

New multimedia and telematic tools for asynchronous distance learning

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Abstract — New tools of modern education, connected mainly with Internet, are described in the paper. Their characteristics, principles of application were discussed in succession. Evaluation trail of their usefulness was done. Possibilities of carrying on laboratory experiments and distance designing were described. Probe to foresee directions of further development of Internet tools in the educational process was done.

Keywords — Internet, open and distance learning, multimedia, compact disc, e-mail.

1. Introduction

Education is a complex and multi-element process. The well-known, traditional tools used in education when there is a face-to-face contact between a lecturer and students, as in case of lectures, design and accounting classes and the laboratory training, still retain their big value. Similarly a book, a manual and a set of lectures have kept their high usefulness in the self-education process. However, the necessity of the development of the new techniques has become evident, together with the dissemination of education and the development of postgraduate continuing education. The techniques of open and distance learning, which facilitate work and education for participants, were originated this way.

The development of multimedia and teleinformatics techniques contributed to the creation of very useful didactic means for the educational and self-educational processes. The practice of the past few years shows that during training courses as well as postgraduate studies at first some educational tools are chosen, and then they are applied at appropriate level to achieve the best results. The process of education at both higher and postgraduate levels requires the new kinds of didactic means and their purposeful use. The multimedia and electronic techniques of the preparation of the new generations of the didactic materials will be discussed in succession and at the end they will be evaluated.

2. Electronic books

Books in the electronic format can be prepared on CD-ROMs or offered by the Internet. The electronic books are computerised versions of paper manuals with multimedia

elements. They are provided with strong search and presentation tools and they contain a large amount of information. E-books can be based on the contents of traditional paper books and offer more possibilities than the text itself. They also involve various human senses in the educational process. The presentation of the material takes into account different techniques of message transfer. It is the acknowledgement of the thesis that data collected with the use of a computer are more useful. The learning process with the use of electronic books is more effective and more pleasant. Users have also the possibility to check their knowledge by the use of tests for self-control. In the case of wrong answers the users have a possibility to learn the appropriate material by the use of a given entry.

The multimedia reference products provide learners with the text information enabling to hear it and also see in motion. A large number of well-organised references enables the learners to study the material more thoroughly. Both experience and practice are also very important, especially in case of complex systems where the interoperation of various coefficients can be understood by the directly gained experience. Simulation programmes are very useful to gain such practical experience.

Electronic books may contain the following multimedia elements:

- text (fundamental text, dictionaries, helpful comments, notices);
- tables, graphs, illustrations, interactive maps, photos (coloured, panoramic);
- animations, films (video sequences);
- 3D objects, sound track (wordy commentary, music, special effects); electronic books, by the use of multimedia and search tools, enable interaction for students.

Information in electronic books can be arranged in the following ways:

- chronologically (according to the event sequence);
- thematically (after selection one of branches of thematic references its sub-themes are presented; after selecting one of sub-themes, references to it are presented; an entry text can be presented after clicking the mouse in such a sub-theme reference);

- text, music and images stored in database can be sorted.

Search of information in electronic books is very easy in comparison with paper books. Electronic books present a completed list of references, within a given thematic entry, into other entries connected with a given training material and supplementary information. These entries have usually the possibility to come back to previous entries. A graphical presentation of thematic links facilitates the learning process. Didactic material can also contain glossaries with the explanation of the terms used in the material.

Paper materials have some limitations as a medium for information transfer:

- description of reality is limited to words and static illustrations, photographs and graphs;
- they are passive (it is difficult to learn e.g. in case of learning a foreign language one cannot check pronunciation);
- feedback and interaction are weak.

The Internet is a very useful tool for education purposes. The didactic materials can be accessible in the real time (by using chat rooms, audio or video conferences, white boards) and in the asynchronous mode (news groups, discussion groups and forums, hyperlinks with other resources). The Internet also offers rich graphics, multimedia and hipermedia. File formats accessible through the Internet are as follows: graphic formats (GIF, JPEG, BMP, TIFF), audio formats (WAV, AU, MPEG, MIDI, MP3, RA), video formats (MOV, AVI, MPEG, MPEG-2), animations formats (GIF89a, Java, Shockwave, FLI and FLC), 3D formats (VRML). Multimedia programs can be created with the use of the following programming languages: C++, Pascal and Visual Basic. The content of CD-ROMs can be updated through the Internet by the use of the plug-in technique connected to the Internet browsers.

In distance learning an electronic book contains the didactic material in the form friendly to users. Such materials have the following advantages: a very high degree of interaction, a very quick search of information, rich presentation technologies (multimedia and simulation programs, a large capacity, a possibility of self-learning and self-evaluation). All these advantages facilitate the learning process considerably. The didactic materials can be accessible in the Internet with the use of the educational portal.

There are a lot of examples of electronic books. One was prepared in the National Institute of Telecommunications in Poland [7]. The electronic books in the *Academic Multimedia Books* series of Warsaw University of Technology (WUT) in Poland are similar in form to them. The books of the *Academic Multimedia Books* series constitute a basis for studies in the distance learning program model SPriNT, which is used at WUT. In the SPriNT model electronic books are provided on CDs and through the Web service using the Lotus Learning Space platform [10]. Experiences

gathered in the field of using electronic books in distance learning at WUT shows it is useful for students to illustrate lectures with rich examples (for example solutions of tasks in the field of mathematics).

3. Simulations illustrating lectures

Lectures can be enriched by the use of simulations, which can be applied to real devices, physical phenomena, systems, etc., and which include an imitation, reproduction, and modelling. Particular aspects of systems or phenomena are imitated in simulations. The main purpose of a simulation is to give a user some assistance to understand the simulated systems and phenomena. The appropriate way of presentation is ensured by good multimedia simulations (simulations that use multimedia elements such as video sequences), sound track (voice, music), graphics (3D objects), etc. A good simulation contains many characteristics of a modelled phenomenon. Simulations may be used to foresee the results of phenomena. They are usually quite large so supercomputers have to be used for their realisation. Simulations are used to give a user some better knowledge of a modelled phenomenon. Simulation programs to serve complex relations of mutually dependent coefficients. Graphics, easy in use, is a key for the creation of attractive simulations. Music, sound effects, graphics and animations are elements used for the presentation of the actual state of a modelled phenomenon. Simulations have many common features but most of them are hidden (a user does not see them). The most visible element is the interface form, which results from the popularisation of software for the sake of simple users. Both the organisation and presentation of a large amount of information is important for the realisation of a simulation. Sound effects, graphics and animations add a multimedia background to dry, uninteresting formulae and equations.

There are different forms of simulation programs: from very simple ones without a user's engagement up to the complex ones, in which a user can actively participate by setting up variable parameters of a process and next observing the progress of a phenomenon.

Simulation programs have various degrees of complexity. At the basic level the complexity of a problem can be simplified or eliminated. At next levels when the complexity is higher and simulations are disseminated in large electronic books, the sizes of such books depend on the complexity and depth of simulation. Educational value of such material is often very high. Simulation programs develop the ability to solve problems, to take decisions and to deduct. The analysis of a current user's activity can be done with the use of an option that enables the repetition of a situation. Good examples of simulations are included in the electronic book *Physics I* which has been published by WUT in the *Academic Multimedia Books* series. Simulations provided in that book were prepared in the MS Excel. The book includes forms which allow students to change parameters of simulations and graphs which illustrate the results.

Other good examples are Java applications and applets prepared by the FernUniversität (Hagen, Germany) for their students [8]. These simulations show e.g. the changes in time of the voltage and the intensity of current in a capacitor.

4. Distance laboratory

The experiments in a real student laboratory is an important component of the educational process at a higher level. At a first sight the educational process, based on the use of the Internet, makes it impossible to carry out laboratory experiments. The analysis of solutions used in the ODL systems shows that some interesting qualities were developed, which can replace traditional technique of preparation and carrying out laboratory experiments. Three basic techniques of carrying out the distance laboratory training have been distinguished:

- **Simulation of measurement results**, by the mathematical model of an experiment, is a simple solution. The development of the mathematical model of an experiment and the description of the system of equations are the starting point. The next step: the selection of the software, accessible for a student, that may give a solution of the system of equations for conditions assumed by the student. The use of the appropriate software for the presentation of calculation results in the form of characteristics and graphs is also very important.
- Another solution is to prepare an environment to **carry out real distance experiment**. The measurement system, controllable by a computer, should be prepared for measurements usually at a school laboratory. Student requests and conditions concerning the experiment are sent to the computer that controls the system by the use of the Internet. In succession the computer realises measurements, records the results, and sends them to students (using for example e-mail).
- In some cases there is a possibility to create **home laboratory** by a student, using his computer and a set of elements (laboratory kit) sent to him by the school. The kind of experiments in which student should show his own self-dependence is especially useful. Unfortunately, only a few experiments can be realised this way because the cost and complexity of many laboratories makes their realisation in home conditions impossible.

FernUniversität Hagen provide a remote laboratory for their students [9]. In these laboratory students can e.g. control and watch a mobile robot through the Web service. The Distributed European Lab prepared by the University Bordeaux 1, the Fachhochschule of Münster and the University of Madrid in the RETWINE (*RemoTe Worldwide Instrumentation Network*) project [11] supported by the European Community is very interesting. Students can make

real remote experiments in the field of electrical engineering through the RETWINE with the use of the Java Applet which presents the full front panel of a remote instrument and provides the full control of experiment.

5. Distance designing

In the practice of engineering, the education leading to designing complex constructions, electronic circuits and informatics systems is a necessity. In such cases some complex software (ORCAD, AutoCAD, etc.) can be of assistance to a designer. A student's task is to get knowledge concerning work with this kind of software and learn about its possibilities.

Students studying in the asynchronous mode, far-away from the university centre, may have problems connected with getting appropriate knowledge because the software mentioned above is expensive and requires installation on a computer with high quality parameters (workstation), so it is impossible to install it on a personal computer.

There is a possibility of a student's distance work with software installed on the university server, by the use of the Internet. Although work in the on-line mode is not possible due to the limited capacity of links, a student may send appropriate instructions to the computer that serves the software and will receive after a short time, the results of the calculations. The time of waiting for a reply should not be greater than a few hours.

The problem of "distance designing" has no appropriate solution yet in the way that is appropriate for its standing in the educational process. In some cases it could be possible to make the professional software available to students in their computers during limited time of study (e.g. 3 months). An other way is to use terminal services, e.g. with the Citrix MetaFrame platform. This platform allows to use any remote applications through the real slow connection (20 kbit/s). In this way students can remotely use any designing tool and any simulation environment, too.

6. Asynchronous communication techniques

6.1. Electronic mail

The electronic mail is the classic tool of asynchronous communication between users of the Internet network. The correspondents situated in different places and having an access to the network at different time can exchange the letters and information. A letter can be sent to a single person or to a selected group of correspondents. Annexes can be added to the letter in the form of some files with text, pictures, calculations, etc.

The electronic mail is based on the post servers and SMPT protocol. Letters to users are put into personal boxes that each should have a unique address. Popular post programs

(Netscape Messenger, Outlook), operating on the basis of POP3 or IMAP protocols, are used for remote reading or sending of messages. The service of accounts, by the use of interactive WWW services (Hotmail, Yahoo), is also given. E-mail is an easy, quick and rather cheap form of contact between students, lecturers and administration. An electronic mail should be accessible by post boxes of universities and training centres not only for lecturers and administration but also for students. This service should be a part of an educational portal.

6.2. News groups and discussion groups

News groups are arranged for publication of advertisements and messages directed at the largest number of recipients. An access to the news server is a condition for participation in news groups. A user must personally connect with a news server and take messages from a selected group. The access to groups may be completely anonymous or controlled and admitted selectively for reading and writing of messages to a specified group. Messages are disseminated by the use of servers through the NNTP protocol. It is rather difficult to speculate about the confidentiality and privacy of a correspondence.

News groups could be successfully used in distance learning for the propagation of the common messages and for exchanging the information between students and lecturers. Discussions groups (or discussion lists) are a form of an electronic mail system for simultaneous transmission of messages to many users. Their proper operation requires some special servers.

In order to participate in a discussion group it is necessary to enter it. Most often it is done by sending a letter with the specified content to the addresses of the discussion group's participants. Discussions list and news group are very popular, but discussion list seems to be more interesting.

6.3. Messaging and discussion systems, discussion forums

In web-based education systems special subsystems are created and used for sending, reception, storage and management of messages and news groups. They can replace e-mail and classical news servers in communication between administration, lecturers and students. They are based on WWW interactive applications. Messages subsystems ensure confidentiality protection and privacy for correspondence nearing a classical e-mail, but they do not offer such big functionality as e-mail because they are closed.

In practice all mentioned above asynchronous communication techniques are used in distance learning as a way to communicate with students. The National Institute of Telecommunications uses electronic mail and discussion forums for communication between students and teachers. The servers use the typical software, for example MS Exchange, Qmail, Sendmail, Dnews or MS Internet Information Server. The discussion forum is in practice provided as

part of all distance learning platforms, for example Lotus LearningSpace, WebCT, Top Class.

7. Synchronous tools as a support for asynchronous distance learning

7.1. A chat

A chat is the simplest form of remote discussion for two or more persons at a distance and at the same time. Exchange of information is based on sending text messages. Quick typing on a computer is very useful. A chat enables to organise virtual class meetings, exchange of questions, answers and comments. It is a good form for improvised distance meetings. Low needs concerning the quality of telecommunication links are its important advantage. Modem connection using 9.6 kbits/s is enough for it.

7.2. Audio conferences

In comparison to chats the audio conferences are a more convenient and more natural form of the Internet based meetings. They allow to ask the questions, to discuss material, to solve problems very quickly. Of course the text, pictures and illustrations may be also presented. The audio conferences require better parameters of the communication links, than in case of a chat. Modem connection using 28.8 kbits/s is enough for them.

7.3. Audio-video conferences

Audio-video conferences are the most complete method for arranging regular distance lectures. The important disadvantage of audio-video conference is the requirement concerning a very high speed of the communication links. For fluent transfer 384 kbits/s is needed. For this reason a wider use of the audio-video conference technique in the Internet might be necessary in the future.

7.4. A white board

A white board is a very interesting form of a group's work at synchronous mode. It enables remote work simultaneously for a few people, concerning the same presentation or application, for instance an editor enabling common writing of notes, formulae, tasks solution. Participants can not only observe performed activities (e.g. marking part of a text) but also can make them themselves. Owing to it, participants can give questions, comments and notices currently, which significantly adds value to this form of work. A white board, (particularly together with chats or audio conferences) is a fine tool for carrying out distance lectures, as well as audio-video conferences. In practice it is even better because it needs significantly smaller speed of connection. In most cases 56 kbits/s modem connection could be enough for it.

All the techniques mentioned above can be used to complete the list of tools for successful distance learning. Chats and audio conferences can be used for an exchange of opinions, solving problems, giving answers for student questions. On a limited scale, lectures can be replaced by the use of audio conferences. The virtual experiments can be carried out by the use of audio-video conferences or a white-board together with a chat or with audio conferences.

Special requirements concerning communications network parameters and high costs of connections are the main reasons that synchronous tools are used on a very limited scale now. It is important that the educational portal should enable synchronous work at least in a chat form, next in an audio conference and white board forms. Possibilities of that kind are offered by a some platforms supporting distance learning (Centra, FirstClass, Learning Space 4).

8. Requirements for computer equipment and networks

The present-day education, especially in case of scientific and technical areas, requires the involvement of more and more modern educational equipment. Computer laboratories that should be connected to Internet, arise at universities and schools. The quick development of various techniques, especially in the electronics and informatics, as well as audio-visual technologies bring impetuous changes to telecommunications networks, computer and audio-visual equipment.

Requirements concerning computer equipment and its connection to the Internet network are different and they depend on the level of technologies being used. It is necessary to have at least processor units of Intel Celeron/Pentium III/IV or AMD Duron/Athlon classes with the operating store of about 64/128 MB for the reproduction of advanced multimedia materials. The contemporary PC systems satisfy the above requirements without any problems.

For distance education purposes a computer should be equipped with a sound card and also loudspeakers. For the purpose of carrying out audio and audio-video conferences a microphone and camera are needed. A CD-ROM reader is also necessary to reproduce materials from CDs. Requirements, concerning the band of a communications line for connection with the Internet for the purpose of distance education, also strongly depend on the type of tools being used. Connection cost is also a very important element. The slow lines of 14.4 kbits/s of the analogue modem can be already used for distance learning if it serves only for the an electronic mail, news, discussion groups and for the review of WWW services not very rich in graphics elements and without multimedia elements.

The enlargement of the band to 28.8 or 33.6 kbits/s (analogue modem) allows to review web services rich in graphics, to use chats, audio conferences or even to work on remote servers by the use of a white board. However,

the good work conditions are really ensured by the use of line of about 128 kbits/s speed (ISDN, HIS modem, xDSL modems, TV modems). A further increase of connection speed to the 384 kbits/s (xDSL modems, cable, TV modems) will give better comfort of work sufficient for carrying out audio-video conferences.

Now many video conferences are carried out by the use of the ISDN because this solution is not so expensive in comparison with other techniques. The ISDN transmits data almost four times quicker than a modem, so graphics, voice and image are transmitted more quickly in comparison with analogue lines. Video conferences may be also realised in point-to-point and point-to-multipoint communication modes.

The ADSL is a technology for networks that enables broadband and asymmetric access for subscribers to public networks and the Internet. Now the ADSL technology is widely used in distance education in countries that do not have funds for the creation of new optical telecommunications links. Another good solution is using TV modems with the cable TV. This technique has become widely offered in cities as it is cheap and often based on the existing infrastructure.

In academic communities and in companies, distance learning could be based on computer networks. Students could use the Ethernet, Fast Ethernet and even Gigabit Ethernet or ATM technology. Especially the ATM is now one of the most effective technologies of multimedia transfer (voice, image and data) so it is useful for distance learning.

9. Conclusions

Multimedia techniques have been developing intensively and together with the Internet are offering new tools for the technology of education. All these new tools have been used for a relatively short time and yet proved their special usefulness in the systems of continuing and distance education. The use of these tools requires knowledge and experience that should be achieved in a very short time, because the development of information technologies seems to be very fast indeed.

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