The Use of Multimedia in Technical Education

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

Keywords

Introduction

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

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

Restructuring of national economy in the post-communist years has influenced not only the economy sector. Besides these problems, the fluctuation of the global economic environment, as well as the economy crisis has significantly affected the educational sector. Although declared but financially undervalued, the transition from the industrial society to the information and learning-based society has had no solid foundation in the material base (Turek, I., Miština, J., 2007). The priority has been given to universities, while the ICT support, as well as teacher training at primary and secondary schools started in early decade of new millennium being supported mainly by
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structural funds of EU. In this demanding situation, as mentioned above, technical education did not achieved sufficient attention at the administration authorities, sponsors, parents and students as well. Although it is difficult to compare because of the principal differences, both in general and technical educational systems in the EU countries including Slovakia (Kozík, T., Pavelka, J., Miština, J., 2004), teachers and researchers have been searching for solutions in the development of effective teaching tools in the completely new environment since the Internet, ICT and electronic multimedia systems have been implemented in society and education. “Successful multimedia programs achieved specific goals, clarified abstract topics that are difficult to understand using traditional teaching media, available to both teacher and student, provided an effective evaluation platform and focused on reaching the concepts rather than entertaining the student with shallow special effects. They provided a visualization tool that can transform abstract concepts into simple demonstrations. They also accommodated individual learning styles and evaluation needs. Students evinced strong acceptance and improved learning, when their instruction included programmes developed with the above principles” (Owen, E. F., Helps, C. R. G., 1996). The growing concern of teachers to improve their theoretical classes together with the revolution in content and methods brought about by the new information technologies combine to offer students a new more attractive, efficient and agreeable form of learning. Technical education is particularly special, since the main purpose of subjects in this area is not only to provide students with theoretical knowledge, but also to enhance their practical skills. Looking for similar multimedia teaching tool in similar educational fields we have been inspired by the programme of interactive multimedia animation with macromedia flash in descriptive geometry teaching (Garcia, R. R. et al, 2007). The software used in the development of the animations was Macromedia Flash; a tool that allows very small vectorial graphics files to be created, thus facilitating their electronic transmission to any user connected to the network, what was the aim of our Multimedia Educational Aid (MEA). Many other experiments, methodologies, implemented teaching tools and multimedia programmes for technical education (e.g. England, E., Finney, A., 2001; Balazinski, M., Przybylo, A., 2006; Frick, T., 2007, etc.) have confirmed the educational value of digital technologies.

Materials and methods

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

The basic research sample will consist of lower secondary pupils of elementary schools (upon ISCED2 recommendations, the subject "Technology" is included in the 5th-9th grade). Therefore, considering the age of the target group (10-15 years), our ambition is not to eliminate the personal contact with teachers, as well as classmates who are the source of many other pupils’ experiences, conducive to learning. What we have in mind is to avoid losing personal contacts and discussions, possibility of learning by observing others, possibility of comparing their learning steps, proceedings, opinions and values with others and seeing if they are right or wrong, and so on. As we know, the quality of education is conditional on the presentation of knowledge, information and facts in various forms, their management and administration, the possibility of communication, cooperation and mutual confrontation, the environment for individual or team activities, practical activities, games, etc. For this reason, we assume that the use of MEA with elements of e-learning in technical education could positively influence cognitive knowledge, psychomotor skills as well as socio-affective values of
pupils. The content of MEA will be focused on the thematic area of electricity. Given the wide range of the thematic unit by ISCED2, we focus on health and safety in working with electrical equipment, identification of wiring accessories and their installation, residential wiring, the technologies in electrical installation, the calculation of energy consumption and the related parts because of the evidence of an adequate amount of available materials in the remaining parts of the thematic unit. The content of MEA, we will try to process so as to ensure the curriculum transformation into e-learning elements, and there has been identification of a part of educational content especially suitable for virtual visualization, based on animation and simulation modelling and technology of visualization based on hypertext, video sequences, etc. The concept of the MEA structure is designed in a modular way. It should consist of five modules, which should correspond to the main thematic sections. These would then be divided into particular topics characterizing smaller logically interconnected sections of the relevant modules. Detailed general structure of the modules and topics, which we follow in the design and implementation of the whole MEA, which is currently in the process of development, testing and evaluation, have been presented in Jurinová, Depešová (2011). Besides the detailed explanation and illustration of the basic facts and functionalities processed within the framework of particular modules by means of the: text - hypertext, images, animations and video sequences (clips), the MEA will contain interactive exercises, tasks, test questions, educational games and ideas for carrying out practically oriented tasks as an element of feedback for pupils. The text remains the essential media in this type of information carrier. The main difference compared to the classic text is its hypertext feature. The learners do not have to pass through the content linearly, but they can jump between different learning parts, or bounce to external materials, so as the hyperlinks allow. Although the hypertext takes the largest part of subject matter content, an important part of providing the content are the information through other media. These are pictures, sounds, videos and animations. For making animations we use Adobe Flash, to work with vector graphics we apply CorelDRAW, for raster graphics Adobe Photoshop and for processing the text information we use MS Word. For the MEA development we will use Articulate Studio '09, which allows the development of courses in the form of presentation. It allows to develop programmable courses, which are quite different from standard presentations created e.g. in MS PowerPoint. Then there is a built-in ability to insert different types of test questions, insertion of programmable objects, whether specific or predefined. The programme also allows exporting presentations into universally accepted Flash format, which can be presented on a web server or the LMS. It supports SCORM and AICC, making it easy, after integration into the LMS, to track results. The process of the MEA development is a part of the author’s (Jurinová) doctoral research headed by her supervisor (Depešová) at the University of Constantine the Philosopher in Nitra, Slovakia. There have been involved undergraduates of Applied Informatics at the University of SS. Cyril and Methodius in Trnava, Slovakia. In implementation, testing, evaluation, adjustment and precision of the final product there will be involved teachers of technical courses at lower secondary schools throughout Slovakia, and, of course, their students. Consequently, carrying out the pedagogical experiment we aim to verify that the inclusion of MEA in the educational process as a part of the “Technology” course will increase the attractiveness and quality of education itself, along with shaping positive attitudes of pupils in this subject comparing to its current style, which has more or less theoretical character. Our goal is to work together on computer literacy of students and shaping a positive attitude towards lifelong learning. For this part of the research, the detailed methodological approaches in implementation of MEA into lessons and into various phases of the educational process will be proposed, so that, given the flexibility and complexity of MEA, they will be able to be modified or extended to include more options with regard to the needs of pupils, as well as to opportunities in area of material-technical provision of schools. But rather than the research itself and its organization we are facing the question of the development of MEA and its components. This paper is devoted to this problem. We focus on the methodology of electronic multimedia courses in general, as a basis for making individual components of MEA. As determined by the methodology,
and as a result of our present work, we introduce a particular multimedia course designed to clarify the issue of lighting circuits in the home, which represents only one part of the prepared MEA.

The life cycle of the electronic multimedia course development

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

1. Development

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

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

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

2. Distribution

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

3. Management

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

Results

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

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

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

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

1. **Providing the technology support - hardware and software**

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

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

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

2. **The course design, the content and additional parts**

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

![Structure of multimedia educational aid](image)

**Figure 1: Structure of multimedia educational aid**

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

- introductory – theoretical part – containing elaborated above thematic parts,
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- 3D interactive house – with a menu of five basic types of the switch connections. The house is interactive and any switch in the house can be activated by using the mouse. The used switch and any other switch associated with it are automatically highlighted. After clicking on the switch light in the house comes on, while on right side of the screen, a window with a functional scheme and a theoretical description of the connection appears. The functional diagram is accompanied by the slow flow of the electric power after switching the circuit.

- testing part – accessible to pupils after introducing all provided of types of connection. It is designed to be easily modifiable. Teachers therefore can modify the test questions to individual needs as required. It consists of a closed multi-choice. Upon completion the tests are evaluated and the learner is offered two options:
  1. Passed – The learner has sufficient knowledge. The application according to the achieved results will evaluate the pupil (in % and a mark).
  2. Failed – The learner will be returned to the beginning to try to complete the knowledge and pass the test.

3. The design of multimedia application

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

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

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

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

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References


