

Information Communication Technologies in Physics Education

A. Dirner¹, M. Domaracký¹, J. Hlaváčová², M. Kovaľáková²,
A. P. Murín¹, B. Zagyí², J. Ziman²

¹*Institute of Physics, Faculty of Sciences, P.J. Šafárik University in Košice,
Jesenná 5, 042 00 Košice, Slovak Republic*

²*Department of Physics, Faculty of Electrical Engineering and Informatics,
Technical University of Košice, Park Komenského 2, 042 00 Košice*

Abstract

It is generally accepted that it is necessary to find new effective ways of communication with talented students and to increase the awareness of society as far as physics is concerned. Information communication technologies can be the tools which help to induce in young people greater interest in sciences, scientific research and physics in particular, and to teach physics in a new attractive way. For this reason the Virtual Collaboration, a free association of Slovak universities and secondary schools students and teachers as well as scientists, has been founded. Its most important activity has been setting up the interconnection of computer networks with the possibility of communicating in a video-conference mode and preparing study materials using ICT technologies - multimedia tutorials. The physics tutorials are also under preparation at the Technical University of Košice, where the common base for e-learning courses is the uLern platform. Tutorials consist of the texts of lectures with simulations, self-assessed tests, questions and problems, and summary. Tutorials can be used for educating students studying at distance, and as supportive study materials for regular students, since their form helps to develop students' creativity, self-esteem and motivation for further study.

1 Introduction

Education has never had as good possibilities of development as now through the use of computers. Computer aided learning introduces new trends in teaching and learning and can enhance the quality of physics education.

The increasing number of personal computers connected to the Internet and new information technologies have brought a lot of new possibilities for obtaining and spreading information. Internet offers interesting possibilities to inform secondary school students about attractive fields of contemporary physics, what is nowadays very important because physics at schools belongs to the least favourite subjects. Teachers from various schools connected to Internet can compare and complete the contents of syllabus, and motivate each other in this way to improve education process. To a certain extent personal communication between teacher and student as well as among students can be substituted by the non-personal communication with the computer containing educational program or with computer as communication mediator with other network users. In this way the teacher can set students various types of problems which are solved by groups consisting of members from distant places connected by network and especially by the interest in the problem given. Teaching materials using e-learning technologies (so called multimedia tutorials) can enhance the quality of teaching and learning.

Multimedia tutorials represents high quality teaching materials but their full implementation in teaching process removes personal communication between teacher and student and can be successful only with students committed to the study since there is, from teacher's side, no personal motivation and study control.

At our departments we have taken part in two projects using information communication technologies (ICT) in physics education: Virtual Collaboration and The

Implementation of E-learning Technologies in Education at the Technical University of Košice.

2 Virtual Collaboration

Virtual Collaboration (VC) [1] is a free association of Slovak universities and secondary schools students and teachers as well as scientists, whose aim is to find new effective ways of communication with talented students and to increase the awareness of the society as far as physics is concerned.

The VC wants to acquaint students with basic questions which physics can answer in a new attractive way, to search for talented young people and to involve them in scientific research by solving physical problems supervised by professional physicists.

The most important activity in the first phase of the VC project was to set up the mutual connection of computer networks with the possibility of communicating in a video-conference way and then to prepare study materials using ICT technologies - multimedia tutorials.

The main technologies used by the VC are:

- Webcasting [2] which is a relatively cheap way of one way via Internet transfer of digital video records which can be archived. In 2000 the VC members - students and teachers - took part in two lectures on antimatter in CERN (European Organisation for Nuclear Research). During live transfer it was also possible to have a look round various laboratories where experiments on antimatter were just carried out and ask questions via Internet. At present we have managed the implementation of active videostreaming based on the products Helix, Real Network and we begin to use this method in education process as well as for physics popularisation.
- Web oriented videoconference technology - Virtual Rooms Videoconferencing System [3] (VRVS) which enables communication between several participants in the videoconference providing simultaneous sharing of sound, video and of the computer presentations at low bandwidth of computer networks,
- Web University which consists of two parts: a) live video-conference transmission between lecturer and a few groups of students using VRVS technology, and b) "video on demand" lectures which are available in Web archive. The VC has joined the CERN's Web University [4] and in the framework of cooperation on the project Life in Universe a series of lectures was given in Slovakia and archived in Web University [5].

Students who have joined the VC then can study multimedia teaching materials individually and communicate with their teachers via available audio-video transmission.

In the framework of the VC project a first step in using multimedia tutorials was done in the teaching of physics at the Technical University (TU) in Košice. Two English tutorials "Particle Adventures" and "Hands on CERN" were translated into Slovak [6]. The Slovak versions are intended as complementary study texts for the basic physics course and as a part of the study text for two optional subjects at the Faculty of Electrical Engineering and Informatics: "Nuclei and Particles", and "Physics and the Present". University students can also participate in the preparation of interactive tests with simple questions and problems which can be interconnected with these tutorials, so the tutorial readers could have possibility to check the level of understanding of a topic studied. For secondary school students who are the VC members these tutorials can be basic study materials.

The preparation of the Slovak version of tutorials was a very interesting individual form of teaching process. The main part of the work was done by the FEEI students in the framework of their seminar works. Interesting feature of this project was that the technical side of the work, which the students were familiar with, was connected with physics - which

they wanted to learn. The students created something useful for the others and improved their English.

Using tutorials in the two above-mentioned optional subjects was a very encouraging experience. After a short introduction the students were given a task – to go individually through the tutorial Particle Adventure. The seminars which followed consisted of discussions with teacher revising what students learned from the tutorial and explaining what was not clear. Seminars were for students a new individual, interesting way of teaching which required their active approach resulting in effectively obtained newest knowledge in subnuclear physics together with insight into the particle physics laboratories all over the world.

3 E-Learning at the Technical University of Košice, Physics Tutorials

The institutional development of e-learning at the TU of Košice began in 2002 when the project "The Model Department for the Implementation of e-Learning Technologies in the Education at the TU of Košice" started. In 2003 another project "The Implementation of e-Learning Technologies in Education at the TU of Košice" was launched. The outcomes of these two projects were the creation of a common technological platform for e-education accessible to all TU departments and institutes - software uLern and the development of courses in this learning environment which will be successively implemented in education at the TU of Košice [7]. ULern software makes possible to design a course, from organisational and the knowledge provided point of views, fully corresponding to the classical courses given at the university [8] and to utilize various media and interactive applications. The only difference is the absence of personal communication between teacher and student, students can study such a course at distance.

The theoretical base for tutorials were the lectures Physics I and Physics II given to students in the first and second year of their study at the Faculty of Electrical Engineering and Informatics, TU of Košice and the problems solved at exercises. Since the course objective is to provide students with knowledge of fundamental physics, the lectures were written in the form of the chapters of classical university textbooks. The solution of typical problems illustrating particular part of a lecture were included in these texts. Each lecture is a printable Word document.

The lectures contain links to simulations of physical phenomena, self-assessments tests, questions and unsolved problems whose answers and solution checking require e-mail communication with teacher.

Both tutorials are divided into 10 units. Each unit contains:

- the text of lecture which includes the solution of relevant physical problems
- the questions which enable the student to check the understanding of particular part of tutorial
- the set of unsolved problems with results
- a self-assessment test
- simulations of physical phenomena
- summary in the form of Power Point presentation
- key words

Both tutorials contain glossaries with terms linked to a pertinent part of tutorial.

We are now in the process of successive integration of our tutorials within teaching. Some of the e-learning technologies are used in so far going on classical lectures of Physics I and Physics II. Power Point presentations embedded in tutorials are used as a guide during the lecture and in the lecture beginning as a brief revision of a previous one. Presentations of

simulations at the lectures are also very popular among students. We have not tested yet self-assessment tests.

Full implementation of tutorials in teaching at university requires to answer a crucial question - for what kind of students these tutorials are intended. Appropriately prepared multimedia tutorials do not require the presence of students at school but checking the answers and consultations to course assignments require e-mail communication between student and teacher. This is, also according to the experience of our colleagues who teach regular courses using uLern environment, very time consuming and maximum number of students per one teacher is 10-14. That is why these tutorials cannot be fully implemented in teaching of regular students of the Faculty of Electrical Engineering and Informatics because their number is too high - approximately 600 - and number of teachers teaching at this faculty is 7-9. In this situation tutorials can be used in a slightly modified form (lectures, simulations, self-assessment tests) as supportive study materials. The fully functional tutorials Physics I and Physics II can be implemented in teaching of a smaller group of students, e.g., students studying at distance who now attend blocks of lectures on Fridays and Saturdays and in teaching of regular students who due to various reasons (illness, stay abroad) cannot attend the regular course.

E-learning technologies in physics education have limited application in training students in laboratory skills. Theoretical background of experiments, their processing and also simulation can be transferred to students through tutorials but real experimental work cannot be substituted by whatever sophisticated simulation.

4 Conclusions

Integration of e-learning technologies improves physics education at universities. Tutorials in modified forms can be used as supportive study materials for regular students.

At the faculties with a large number of students attending physics courses the implementation of fully functional physics tutorials in teaching process with communication of students with tutor via e-mail is limited by the number of teachers. The solution could be a virtual classroom with VRVS technology. Fully functional tutorials can be used in education of students studying at distance and a small number of regular students.

References

- [1] <http://vk.science.upjs.sk>
- [2] <http://webcast.cern.ch>
- [3] <http://www.vrvs.org>
- [4] <http://webuniversity.web.cern.ch/webuniversity>
- [5] <http://webuniversity.science.upjs.sk>
- [6] <http://www.tuke.sk/feikf/preklady>
- [7] J. SINAY, P. KOŠČ, S. BENČO, D. KOCUR : Implementácia e-vzdelávacích (e-learningových) technológií do výučby na TU v Košiciach, Conf. Rec. e-Learn Žilina 2004, Slovakia, pp. 225-230
- [8] J.SINAY, D. KOCUR, P.KOSC, S.BENCO, Conf. Rec. ITHET 2004, Istanbul, Turkey (<http://ithet2004.boun.edu.tr>)