk Groups (MLARG).

References

Mobile learning at risk groups. [online]. [Accessed 2011-10-21]. Available at: <http://mlarg.boun.edu.tr>.

O'MALLEY, C., G. VAVOULA, J. P. GLEW et al. *MOBIlearn Project Report: Guidelines for Learning/Teaching/Tutoring in a Mobile Environment* [online]. United Kingdom, 2005 [Accessed 2011-10-21]. Available at: http://www.mobilearn.org/download/results/public_deliverables/MOBIlearn_D4.1_Final.pdf.

VANĚČEK, D. *Informační a komunikační technologie ve vzdělávání*. Praha: ČVUT, 2008. ISBN 978-80-01-04087-4.

VANĚČEK, D. *Progressive Education Methods. New trends in engineering pedagogy*. Praha: ČVUT, 2006. Workshop of the International Society of Engineering Education IGIP. ISBN 80-01-03459-3.



THE APPLICATION OF MULTIMEDIA AT THE LECTURE- EXPERIMENTAL TOURS AT SECONDARY SCHOOLS

Ol'ga Holá, Faculty of Chemical and Food Technology of Slovak University of Technology, Bratislava,
Slovak Republik, olga.hola@stuba.sk

Abstract

The lecture-experimental tours at secondary schools of Slovakia have been realized within the scope of the APVV (The Slovak Research and Development Agency) project solving: “Physics and Chemistry in our Life Today and Tomorrow”. These lectures consist of lectures supported by power-point presentations, illustrative demos of lectured problems, as well as simple experiments. In the lecture part various information and communication means are used – e.g. the Internet connection, various CDs, DVDs and our own video film library. In our paper we inform of these courses and of their objectives and responses.

Keywords

lecture-experimental tours, multimedia, video film library, power-point presentations, demonstrations

Introduction

Many teachers as well as scientists all over the world are looking for new forms of education or popularisation of the natural sciences. Many conferences are devoted to research in the didactics of sciences (Ciešla, et al., 2006), (Nodzyńska, et al., 2010), (Zelenický, et. al., 2010). In many contributions (Lamanauskas, et al., 2007), (Krupa, et.al., 2008), (Krupa, et.al., 2009), (Krupa, et.al., 2010), (Science, 2007), new teaching methods that can increase students' engagement in the learning process are presented. There are also many forms of popularisation of the natural sciences presented e.g. at conferences (Šípoš, et.al., 2010), (Dobis, et.al., 2007).

In the last decades the great changes have arisen in the teaching-learning methods in connection with a penetration of science and new technologies into our lives, our households. Personal computers found their way in and their use ranges from elementary schools to universities. The young generation inclines to working with new information technologies and therefore the computer-based education and the implementation of the multimedia tools into the educational process usually results in a positive response from students.

We search for the new forms of education of young generation in the field of natural and technical sciences as well. We try to overcome the distaste and sometimes an unconquerable aversion to physics and on the contrary to arouse the interest of youth in the world of nature around us, by means of application of the idea “science through play”. One of the ways to achieve these goals is the realisation of lecture-experimental tours at secondary schools with various presented themes. These lectures consist of power-point presentations, virtual as well as real demonstrations, video clips but also video films concerning the theme of lecture. Simple experiments are an inseparable part of these lectures.

Simultaneously with the popularisation of well known natural phenomena we are also trying to transfer new scientific and technical knowledge.

Methods

Preliminary phase of tours

We are living in the epoch of modern technologies and it leads naturally to the penetration of information and communication technologies into our lives. This fact intensively influences the quality of life. Young generation has been acquiring a majority of the new scientific, technical as well as medical knowledge by means of audio and video records through TV. Therefore, video as a part of our lives can be the appropriate didactic tool for teaching various subjects at all levels of education. Such videos can be motivational; they can awake the interest of young generation in understanding phenomena that surround them.

The beginning of multimedia usage in physics lectures at our faculty (FCHFT) dates back to 2002 and this opportunity came with the Internet connection. It opened new possibilities to use the Internet directly to show those physical animations and video-clips that could not be freely downloaded.

At FCHFT we have used miscellaneous multimedia tools in physics lectures. We have used the possibility of presentation with self-made figures, scanned images, photographs or measured data in graphs from various sources. The application of short animations or applets seems to be very useful. Applets are such animations that allow the modification of input data according to our needs. Let us mention some of the applets screened at our lectures e.g. applets of projectile motion, applets of a simple hydraulic lift or applets demonstrating the equation of continuity. Elastic and inelastic collisions (Fig. 1) or free fall have counted among the most interesting ones.

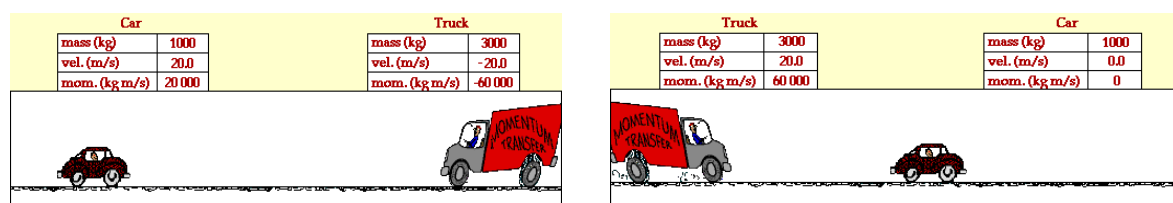


Fig 1. Applet of the elastic and inelastic collisions

In our lectures we have used some animations from various multimedia CDs, for example the “Animated Physics” CD (Neubauer, 2001), which we used mainly to demonstrate electric and magnetic forces.

Video clips provide an illustrative approach to the investigated physical phenomena for students. We have picked out many available video clips originating from various physical web sites that were usable at our tour lectures. But some years ago we began to prepare our own video clips at our Department of Chemical Physics of FCHFT (Holá, 2006a). These video clips record various real life situations as well as laboratory experiments. We also created a few instructive video clips that were dedicated to measurement methods, and video clips recording unique workplaces. Finally, we combined video clips of these everyday life activities with corresponding ones prepared experimentally in our laboratory. It was the first step in implementing the idea of making our own **video films** (Fig. 2). The common leitmotiv of our video films is “Video films from the world of Physics or Physics in the world around us” (Holá, 2006b). We still continue the filmmaking, and new video films are being prepared. In Table 1

we provide the list of our video films from the field of Physics and Chemistry and Table 2 contain videos from the field of Ionizing radiation and Radiation protection. These short video films have a Slovak voiceover providing professional comment.



Fig 2. Shot from the video film “Projectile motion”

Table 1. Video film library of Physics and Chemistry

Physics and Chemistry (P+CH)
1. Projectile Motion
2. Inertia Forces
3. Equation of Motion
4. Electrostatic Field
5. Magnetism
6. Our Sun
7. Games with Fluid
8. Reflection and Interference
9. Optical Lattice
10. Chemical Reactions Known, Unknown?

Table 2. Video film library of Ionizing radiation and Radiation protection

Ionizing radiation (IR)
1. Radioactivity
2. Irradiator
3. X-rays and Diffraction Device
4. Application of X-rays in Medicine
5. Modern Techniques in Radiology and Nuclear Medicine
6. Nuclear Medicine – Open Radiation Sources in Diagnostics and Therapy

7. Ionizing Radiation and Radiation Protection
8. Days of Radiation Protection

We have also used the **Coach** environment, which enabled us to perform rather expert scientific video analyses (Fig. 3), providing tools for measurement of positions of several data points in different frames of the clip. We have used scientific video analyses predominantly to demonstrate various situations of everyday life. It is very useful and entertaining to observe the video with the points of interest marked and traced during the whole trajectory. In addition, while the clip is being played, the graphs of the measured dependence are displayed along with their derivative or integral. Hence at the same time we can observe, for example, the increase of the distance in the uniformly accelerated motion and simultaneously the course of the dependence of the speed on time and calculation of the acceleration. A great advantage is the possibility of pausing the video, multiple replaying, speeding up or slowing down the video-clip of the observed processes.



Fig 3. Video clips analyzed by Coach

We demonstrate e.g. the uniformly accelerated linear motion as well as uniformly decelerated linear motion. The video of a bicycle at first speeding up and then slowing down allows calculating the average acceleration using the quadratic curve fit for position data or using the linear curve fit for velocity data. The video clip of the counter-motion of two cars – one of them moving with constant motion, the second one with accelerated motion – enables us to compare the distances, to calculate the time and distance of their encounter. The uniform circular motion was analysed by the video clip of the motion of wall-clock hands (Fig. 4). The angular velocity is calculated and immediately displayed from the recorded dependence of the angle on time.

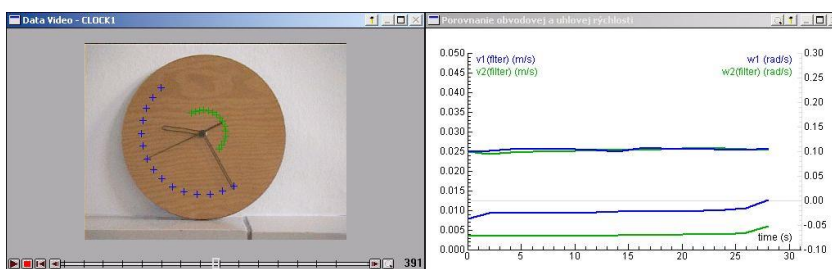


Fig 4. The motion of wall-clock hands - scientific video analysis by Coach

The free fall of a volley-ball, the projectile motion illustrated by a basketball shot – they are the next examples of video clips analysed by Coach. Fall in a resistance medium was demonstrated by the fall of a paper cupcake in air.

The abovementioned video-analysis activities can be used at secondary schools mainly for demonstration and revision purposes.

Our experiences with the application of various multimedia tools in university lectures helped us with the multi-purpose use of similar methods in our lecture-experimental tours at secondary schools.

The next interesting form of transfer of information is “science through play”, where students can play “researchers” either by demo experiments or by interactive tests. Therefore, besides the use of modern multimedia, it is also necessary to work with simple demonstration tools. During such popularising activities it is very important to give students the possibility to carry out the laboratory experiments by themselves.

Moreover, simple “Physics toys” are convenient instruments for raising the interest of youth; students become curious as they cannot guess how they work. These physics toys usually circulate among students during our presentation.

Therefore, in the preliminary phase of our tours, we concentrate on the choice of suitable multimedia tools, physics toys, on the preparation of new teaching aids and creation of interesting physical and chemical interactive experiments.

The lecture-experimental tours

The main planned activity of the abovementioned project is the realisation of the lecture-experimental tours at secondary schools. We have sent letters to some secondary schools, in which we offered our lecture-experimental activities from the field of Physics and Chemistry. Until now we have prepared 10 themes and 6 more themes are being developed. The following text is a list of 10 presented themes with the brief content of each and remark as to which ICT can be applied. These topics have two parts – the first one is usually undemanding and the second one is more sophisticated. According to the requests of schools, the content can adapted to changing conditions.

1. *Movement and cause of movement*

2 lectures “What is movement and where does it originate?” and “Inertia forces”.

ICT multimedia tools used:

- video films “Projectile Motion”, “Inertia Forces”, “Equation of Motion”;
- Internet video clips;
- DVD “Animated Physics”;
- Coach laboratory system.

2. *Liquids at rest and in movement*

2 lectures “Applications of Pascal’s law and Archimedean principle”, “Bernoulli's relation in our lives”

ICT multimedia tools used:

- video films “Games with Fluids”, “Bernoulli’s Principle”;
- internet video clips;
- DVD “Animated Physics”;
- Internet applets.

3. **Light**

2 lectures “Sun and other natural and artificial light sources”, “Origin of light and its characteristic behaviour and characteristics”

ICT multimedia tools used:

- video films “Our Sun”, “Reflection and Interference”, “Optical Lattice”;
- Internet video clips;
- optical illusions;
- Internet applets.

4. **Magnetism in nature and use of strong magnets**

2 lectures “Magnetism and magnetic materials”, “Use of strong magnets – MRI, cyclotrons, synchrotrons”

ICT multimedia tools used:

- video films “Magnetism”, “Modern Techniques in Radiology and Nuclear Medicine”;
- video clip “Proton Synchrotron in Ružomberok”;
- internet video clips.

5. **Magnetism and chemistry**

2 lectures “Origin of magnetism”, “Nuclear magnetic resonance and Electron spin resonance techniques in research and medicine”

ICT multimedia tools used:

- video films “Magnetism”;
- Internet video clips.

6. **Radioactivity - bugbear of mankind or our fellow**

lecture “Radioactivity around us”

ICT multimedia tools used:

- video films “Radioactivity”, “Irradiator”, “Ionizing Radiation and Radiation Protection”;
- Internet video clips.

7. **X-rays and their usage**

2 lectures “Generation of X-rays”, “Usage of X-rays in science and medicine”

ICT multimedia tools used:

- video films “X-rays and Diffraction Device”, “Application of X-rays in Medicine”;
- Internet applets.

8. **Modern physics and chemistry in medicine**

2 lectures: “Do you know principles of CT, MRI, ultrasonography, PET?”, “Nuclear medicine. What is radiopharmaceutical?”

ICT multimedia tools used:

- video films “Modern Techniques in Radiology and Nuclear Medicine”, “Nuclear Medicine – Open Radiation Sources in Diagnostics and Therapy”.

9. **Chemical reactions known and unknown**

lecture “What is a chemical reaction?”

ICT multimedia tools used:

- video film “Chemical Reactions Known, Unknown?”;
- Coach laboratory system.

10. Insulation methods of aromatic matters

lecture “Insulation techniques of natural matters”

ICT multimedia tools used:

- video film “Chemical Reactions Known, Unknown?”;
- Coach laboratory system.

Results

According to the responses to our letters we set the targets of our tours. Up to the present we have realised about 28 lectures with physics themes and 13 lectures with chemical topics at secondary schools from all parts of Slovakia; from Bratislava to Košice. Our lecture-experimental tours took place in several schools in Bratislava, twice in the Natural Sciences Museum (Fig. 5) in Bratislava in 6 secondary schools, in secondary schools in Púchov (Fig. 6), Prievidza (Fig. 7), Košice (Fig. 8), Krompachy, Komárno, and Slovenská Ľupča. All the mentioned topics have been presented at these lecture-experimental tours (in compliance with the requests of schools), the greatest interest was in the following themes: “Radioactivity – bugbear of mankind or our fellow”, “Magnetism in nature and use of strong magnets” and “Liquids at rest and in movement”.



Fig 5. Topic “Magnetism”



Fig 6. Topic “Modern physics and chemistry in medicine”

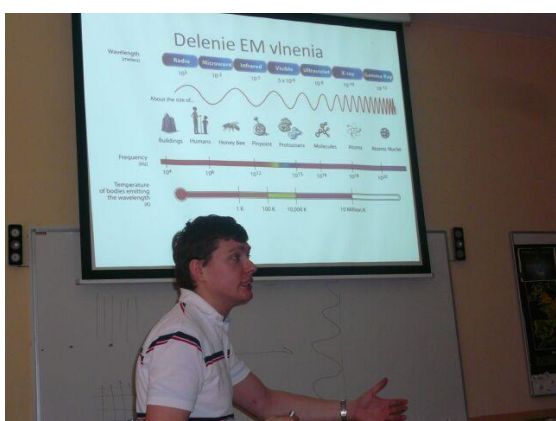


Fig 7. Topic “Light”



Fig 8. Topic “Liquids”



Fig 9. Experiments in chemical reactions



Fig 10. Experiments in magnetism



Fig 11. Dosimetry in radioactivity



Fig 12. Experiments with liquids

Every presentation consisted of a lecture with power-point presentations, of illustrative demos, as well as of simple experiments (Fig. 9, 10, 11, 12). Students tried some of these experiments in practice by themselves; other demonstrations were shown by the lecturer.

At the beginning of each lecture, students received a written form with questions concerning the topic and in the end of the lecture their answers were evaluated.

In the following Table 3, some question examples are listed:

Table 3. Examples of quiz questions

<p>Subject <i>Liquids at rest and in movement</i></p> <ol style="list-style-type: none"> 1. What is the hydrostatic paradox? 2. Why is it that heavy cargo and container ships do not sink? 3. Why is swimming easier in the sea than in the pool? 4. What is the hydrodynamic paradox? 5. On what does the velocity of flow depend?
<p>Subject <i>Light</i></p> <ol style="list-style-type: none"> 1. What is light? 2. Which natural light sources do you know?

<ol style="list-style-type: none"> 3. Which artificial light sources do you know? 4. What kind of phenomenon is applied in optical cables? 5. What is the cause of rainbow?
<p>Subject <i>Radioactivity – bugbear of mankind or our fellow</i></p> <ol style="list-style-type: none"> 1. What is the classification of ionizing radiation? 2. Of what do the atom and nucleus consist? 3. Give a definition of the radioactivity and its unit. 4. Which sources of irradiation are most important for human beings? 5. Specify three basic principles of radiation protection.
<p>Subject <i>Chemical reactions known and unknown</i></p> <ol style="list-style-type: none"> 1. What is a chemical reaction? 2. Why do candles in a vessel filled with acetic acid go out when sodium bicarbonate is added? 3. Specify at least two modifications of carbon. 4. In the “Blue Tube” experiment the solution after mixing is blue coloured again. Explain why. 5. Write down at least two applications of hydrogen peroxide.

In the Fig. 13 and 14 we can see students focused to solve the given questions. The preliminary evaluation of the success rate is about 70 %. We consider this result to be very good, because many students heard the information about various phenomena for the first time during our presentation, and in addition to this fact, many students had a negative attitude to subjects of physics and chemistry (presentation is usually performed not only for the students interested in natural sciences, but for all classes).

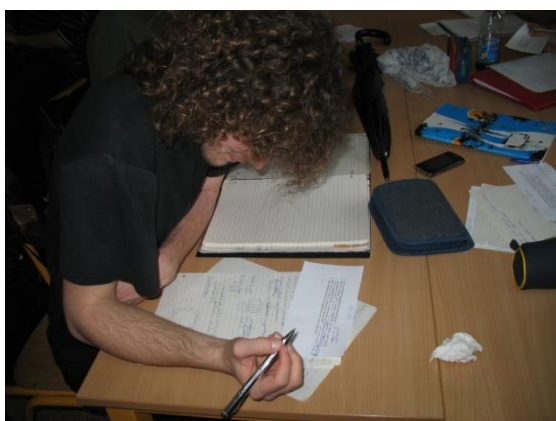


Fig 13. Problem solving



Fig 14. Students are focused

Some students who successfully answered this quiz were symbolically rewarded (Fig. 15, 16). With this form we caught student’s attention as well as gained feedback on their understanding of the matter.



Fig 15. Students were rewarded for their efforts



Fig 16. Symbolic rewards

Discussion

What were the goals we wanted to achieve by using various multimedia didactic tools in teaching-learning process in physics and chemistry? Generally we can say that the function of personal computers is to facilitate the treatment of experimental data and solving of physics problems. But personal computers also allow us to create and use various multimedia didactic tools, e.g. animations, applets, video clips, video films and Internet websites directly in the teaching-learning process. Such an approach corresponds with our idea and concept of modern education.

We can summarise the advantages of using the abovementioned multimedia tools in our lecture-experimental tours: an improvement of the teacher-student interaction, an awareness of the physics basis of everyday phenomena in our lives, an increased attention, activity and motivation to learning, a stimulation of the imagination and the question asking and problem solving. Moreover the use of multimedia enables us to update information and to look for new virtual experiments.

On the other hand disadvantages exist as well, e.g. intense preparation demands, time consumption and demands on technical equipment.

Conclusion

Our objectives are: to enhance students' awareness and ability to recognise natural sciences interconnections. Moreover we want to stimulate their imagination and to offer a different, more attractive approach to learning.

Our presentations are suitable as a form of revision of the curriculum, while providing new aspects on the topic and information on the research in the given field. In all the schools where we lectured, our presentations were accepted very well by students and by teachers. We can say that the atmosphere at our presentations was very congenial and therefore we want to continue in these activities.

Acknowledgements

This work was supported by the Slovak Research and Development Agency under the contract No. LPP-0230-09.

References

- CIEŚLA, P. Research in Didactics of Chemistry. In: *Proceedings of the II. International Conference*. Kraków, 2006. ISBN 83-85886-12-5.
- DOBIS, P. and J. BRÜSTLOVÁ. New Trends in Physics. In: *4th International Conference on Physics Teaching in Engineering Education*. Brno: University of Technology, 2007. ISBN 978-80-7355-078-3.
- DOBIS, P. and J. BRÜSTLOVÁ. New Trends in Physics. In: *New Trends in Physics*. Brno: University of Technology, 2007. ISBN 978-80-7355-078-3.
- European Science Teachers Initiative. *Project report* [online]. 2004 [Accessed 2011-11-11]. Available at: <http://www.eurovolvox.org/Private/Workplan/PDF/ESTICPF30Jun04.pdf>
- HOLÁ, O. Video film creation from the world of physics. In.: *Proceedings of the 15 Conference of Slovak Physicists*, Stará Lesná, 2006. ISBN 978-80-969124-4-5.
- HOLÁ, O. and K. HOLÁ. Video filmmaking – as a multimedia didactic tool of education. In: *Proceedings of the II. International Conference*. Kraków, 2006. ISBN 83-85886-12-5.
- KRUPA, D. and M. KIREŠ. Tvorivý učiteľ fyziky II. In: *Proceedings of the National festival of Physics*, Košice, 2009. ISBN 978-80-969124-8-3.
- KRUPA, D. and M. KIREŠ. Tvorivý učiteľ fyziky III. In: *Proceedings of the National festival of Physics*. Košice, 2010. ISBN 978-80-969124-9-0.
- KRUPA, D. and M. KIREŠ. Tvorivý učiteľ fyziky. In: *Proceedings of seminar*, Košice, 2008. ISBN 978-80-969124-6-9.
- LAMANAUSKAS, V. Science Education in a Changing Society. In: *International scientific collection*, Lithuania, 2007. ISSN 1822-7864.
- NEUBAUER, J. *Animovaná fyzika* [CD-ROM], 2001.
- NODZYŃSKA, M. and J. R. PAŠKO. Research in Didactics of the Sciences, In: *Proceedings of the conference*. Kraków, 2010. ISBN 978-83-7271-636-1.
- SCIENCE teaching festival, Science on Stage 2, Grenoble, France. EIROforum ESTI. Book of Project Summaries and National Reports.
- ŠÍPOŠ, J. and L. MAJERNÍKOVÁ. Vzdelávanie k vede a technike na stredných školách. In: *Proceedings of the conference Quo vadis*. Bratislava, 2010. ISBN 978-80-970496-4-5.
- ZELENICKÝ, L. Aktuálne problémy fyzikálneho vzdelávania v európskom priestore. In: *Proceedings of the conference Didfyz 2010*. Nitra, 2010. ISBN 978-80-8094-795-8.



INQUIRY BASED LEARNING OF SELECTED COMPUTER SCIENCES CONCEPTS AND PRINCIPLES

Eubomír Šnajder, Institute of Computer Science, Faculty of Science, Pavol Jozef Šafárik University in Košice, Jesenná 5, 040 01 Košice, lubomir.snajder@upjs.sk

Ján Guniš, Institute of Computer Science, Faculty of Science, Pavol Jozef Šafárik University in Košice, Jesenná 5, 040 01 Košice, jan.gunis@upjs.sk

Abstract

In the article we describe the proposal of two unplugged activities verified in practice together with methodological commentaries on how to use them in computer science education. The first activity is oriented on discovering and understanding the basic principles and rules of computer communication carried out by pupils themselves. We encourage pupils to simulate communication in a computer network and solve raised problems. The aim is to lead pupils to discover the encoded message within transmitted information (the structure of TCP/IP packet) and to realize the significance and importance of communication protocols. The second activity is oriented on discovering and devising the principles of information encoding; the code length dependence on the quantity of states, unambiguous encoding, the use of n -ary trees in encoding, etc.

Keywords

teaching computer science, conceptual subject matter, problem solving, experiential activities, constructionism, inquiry based learning

Introduction

The current school reform in Slovakia that launched in 2008 brought many changes to computer science teaching. Time subsidy of computer science education on the second level of elementary schools and at grammar schools has increased. Teaching the new syllabus of computer science education was introduced from the second grade of elementary schools. Not only has the school reform brought greater flexibility of choice of the teaching content to schools and to teachers; it also emphasises the use of modern teaching approaches that seek to fulfil the specific objectives of teaching computer science, and it has identified the core competencies of pupils. Schools are able to define themselves properly within the region and the teacher has greater freedom for self-realisation. From the perspective of pupil learning, the reform promises to move away from memorising towards the active involvement of pupils in the learning process.

The State Education Programme contains a framework of graduate profile, a general curriculum for each school level and a general curriculum for each school grade. Schools have created their own terms and specifics of school educational programmes based on the State Education Programme. Their implementation in practice requires adequate human and material resources (professionally and methodically skilful teachers, current textbooks, methodology and access to digital technologies). Schools and their teachers are able to acquire didactic equipment, to create their own methodology for teaching, to supplement and/or extend their education and to

get thematic and methodological materials through various EU projects (ESF, MVP, DVU_i).

From the viewpoint of computer science education we consider it very important to educate pre-service and in-service computer science teachers in terms of modern concepts of learning (constructivism, constructionism, connectivism). Our goal is that the teacher is able to creatively use the gained knowledge in their own teaching.

In this paper we present two well-tested activities in which we want to introduce a concept of teaching computer science where pupils actively discover the principles and procedures of computer science, similar to activities described in (<http://csunplugged.org>). The pupils engage their higher cognitive functions (analysis, evaluation, creativity) in learning; they are curious, thoughtful, and critical. Teachers can help to create a pleasant atmosphere of creativity (commissioning problems packed into tricks, magic, puzzles, simulations, case studies), they support the process of discovering knowledge mainly through dialogue with pupils (Socratic, heuristic, controlled) and also through their own example – when they show their thinking, their openness to the pupils' reasoning development, when they show how they correct and adapt their problem solving, etc. (Šnajder, 2009, 2010 and 2011). According to (Bell, 2008) the following two activities fall into structured inquiry and guided inquiry levels.

Activity 1: Data transmission network, IP packet

This activity is a free sequel to the activity *Data transfer in network – simulation by paperwork communication* (Šnajder, 2011) we carried out with 9 years old pupils. Its aim was to make pupils discover the basic rules of data transmission network. This next activity is more in depth and brings more of the real network communication. Pupils' activity is aimed at discovering and devising the IP packet structure and rules of communication in the Internet network.

Problem: What form and requisites should a message in the internet network have? Design the structure of this message. According to which rules governing the communication on the internet?

Thematic area: Communication through IT.

Topics: message and its parts, TCP/IP communication protocol

Input knowledge

- explain the meaning of the concept of computer network;
- propose a simple home computer network with an emphasis on functionality and safety;
- compare designs of simple computer networks in terms of safety;
- explain the function of selected network devices in a computer network.

Objectives

- specify the parts of message necessary for successful communication in the Internet network;
- explain the importance of parts of messages over the Internet network;
- explain the importance of communication protocol.

Age group: 15 years old pupils.

Time requirement: 2 lessons.

Used teaching aids and equipment: blackboard, colour markers, computer connected to the Internet network, smaller sheets of paper.

Course exercises

Pupils know the meaning of the concept of computer network, know what facilities may be located in the network and know the function of these devices.

During this activity pupils simulate a computer network and communication in it. Messages are sent in written papers. Role of the teacher is to generate an error, which can occur over real communication in a computer network. The pupils' task is to specify the rules of communication in the network to eliminate the consequences of these errors.

The teacher can generate sequences of various errors. It depends on the actions and reactions of pupils.

With pupils, we gradually discover the rules of communication and course of our activity is the following:

Identifiers of sender and recipient have to be parts of the message

We chose one of the pupils and gave them the role: "Choose one of your classmates and send them a specific question!"

Comment: The use of asking questions have been chosen deliberately. The question is naturally expected to have an answer. The pupil should be aware that it is not enough to enter the recipient (Destination IP address) of the question, but that they must also provide the sender (Source IP address) where the subsequent response to the question will be sent. We expected pupils to use sender and recipient identifiers quite naturally. However, it was not so. The pupils realised the problem only when they tried to deliver the paper sheet with answer. We assume that we have partly caused this problem too. The pupils saw each other, so everybody knew who the sender of the message was and did not consider it necessary to explicitly state their identifier.

With such an active, experiential learning, we can recognise some of the pupils' misconceptions. For example, one pupil solved this task by writing the question only on the paper. The paper sheet aimlessly "wandered" through the pupils' network and vainly searched for its recipient. When we asked the sender why he did it that way he answered that he sent SPAM. The paper with the message actually went through each pupil (even repeatedly through some). The number of the receivers was large (the same way as with SPAM), but the principles of SPAM distribution is exactly the opposite.

This situation, although we did not plan it in advance, allowed us to ask another question: *How long should this sheet of paper wander over the network?* Pupils suggested calculating the time it takes for the paper to find its recipient. If it reaches some critical value, it should be destroyed. After a series of questions such as "Who should calculate it?", "How to know the time for which the paper moves between two nodes?", "Where should this time be recorded?" pupils have come to the conclusion that it would be preferable to record the number of "jumps" of a paper on the same paper. Anyone who moves this paper increases this number. If the value is equal to any previously defined value, the paper is destroyed. It works similarly in computer networks (Time to Live), although there it works as a countdown.

Acknowledgment of receipt

Here, too, we asked a pupil to send a question to one of the classmates. But the teacher (the error generator) destroyed the paper on the way.

Comment: The sender sent the message, but the recipient did not know about it. The recipient did not get the message, but the sender did not know about it. How to resolve this impasse?

The pupils suggested that the recipient of the message confirmed its receipt to the sender. We

repeated the communication with this new rule. This time, however, the error “occurred” during the receiving of the confirmation message. Problematic situation arose again and pupils had to solve it. They suggested that if there is no response within the time limit, the sending is repeated.

This solution is also interesting from the perspective that defines the rules for communication (communication protocol) itself. But if the rules of communication are clear in advance, is it necessary to indicate them in the message itself? If we focus on the issues of protocols, we can hold a discussion in this direction. In this activity, this rule remained part of the message itself – therefore, not as a rule of the communication protocol.

Message fragmentation

We selected a pupil and asked them to devise a way to send an extensive message to their classmate and to send it in this way.

Comment: For time reasons we did not force pupils to write an extensive message. The message can be shorter, but we agreed that only one word fits on one paper sheet. Given the intellectual maturity of the pupils we could afford this abstraction of reality, without compromising the understanding of the real problem. The selected pupil quite intuitively broke down the message to more papers and sent them to their classmate. The message reached the recipient, but it was not clear in what order the various papers were to be put together. The pupil edited their method so that he numbered each paper (Fragment Offset). The recipient therefore had no problem to compound parts of the message in the correct order. When asked whether the recipient can be sure that the message is complete, pupils said they cannot. The sender improved their method again – he added the total number of papers to each paper (like Flags). Now the recipient knows clearly how to compose the entire message and knows that it is complete.

The contents of message checking

We have asked one of the pupils to send a question to the selected classmate.

Comment: During the transmission of this message through the pupils’ network we modified the question in the message. Changes were made so that the question makes sense and there is an answer to it. The recipient has sent a reply to incoming question. However, this response did not make sense in the context of the original question. The pupils’ task was to find out what happened and how to prevent it.

Pupils suggested various ways for verifying the contents of the message. The message should contain e.g. a number of its letters or words. On the question of whether we can on the basis of these numbers verify with certainty the contents of the message they said we do not. Furthermore, they suggested to encode the message with 1 and 0 and to verify the number of these characters. Here they encountered the same problem. They proposed to send the message twice. If two identical messages arrive we can be almost sure the message has not been changed on its way to its recipient. The fact that we had to send twice as much data did not matter at this stage. The pupils started to think otherwise, when we asked them whether they would mind if they downloaded a film from the Internet for two hours instead of one. They had already begun to realize the consequences of such duplicity. We concluded that we cannot verify with certainty that the message has not been changed on its way to the recipient. We can, however, say it with a high probability (Header Checksum). The pupils’ grasp of efficiency is also interesting. For small quantities of data we essentially do not care whether the data are sent once or twice. Pupils do not always realise the consequences of inefficiency in real situations.

Data privacy

Again we asked the selected pupil to send a question to their classmate. The answer, however,

should be private. The pupil's task was to figure out how to conceal the message.

Comment: The current method of sending the message makes it possible to read the message content for each classmate on the network. It is enough that the message on its way to the recipient passes through a particular pupil.

Pupils, based on their existing knowledge, decided to encrypt messages. They bent the paper in half to express this fact. The message itself was contained inside the paper, while the outer side of the paper contained information necessary for its delivery.

Activity evaluation

Pupils' activity is aimed at discovering and devising the IP packet structure and rules of communication in the Internet network. Our goal is not to give the finished knowledge to pupils. Our goal is that pupils discover this knowledge by themselves and give reasons for their conclusions through solving simple problems. We are confident that many of the concepts and principles of computer science are based on common sense and logical thinking. We assume therefore, that pupils can come to this knowledge on their own (although through simplified models) under the coherent guidance of the teacher. Knowledge gained by active problem-solving fits better into students' cognitive structure. It will have a higher durability than knowledge provided to pupils as a ready-made facts.

At first glance it may seem that the amount of time (2 lessons) dedicated to this activity is disproportionately large to achieve the objective (the structure of IP packet). Let us remember however that the activity involves the development of pupils' skills such as competences of lifelong learning, competence in information and communication technology and competence to solve problems. Therefore the goal is not only the result itself, but also the path pupils take to understanding.

Pupils have a problem with "reducing themselves" to the intellectual level of a machine. They often transfer their own characteristics, experiences and intellect – although machines do not have them – to machine operation. E.g. they route the answer to the opposite direction than the question, do not wait for the acknowledgment of receipt of message (because I saw it), they put together received parts of a message in the order that makes sense to them and so on. At first glance it may seem counterproductive – "forcing" pupils to think so primitively; but in fact they are often confronted with the primitive level of machines. Knowing to estimate the behaviour of the machines in advance can be, in the future, very useful for pupils.

Pupils think of computers as very quick machines – moreover, performance of computers is increasing all the time. They do not realise, however, that computer is processing more data. The amount of data is growing faster than the performance of computers. We encounter this problem especially in programming. Pupils do not realise the reasons and do not feel the need to deal with the efficiency of algorithms. They are often satisfied with the fact that the program works.

At the beginning of this activity, we assumed that pupils will utilise the acquired knowledge and communication will be more sophisticated. Yet in fact, pupils always focused on solving the current problem. All paper sheets contained only a message and an address of recipient and sender. Pupils used other particular requirements only when we were solving a specific partial problem of communication.

Version	IHL	Type of Service	Total Length	
Identification			Flags	Fragment Offset
Time to Live	Protocol		Header Checksum	
Source IP address				
Destination IP address				
IP Options			Padding	
(Encrypted) Data				

Fig 1. The IP packet structure

We simply do not think these activities to be single-use activities for pupils. We always try to design them so that we can develop pupils' learning further on the basis of the activity results. The described activity is a suitable introduction to the layered model of TCP/IP. But furthermore, the names of the people who communicate with each other are not IP addresses. E.g. they are identified by e-mail addresses. And how the e-mail gets to the proper recipient, if the devices in the network are identified by their IP addresses? That can be the subject-matter of the next pupil activity.

Activity 2: Information encoding, binary search

Problem: Describe the way how to find out one card chosen from a package of 32 German deck cards. Do you proceed randomly or according to some rules? How many trials do you need to find the chosen card? Can you improve your procedure of finding the chosen card? Explain the relationship between finding a card and information encoding?

Thematic area: Information around us; Procedures, problem solving, algorithmic thinking.

Topics: Information encoding, calculation of information quantity, binary searching of elements in an ordered sequence according to a selected key.

Input knowledge: Operating calculations with various positional numeral systems (writing successor of a number, conversion of number notation between various bases).

Objectives

- To explain that the amount of information necessary to determine a chosen card depends on the total number of cards and also on the manner of questioning (the number of different answers to the questions).
- To explain that after each answer to a question we acquire more and more information, after binary question we acquire 1 bit of information (after ternary question 1 trit of information, after decimal question 1 dit (ban) of information).
- To give reasons that for a clear determination of one chosen card from the package of 32 cards we need to ask 5 binary questions (for one from 27 cards we need to ask 3 ternary questions, in general for determining a card from a package of K cards we need to ask $\lceil \log_N K \rceil$ N -ary questions at most).

Age group: secondary school pupils (university students).

Time requirement: 1 lesson.

Used teaching aids and equipment: a package of 32 German cards.

The progress of solving the problem

In the first phase of solving the problem the pupils themselves play the game in pairs, where they alternate in guessing the chosen card. In the second phase, by means of the Socratic debate

with teacher, pupils discover a sophisticated way of determining the chosen card. Finally, in the third phase after playing the card guessing game, pupils study information encoding using binary numbers, calculating the amount of information, using binary tree for searching, information encoding and showing the uniqueness of this encoding.

In the first motivational and experimental phase teacher motivates pupils to discover the best way how to guess a card chosen by a classmate by themselves. Before pupils' experimentation, it is important for teacher to warm up their thinking by asking some questions, for example. "Do you know the package of 32 German cards? What kind of suits (colours) and values are there? How many cards are in the whole package?" Clever pupils can carry out the activity without manipulating the tangible objects – cards, using only the help of their imagination and thinking. We encourage pupils to play the game several times in different roles and also to record number of questions for each card guessing. The first phase we conclude with questions, e. g. "How many attempts do you need during the card guessing? Who was better? Did you guess randomly, or did you use a sophisticated way of finding out the card?"

In the second phase of solving the problem we use the experience acquired by pupils from the first phase and by Socrates debate we try to analyze pupils' random guessing and jointly come to a systematic way of finding the card – the binary search algorithm. An example of possible dialogue:

Teacher: Considering the random guessing of the card, can we guess the card on the first try?

Pupil: Yes, but in this way we will not always be successful.

Teacher: How many guesses can we reach in the worst case?

Pupil: Well, if we have a really bad luck, then 32 guesses.

Pupil2: We can maybe make more than 32 attempts, but I think that 31 attempts will be sufficient for guessing it in the worst case.

Teacher: What can we say about a set of cards with the desired card during gradual questioning?

Pupil: That this set will be reduced question by question.

Teacher: How will it be reduced?

Pupil: After each question this set will be smaller by one card.

Teacher: Yes, in a random guessing a set with the desired card will shrink by 1 until we guess the right card.

Next, the teacher puts the cards on the table face up and organizes them by their colour (suit) and values. They can also use a projector for showing the cards to all pupils and continue with the dialogue.

Teacher: Try to ask a question in order to reduce the set with the searched card by more than only one card

Pupil: Is it green?

Teacher: Yes, great. How big will the set be afterwards?

Pupil: If the answer is 'yes' then the desired card will be one of 8, otherwise one of 24 cards.

Teacher: OK. Try asking a question in a way that regardless of the answer, you will have equal chances of finding the card in either group.

Pupil: Is the value of the searched card a number?

Teacher: Excellent. And how will it reduce the set with the desired card?

Pupil: By half.

Teacher: Yes, exactly. Now try to ask a question concerning the colour of the desired card that will narrow the set in half.

Pupil: Is it a red card or green?

Teacher: Excellent. Is the colour of the searched-for card one of the following colours: red, green? What will be the further question concerning the colour of the searched-for card?

Pupil: Well, after this question I know that the desired card is either from the colour set {red, green}, or colour set {acorn, ball}. Then I ask for the one colour from the selected set. E. g. when the first set is chosen, so I ask – Is it red? And then I definitely know the colour of the desired card.

Teacher: Yes, first you asked about one pair of colours and then you asked about one from the pair. At the beginning we have 32 cards. After the first “yes/no” answer the set with the searched-for card is reduced to 16 elements, after next answer to 8 elements. I believe that it wouldn't be difficult for you to propose further questions for determining the value of the searched card.

Pupil: I ask whether the card is a number. After answering this question only 4 cards remain. Either they will be numbers, or figures. After my next question only 2 cards will remain and finally by the last question I will definitely know the desired card.

Teacher: Perfect. While asking the questions it is important to find and formulate a convenient attribute through which a set with the desired card can be reduced. How many questions did we need for guessing, or finding the searched-for card?

Pupil: 5.



Fig 2. Gradual narrowing of a set with the selected card from 32 cards to 1 card

Teacher: Yes, we need 5 questions. At the beginning the set with the desired card has 32 elements. After each answer this set is reduced by half gradually to 16, 8, 4, 2 cards and finally to 1 card, which is illustrated in Fig. 2.

After pupils discover the way of questioning, the teacher leads a dialogue to generalise the solution of the problem. Pupils can very easily discover the fact that for finding a card from 64 cards it is necessary to ask 6 questions, and from 1024 cards 10 questions are needed. Then the teacher shows that for $N=2^K$ cards the sequence of cards with searched card is decreasing as follows: $2^{K-1}, 2^{K-2} \dots 2^{K-K} = 2^0 = 1$. Pupils can conclude from this sequence that for finding a card from package of 2^K cards it is necessary to ask K “yes/no” questions. At secondary school level pupils who know logarithmic function can express that for finding a card from N cards it is necessary to ask $\log_2 N$ questions. They can also discover a formula for $N \neq 2^K$ cards.

There is a binary tree that is considered a useful tool for understanding the relationship between the total number of elements (e.g. cards) and the number of bits necessary for encoding all the elements and also the number of binary questions for finding out a searched-for element.

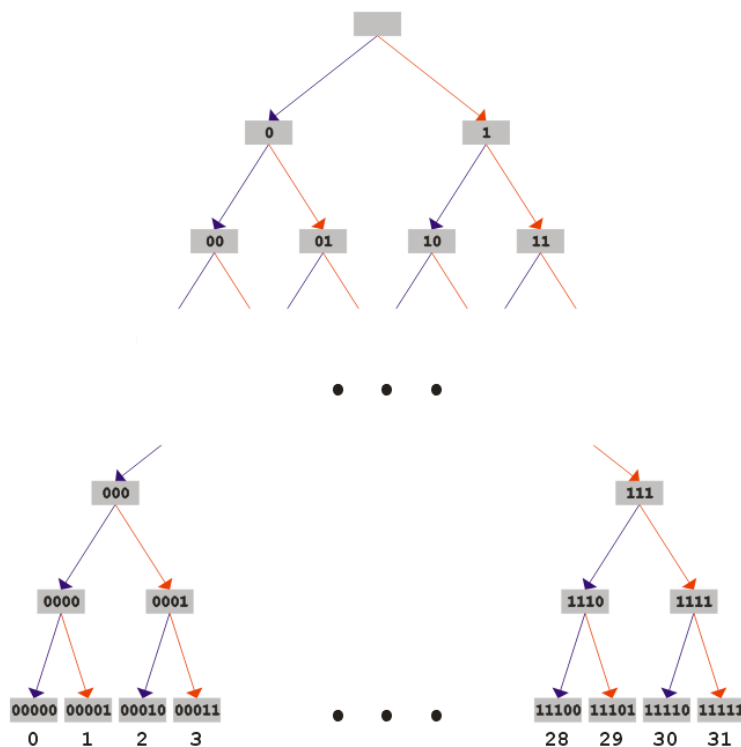


Fig 3. Binary tree with the depth of 5 and $2^5 = 32$ leaves assigned by binary numbers

Let's create a binary tree (Fig. 3) starting with an empty root node. From the node we draw two edges leading to two child nodes. Let's assign the left child node with the value from the parent node and add a "0" digit to the right side of that value, and the right child node with the value from the root node adding a "1" digit to its right side. This procedure can be applied for each node. It is clear that in K^{th} depth of binary tree there are vertices that are assigned by numbers with K binary digits. If we would like to find an arbitrary number with K binary digits we need to know answers for K binary questions. In other words we can say that for the representation of a number from 2^K numbers we need K binary digits or acquire K bits of information. In the guessing card game we can receive one 5-bit information (e.g. red king) to know definitely all about the searched card, or one 2-bit information about its colour (e. g. red) and one 3-bit information about its value (e. g. king), ... or five 1-bit information illustrated in Fig. 2. Previous consideration shows relation between bit as a binary digit and also as a binary information unit.

From the binary numbers we can move to N -ary numbers. For guessing, or finding one of 2^{10} numbers we need to ask 10 binary questions and to acquire 10 bits of information. For finding out one of 10^3 numbers we need to ask 3 decimal questions (value of 1st decimal digit, 2nd decimal digit, and 3rd decimal digit) and to acquire 3 bits of information. For determining the chosen card among 3^4 cards organized in square with 9×9 positions, we need to ask 2 nonary questions or 4 ternary questions. In general, for determining one of the K^L elements we need to acquire L K -nary information. Examining a K -nary tree, pupils can deduce that K -nary tree with the depth L has K^L nodes, and also that the depth of K -nary tree is closely related to logarithmic function (with the base K) and number of digits of a K -nary number.

Comments, alternatives, enhancements, advices

This methodology was based on the experience of teaching in different target groups (from 3rd grade elementary school pupils, gifted pupils from 7th to 9th grades of elementary school, the 1st year of secondary school pupils, to pre-service and in-service computer science teachers) and on different tasks; searching words in a dictionary, guessing integer numbers from 1 to 16,

guessing one of the 32 (or 27) cards obtaining binary (or ternary) answers, etc.

Of course for different target groups we have achieved different range and depth of subject matter comprehension. Pupils from 3rd grade of elementary school have discovered for themselves a better way of finding a word in the dictionary – utilising the alphabet ordering of words in the dictionary and remembering boundaries of pages where the chosen word can be found and then browsing the dictionary page by page. They understand that “spider” (binary tree) is a good aid for guessing integer numbers (Šnajder, 2011).

Gifted pupils from 7th to 9th grades of elementary school very quickly discovered a principle of effectively finding a card using binary (or ternary) questions. They were very active, asked many questions, created and verified hypotheses, and were very consistent and critical (they verified the card package in order to ensure that it is not an irregular one). Only some of them knew how to work with other than decimal numbers, but after using the above described Socratic debate and experimenting, all of them understood the principle of representing numbers in other than decimal system.

Pre-service and in-service computer science teachers appreciated the magic trick with cards as a very appropriate activating teaching method which helps to better understand selected computer science principles and they also joined the solving with great interest and pleasure. During a lecture with a group of pre-service computer science teachers a lively discussion arose. Students replied several times to the trick of guessing one out of 27 and more cards. They were surprised to find the searched-for card from a package of 30 cards after 3 ternary answers. After explanation of this issue with regards to probability students have comprehended the whole problem.

Teachers can use a special set of cards instead of German cards, e.g. cards with computer devices, binary numbers, animals, fruit, etc. that could be more appropriate for younger pupils but also to remember the selected notions of computer science and for closer relation to other school subjects.

Although we did not use computer support in our methodology we think that computer animations, interactive applets etc. could be helpful for individual discovery of the selected notions, principles and relations and also for their better illustration and revision. On the other hand we consider the role of the teacher to be crucial in the methodology because of their creativity and ability to lead adaptive dialogues with pupils.

To achieve satisfying results of learning regardless of target groups’ diversity we recommend heeding the following aspects:

- To motivate pupils to solve a given problem (e.g. how to reveal the principle of the magic trick), to encourage them by appreciative words.
- To maintain pupils’ activity by asking questions, discussing and experimenting that help to develop pupils’ creativity and critical thinking.
- To provide adequate amount of questions and clues/hints and to do it in proper order so that pupils may discover new knowledge by themselves or with little help by the teacher.
- To repeat an idea several times from various points of view in order to clarify and consolidate new knowledge.

Conclusion

In this paper we have mentioned tasks aimed at understanding some concepts and principles of computer science. The tasks are directly applicable to the lessons using various levels of inquiry

based learning with regard to pupils' age or inquiry experience. We are not focusing only on what a pupil can do alone. What pupil can do today, even with the help of the teacher, they will be able to do alone tomorrow (Vygotsky, 2004). So a good learning precedes pupil's current development level. Although the current development level of pupils (their level of knowledge) may be on the same or very similar levels, not every one of them will be able to move forward at the same pace; the zone of proximal development of each of them may be different. Poor consolidation of knowledge seems to be a "weakness" in the Socratic method (learning through questions). Instead of breadth we focus on depth in learning and the proper understanding. Instead of specific procedures and tools we prefer reasoning, contemplation, curiosity and critical thinking. The method of questioning is also important. Questions should be asked logically, not psychologically (Socratic method, 2011, online).

The findings, published in this paper, were developed under a grant LPP-APVV 0057-09 and grant KEGA 326-009UPJŠ-4/2010.

References

- BELL, R. The Many Levels of Inquiry. *Science and Children* [Online]. 2008, 46, 26-29. [Accessed 2011-12-15] Available at: http://learningcenter.nsta.org/files/sc0810_26.pdf.
- Computer Science Unplugged: Computer Science Unplugged* [Online]. 2011. [Accessed 2011-12-14]. Available at: <http://csunplugged.org/>.
- GARLIKOV, R. *The Socratic Method*. [Online] 2006. [Accessed 2011-12-09]. Available at: http://www.garlikov.com/Soc_Meth.html.
- KALAŠ, I. et al. *Východiská a inšpirácie, Línia: Moderná škola. Ďalšie vzdelávanie učiteľov základných a stredných škôl v predmete informatika*. Bratislava: Štátny Pedagogický Ústav, 2009. ISBN 978-80-89225-51-4.
- ŠNAJDER, Ľ. *Ďalšie vzdelávanie učiteľov základných škôl a stredných škôl v predmete informatika – Metodika výučby tematickej oblasti Informácie okolo nás*. Bratislava: Štátny pedagogický ústav, 2010. ISBN 978-80-8118-051-4.
- ŠNAJDER, Ľ. *Ďalšie vzdelávanie učiteľov základných škôl a stredných škôl v predmete informatika: Aktivizujúce metódy vo výučbe školskej informatiky*. Bratislava: Štátny pedagogický ústav, 2009, ISBN 978-80-89225-96-5.
- ŠNAJDER, Ľ. Úlohy zamerané na aktívne učenia sa vybraných pojmov a princípov informatiky. In: *Didinfo 2011*. Banská Bystrica: UMB Banská Bystrica, 2011.
- VYGOTSKY, L. S. *Psychologie myšlení a řeči*. Praha: Portál, 2004. ISBN 80-7178-943-7.



QUESTION OBJECTS – SOURCE OF ELECTRONIC QUESTIONS

Miroslav Hrubý, University of Defence, miroslav.hruby@unob.cz

Abstract

The high quality electronic tests and self tests should be an indispensable part of modern study materials and study environment. The described theory says that the items of electronic tests and self tests are electronic questions and that every electronic question is generated by the so called question object. Each question object belongs to one of the defined types. The main goal of this paper is to introduce a prepared formal description and describe the set of useful types of electronic question objects regardless of their connection with the existing software. The author tries to bridge the possible gap between the educational needs and the range of various types of available software.

Keywords

education, electronic question, electronic test, electronic self test, question object

Introduction

Modern technologies penetrate not only into teaching methods (Hrubý and Janáková, 2011), (Staňková and Bušínová, 2010) but also into methods of assessment (Ventouras et al, 2011). The important role is played by the standardisation efforts, especially by the Sharable Content Object Reference Model (SCORM) (SCORM web pages, 2012). It can also be useful to be familiar with the Question Markup Language (QML) which provides the training and education sectors with their own open and platform independent method of maintaining questions for use in tests and assessments (QML web pages, 2012). The important role in this process is played by students' acceptance of computer based assessment (Terzis and Economides, 2011). On the other hand the accessibility of electronic self tests plays a key role in required students' study activities (Hrubý and Dvorský, 2009). Some interesting approaches can be found (Mullins et al, 2001). The useful technology for the teaching and learning processes can be based on (Carmel et al, 2000).

From the general point of view a question object can be the most important term of the modern electronic testing. The question object is a special object which has a capability to generate electronic questions. The type of a question object determines the type of questions which this question object can generate. The collection of electronic questions forms an electronic self test or electronic test.

It can be said that especially high-quality electronic self tests can strongly motivate students in all fields of study. Various educational institutions, companies and individuals use various authoring software to produce electronic self tests and electronic tests. The resulting products can often vary greatly from the point of view of the achieved useful value for learners.

For instance, ToolBook II Instructor can serve as an example of a good authoring tool with rich possibilities for electronic testing. Nowadays latest version of this software can be found at ToolBook web pages (ToolBook web pages, 2011).

The main goal of the paper is to support a sensitive use of ICT in education in the field of electronic testing and to open this problem domain for wider range of takers. The author presents a possible approach to creating a formal description of the basic concepts of the area in focus. He defines basic terms, such as Universal Question Object (UQO), Question Object (QO), Electronic Question (Q) and Life Cycle of a Question Object (LC_QO). The proposal of all stages of the LC_QO is given.

Materials and Methods

The main terms of the article Universal Question Object (UQO), Question Object (QO), and Electronic Question (Q) can be generally described by the following definitions.

Definition 1

Universal Question Object (UQO) is a generic concept that can be described as a structure

$$\text{UQO} = [\text{assgn}, \text{defr}, \text{evalr}, \text{fdb}] \quad (1)$$

where

assgn is the assignment;

defr defined reactions;

evalr evaluation of reactions;

fdb is feedback.

Firstly, the assignment (assgn) can be a structure of various types. The assignment should be given in a form suitable for the tested person. For instance, in foreign language testing the concrete assignment can consist of a video file with a discussion of two persons which is followed by a question and an offer of a set of possible answers.

Secondly, defined reactions (defr) are possible reactions by the tested person which can be expected. These will be evaluated in compliance with the evaluation of reactions (evalr).

Thirdly, feedback (fdb) is the system response on the user's reaction to the given assignment (assgn).

UQO is the most abstract term of electronic testing. It is a source core object and term for deriving and defining all special types of question objects templates. Each question object type template is connected with specific authoring software. Each question object is formed on the basis of a question object type template. Question object type template can be changed into a unique question object after getting all necessary data from its creator. Question object can be defined as follows.

Definition 2

Question Object (QO) is a structure

$$\text{QO} = [\text{id}, \text{qf}, \text{ans}, \text{sco}, \text{fdb}] \quad (2)$$

where

id is the name of the question object type template;

qf is the question formulation;

ans are answers;

sco is scoring,

fdb are feedback conditions (feedback can be immediate or delayed).

Answers (ans) can be a small database that consists of various possible answers which differ in number of points that a tested person can receive. Scoring (sco) can use positive and also negative points connected to every possible answer that is defined. Good scoring setting is often a very sensitive and difficult task.

Definition 3

Electronic question (Q) is a structure

$$Q = [QO, as] \quad (3)$$

where

QO is a question object;

as is the list of answers that were generated from QO.

It is necessary to say that 'as' is a subset of 'ans' from the previous definition 2.

ToolBook Instructor (ToolBook web pages, 2011) can serve as a good example of authoring software which is suitable in the field of electronic testing. Nowadays electronic testing needs to define the set of useful types of electronic question objects (electronic question object type templates). This chapter covers, from the author's point of view, the most important ones. They are as follows:

- Multiple Choice;
- Multiple Choice Multiple Correct;
- True-False,;
- Matching;
- Short answers.

Results

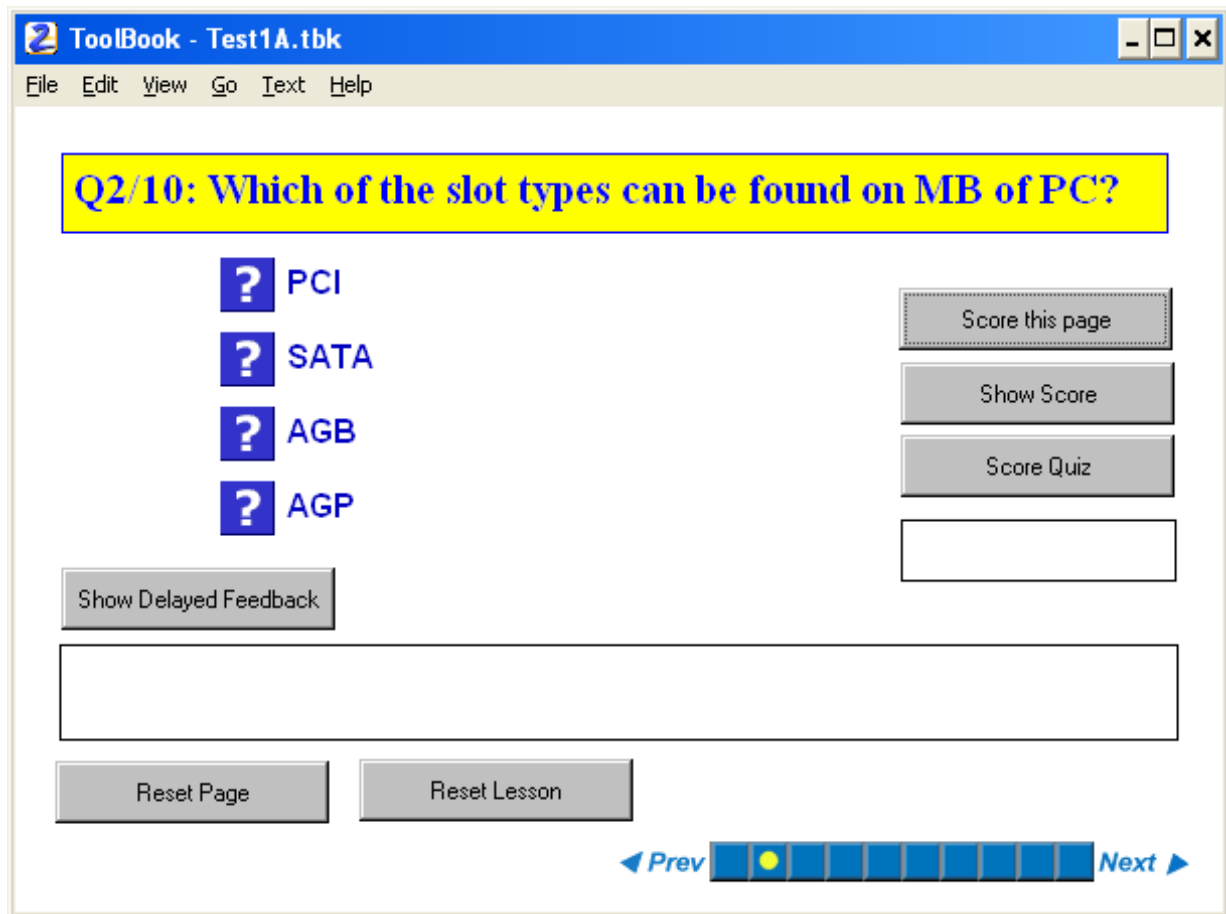


Fig 1. The example of a Multiple Choice Question

The multiple choice question seems to be the most useful common object for electronic testing. That is the reason why it was selected for more detailed description. It can be used in an ‘anatomic description’ of the question object.

Anatomy of the Multiple Choice Question and its Extended Properties Setting

After user adds a question object to a page, they can specify its appearance and behaviour in the Properties for Question dialogue box. This dialogue box differs slightly for each type of question object. The Properties for Question dialogue box consists of five Tabs as follows:

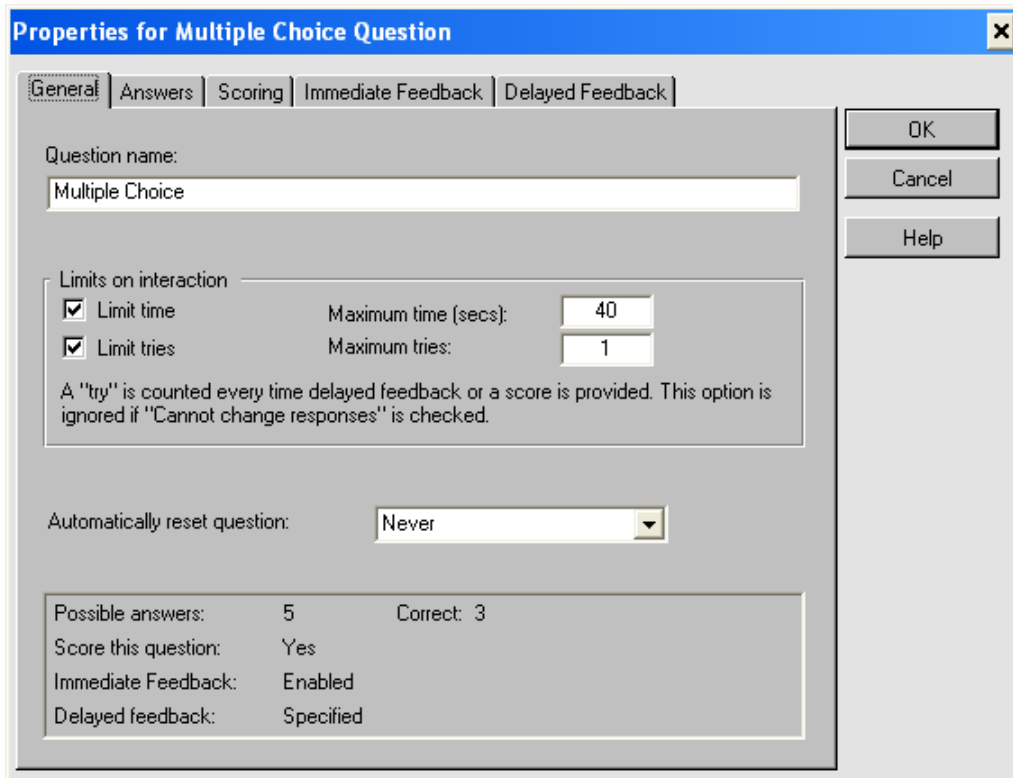


Fig 2. The Extended Properties for Multiple Choice Question – General Tab

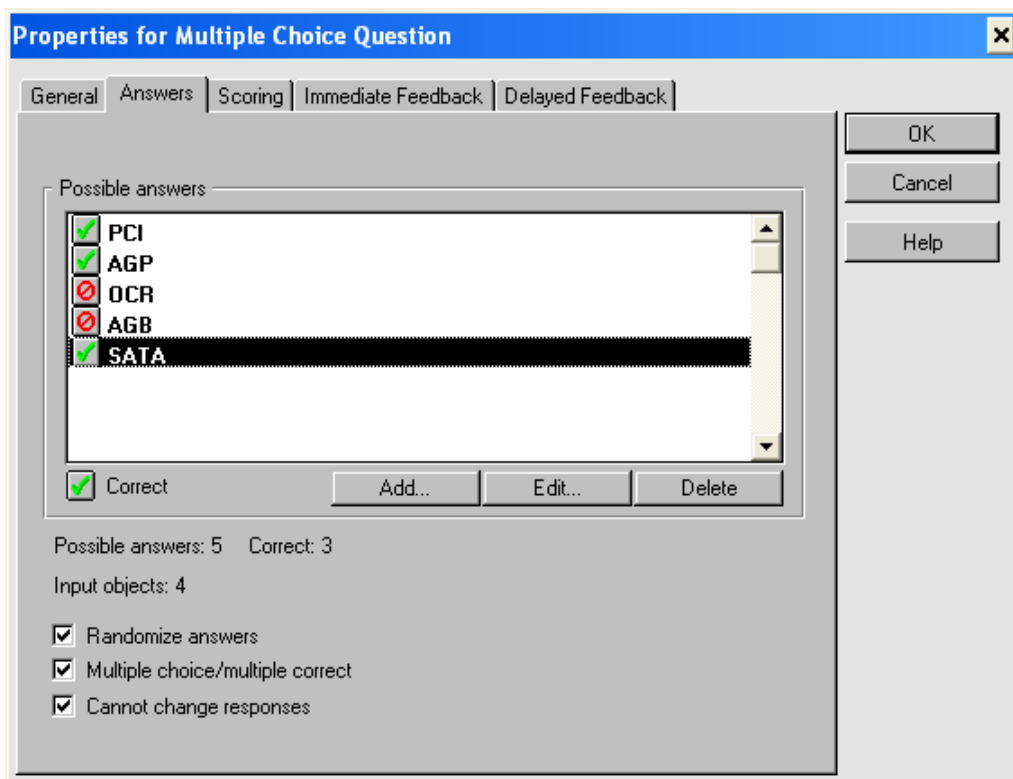


Fig 3. The Extended Properties for Multiple Choice Question – Answers Tab

The simplest scoring is a tally of the questions the student has answered correctly. For more flexibility, it is possible to assign different point values to different questions. It is also possible

to assign a weight to each correct answer by specifying a correctness factor within any question object. Points can be also subtracted from the student’s score for incorrect answers.

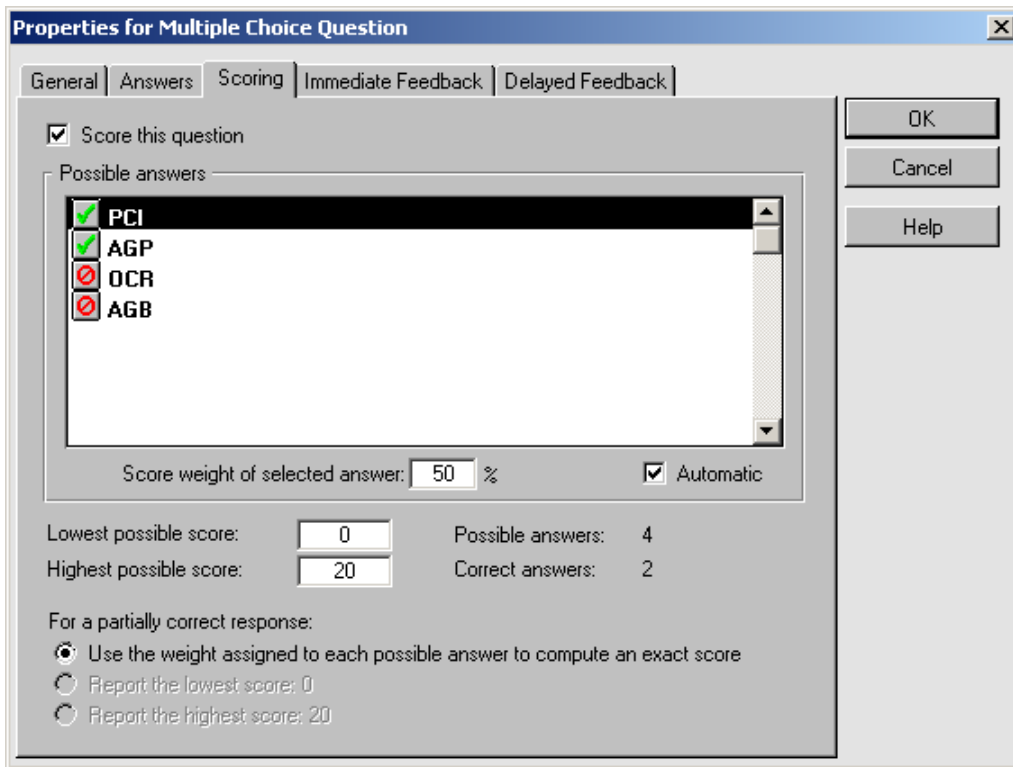


Fig 4. The Extended Properties for Multiple Choice Question – Scoring Tab

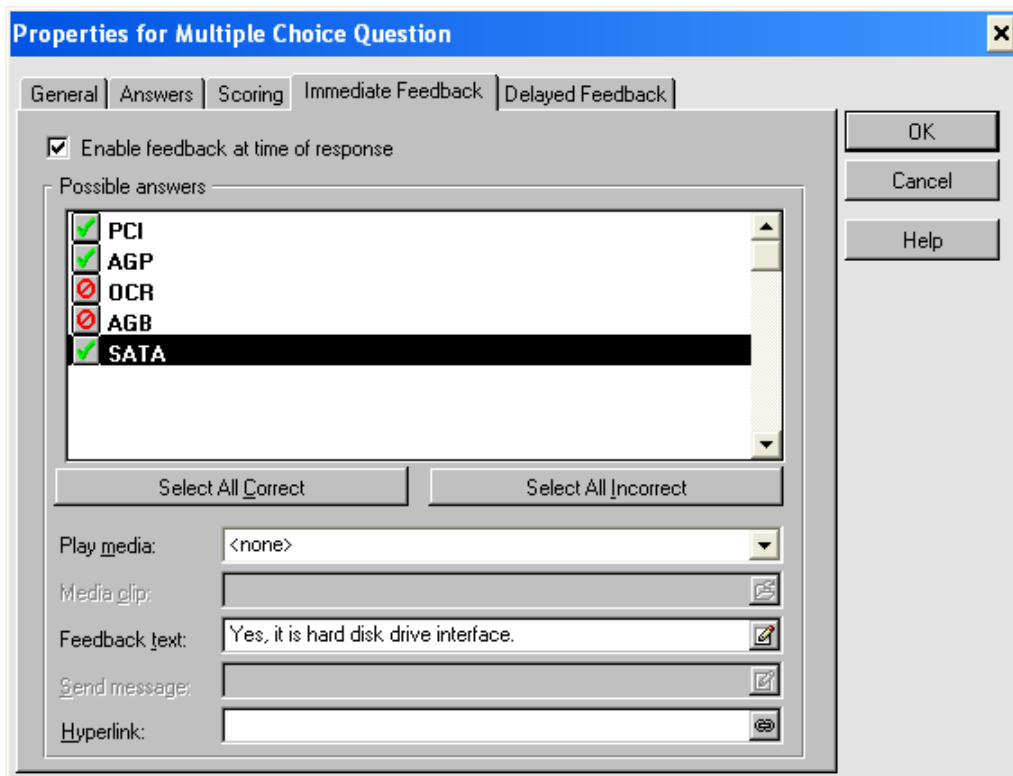


Fig 5. The Extended Properties for Multiple Choice Question – Immediate Feedback Tab

ToolBook Instructor provides several types of feedback that user can specify for question objects. For example, user can play a sound or media file, display text, navigate to another page, navigate to a URL (a Web address). It is possible to combine these methods and use more than one type of feedback in response to the user's choice. Feedback for a question object can be immediate or delayed. Delayed feedback is useful for providing feedback on multiple-choice/multiple-correct questions where we want the student to select several correct answers and then click a button to receive feedback on the selected set of answers.

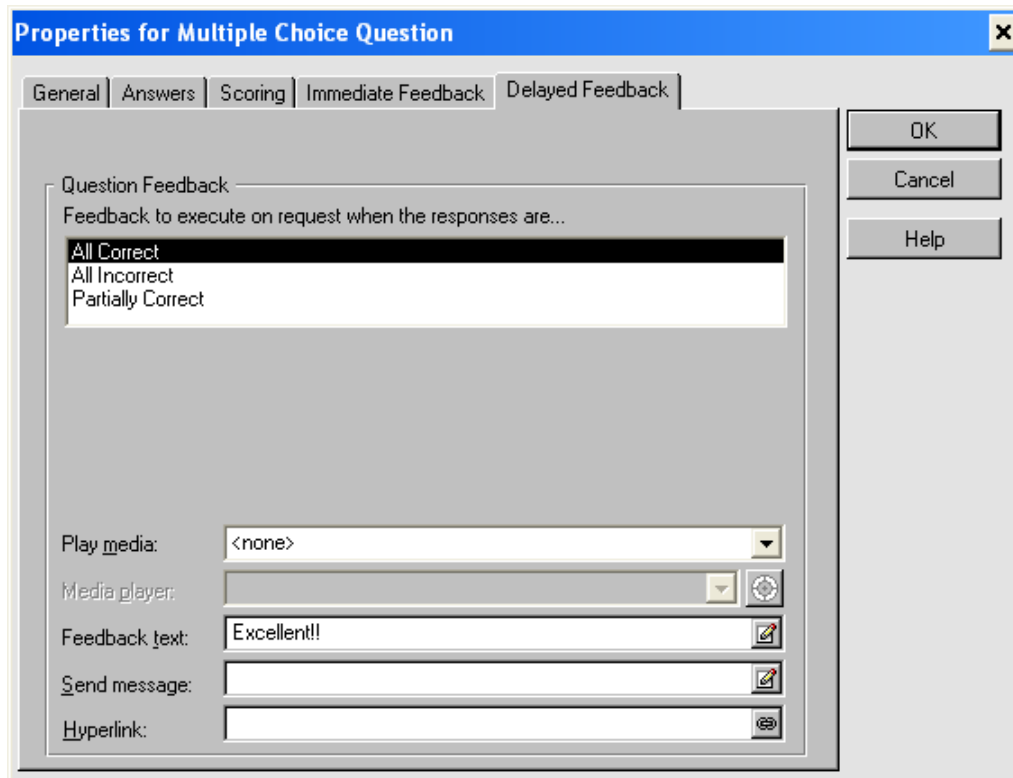


Fig 6. The Extended Properties for Multiple Choice Question – Delayed Feedback Tab

Discussion

Life cycle of an electronic question object can be defined as a sequence of particular stages.

Definition 4

Life Cycle of an electronic Question Object (LC_QO) is a structure

$$LC_QO = [S1, S2, \dots, S8] \quad (4)$$

where

- S1 is creation of the main idea of the question object proposal;
- S2 is making a standardised description of the question object proposal;
- S3 is discussion and adjustment of the question object proposal;
- S4 is creation of the accepted question object in chosen authoring software;
- S5 is discussion and adjustment of the overall design and especially the graphic design of electronic questions;

- S6 is question object usage;
- S7 is maintenance of the question object;
- S8 is discarding of the question object.

The Main Idea of the Question Object Proposal

This proposal should be created by the course supervisor, some of the course teachers or students. The goal is to prepare a primary description of the appropriate idea. The author of the proposal should formulate the suggestion of the type of QO, its purpose and its future use.

Making a Standardised Description of the Question Object Proposal

The goal of this second stage is to prepare a standardised proposal with the help of standardised description tools. It should be a task for a team supervised by the course supervisor or other responsible person who is closely connected with the course and their grasp over the course issues is sufficient, close to the role of the course supervisor.

Discussion and Adjustment of the Question Object Proposal

The standardised description of QO should be discussed in a team of three persons (at least) led by the course supervisor. This team should discuss the standardised description from the expert, pedagogical and psychological point of view. The result should be the final QO description.

Creation of the Accepted Question Object in Chosen Authoring Software

The creation of the accepted QO in selected authoring software should be made by a person who has a very good knowledge of appropriate authoring tool and has a very good sense for graphics. Improper graphic representation of future electronic questions generated from QO could prevent students from using them and debase the value of a high-quality description of the QO.

Discussion and Adjustment of the Overall Design and Especially the Graphic Design of Electronic Questions

Assessment of QO creation, suggestion of possible modifications and their step by step inclusion can be called 'QO debugging'. The final assessment should be done with the participation of students. Expert, pedagogical and psychological approaches should be used. At the end of this period the QO will be released for practical use in the course teaching. This QO will be a member of a list of active QOs.

Question Object Usage

Every question object from the list of current question objects is then used for the generation of electronic questions. These questions can be used in self tests and tests according to the course supervisor's instructions. The use of the QO lasts until it is discarded from the list of active QOs.

Maintenance of Question Object

The maintenance of the QO is based on the realisation of small changes in the QO according to the requests of the course supervisor. These requests are specified by the course supervisor in accordance with the permanent feedback from the teachers and students of the respective course.

Discard of Question Object

The discard of the QO means the removal of the QO from the list of active QOs. It stops the use of this QO in teaching and learning processes connected with the specific course. This QO can be used as an inspiration for creators of new objects in the future.

Conclusion

The paper describes the necessity of a global point of view on electronic testing. That is the reason why some terms were defined and the life cycle of a question object was formulated. The electronic testing should be based on the formal description of question objects which are needed in actual teaching and learning processes. One of the most important notes is that the formal description of the useful types of question objects should be developed and improved independently on the existing software. Software creators should then be inspired in this theory.

The recommendations for the further development of electronic tests and self tests are as follows:

- Electronic tests and self tests should be the necessary supplement of study materials at educational institutions.
- List of available and recommended QO type templates should be prepared and known at the educational institution.
- Every department of the educational institution should have a contact and responsible person for the electronic question objects creation. This contact person should be interested in both the theory and also practical usage of electronic tests and self tests.
- Close cooperation with students is a key for a high-quality tests and self tests creation and usage.
- Electronic self tests should always be used without monitoring the students.

The electronic testing issue deserves more attention than it has been paid so far. This difficult work is sometimes underestimated. Design and implementation of high-quality QOs, based on study texts, is a difficult process but it is a very useful activity. The process of creation of the QOs should be opened to a wider range of people; the course supervisor's contribution is always irreplaceable. High-quality electronic tests and self tests available to learners will undoubtedly strengthen their motivation.

Acknowledgements

This article was supported by the project for the UoD CIS Department development.

References

- CARMEL, D., M. SHTALHAIM and A. SOFFER. eResponder: Electronic question responder. In: *Cooperative Information Systems, Proceedings. Lecture Notes in Computer Science*, vol. 1901, 2000. ISSN 0302-9743, ISBN 3-540-41021-X.
- HRUBÝ, M. and J. DVORSKÝ. Possible 'Roadblocks' In: *Distance Learning, Simulation and Communication 2009. Proceedings*. Brno, 2009. ISBN 978-80-7231-638-0.
- HRUBÝ, M. and M. JANÁKOVÁ. Personal data protection analysis with links to operating and database systems. In: *Comptes Rendus de l'Academie Bulgare des Sciences*, vol. 64, no. 5, 2011. ISSN 1310-1331.
- MULLINS, M. E., M. WILL, A. MEHTA et al. Evaluating medical students on radiology clerkships in a filmless environment: Use of an electronic test prepared from PACS and digital teaching collection images. In: *Academic Radiology*, vol. 8, no. 6, 2001. ISSN 1076-6332.
- QML: Question Markup Language. *Question Mark* [online]. 2012 [Accessed 2011-11-26]. Available at: <https://www.questionmark.com/us/qml/Pages/default.aspx>.
- SCORM - Shareable Content Object Reference Model. *SCORM Development Tools* [online]. 2011 [Accessed 2011-11-26]. Available at: <http://www.scormsoft.com/scorm>.
- STAŇKOVÁ, E. and H. BUŠINOVÁ. Implementation of the Moodle Course Management System in English Language Training at the University of Defence. In: *AiMT*, vol. 5, no. 2, 2010. ISSN 1802-2308.
- TERZIS, V. and A. A. Economides. The acceptance and use of computer based assessment. In: *Computers & Education*, vol. 56, no. 4, 2011. ISSN 0360-1315.
- ToolBook 11. *SumTotal* [online]. 2011 [Accessed 2011-11-26]. Available at: http://www.sumtotalsystems.com/products/content-creation/toolbook_overview.html?src=tbhome.
- VENTOURAS, E., D. TRIANTIS, P. and C. STERGIPOULOS. Comparison of oral examination and electronic examination using paired multiple-choice questions. In: *Computers and Education*, vol. 56, no. 3, 2011. ISSN 0360-1315.

EDUCATIONAL ACTIVITIES AND CURRENT TRENDS IN SCIENCE AND RESEARCH AT THE DEPARTMENT OF ICT (UNIVERSITY OF OSTRAVA)

Kateřina Kostolányová, University of Ostrava, Pedagogical Faculty, Department of Information and Communication Technologies, katerina.kostolanyova@osu.cz

In today's information society, it is assumed that our learning will be supportive to extend our ability to work with and process information. After graduation, students should be able to find their way in the world of information, they should be able to find the information they require, review it critically and use it actively.

The Department of Information and Communication Technologies (KIK), which edits the ICTE Journal, was founded in 2000 at the Pedagogical Faculty of the University of Ostrava. It originated from the department of Technical Education, where various didactic tools were concentrated – reverse slide projectors, projectors, tape recorders and, with the intention to demonstrate modern technology, also a few computers, which were by then seen rather as “magical” tools. However, four modern classrooms were gradually built and equipped with the latest computer technology with the intention to teach about information and communication technology. In the early days, the department taught future teachers to use audio-visual technology and computers in their future profession. The department was, at the same time, searching for its own mission. This was later found in two different areas: in the area of education technology, the potential of which was then not fully experienced within the University of Ostrava; and the educational sector that called for people educated for the role of “ICT coordinators”.

These two areas became the basis for the conception of the whole department and defined its mission both in the areas of education and research.

Education activities

The Department of Information and Communication Technologies at the Pedagogical Faculty of the University of Ostrava contributes to the expansion of information and computer literacy in a number of different areas by:

- offering subjects in the field of IT and multimedia for the whole university;
- offering subjects in the field of media education;
- providing its own study programmes;
- providing a lifelong education course for the ICT coordinator qualification;
- offering whole-university modules of information technology related subjects.

Current trends in science and research activities

Since its foundation in early 2000, the department has been pioneering new forms of education at the Pedagogical Faculty by means of eLearning. At the department learning is completely organised (especially in the case of the combined form of study) in the LMS Moodle environment. For the full-time form of study, this platform serves as a storing point for learning materials and tasks fulfilled by students in various fields of study.

The future of the department is focused on research, which goes hand in hand with the major direction of the university research – education supported by ICT. In particular, we have been focusing on several aspects of support for these research intentions:

- development of *the laboratory of intelligent pedagogical processes* and its systematic integration into current education;
- *eLearning*, which is closely connected to our effort to consider different learning styles; preparation of a learning environment tailored to the needs of the student i.e. personalisation of learning;
- these two partial missions correspond with the following research intention – *Data Mining*, i.e. knowledge discovery in data gathered in various statistics inquiries (learning support, e-courses, study administration etc.) and in the areas applicable to the area of education (for example the analysis of audio signals and its application in the learning processes);
- last but not least we focus on the use of Petri nets for the modelling of educational procedures, creating study supports and content of various subjects and learning procedures.

The research conception of the Department of Information and Communication Technology leads to mastering current global methods and tools essential for the education of a wide spectrum of students. The research activities focus on the development of modelling and optimisation methods for educational processes (methods of educational forms comparison, of controlling attitudes to learning processes) and simulation and animation methods (expansion of simulation and animation models oriented on pedagogical practice, the use of simulation and animation to gain higher efficiency in the learning process, the methodology for creating multimedia learning tools).