COMPUTER-BASED EDUCATION IN PHYSICS

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Abstract

The contribution deals with a short history of the usage of personal computers in teaching of physics at the Faculty of Chemical and Food Technology (FCHFT) of Slovak University of Technology in Bratislava. At first, computers were used in our faculty laboratory, as well as in seminars in special computer rooms where we tested the level of acquirement of the subject matter. Then step by step the miscellaneous multimedia tools were introduced also into physics lectures. What were the goals we wanted to achieve by usage of multimedia didactic tools in teaching-learning process? These aims were - to enliven an interest in physics, to improve the clarity of teaching.
The response of students on such kind of teaching process has been studied too. We have prepared student's opinion questionnaire to find out a feedback and monitor if our aims and intentions were fulfilled. The questionnaire was anonymous and was administered at the end of the winter term of the academic year 2006/ 2007. Results of this survey will be analysed at the end of this article. The new impulses and conclusions of this survey will be implemented in our further pedagogical practice.
Key words: *animation, didactic means, demonstration, internet, PC, video.*

Introduction

In the last decades the great changes have arisen in our life, science and technology penetrates our households more and more. The changes have arisen also in the teaching-learning methods for the same reasons. Personal computers found their way and usage from elementary schools to universities. The young generation inclines to the work with new information technologies and therefore the computer-based education and the implementation of the multimedia tools into the educational process usually result in a positive response of students.

Past and Present

Laboratory exercises

In recent past our laboratories were the first and the only place, where students could come into a contact with personal computers. By means of PC they processed experimental data and obtained tables, performed calculations of physical quantities and received required graphs.

The great expansion of PC began and computers have been used almost in every activity – from experiment, through its treatment by calculations to the final output in the form of tables and graphs. Students gained a lot of knowledge and ability through the usage of PC but they failed to understand the physical principles behind the experiments and the physical evaluation of the obtained results. Therefore the optimal variant of PC usage in laboratory was looked for.

At present the student shall control the physical conditions of experiment, he or she shall be familiar with the theory of uncertainties and he or she shall interpret the results. PC should only be an aid for mathematical treatment of experimental data.

Seminars

The development and availability of personal computers have been reflected also in teaching of physics in seminars. At first, computers were used in our seminars in a special computer classroom where we tested acquirement of the subject matter by interactive teaching software Educa ("Grada", 1993). We took advantage of this computer room only at the end of terms. The aim was to play on the natural inclination of new generation to work with PC and simultaneously to use it for students self-testing of the teaching matter. But the stepwise reduction in the teaching load of physics caused that we had to cease this activity.

Nowadays the quota of physics lessons is decreasing in connection with the restructuring of school bachelor system at the Slovak University of Technology (Hola, O. & Laurinc, 2006). Therefore, it is necessary to look for new effective forms of teaching in the framework of full-time study as well as distance learning or correspondence study - e-learning. As a result the education based on PC will be very important in seminars again. We make plans for the future to give students a possibility of the individual calculation of physical problems by means of distance communication in the combined form of study (presence attendance and distance form). Therefore we have just prepared the first trial module of Physics course 1 in LMS Moodle for the purpose of our faculty. But the usage of such form of study assumes rather good knowledge of the secondary mathematics and physics as well as the students' own initiative and willingness to study more than is necessary.

Lectures

The beginning of multimedia usage in physics lectures at our faculty dates back from 2002 and this opportunity arose from equipping of the special-purpose lecture hall with an in-built data video projector. It enables us to mediate information prepared on a personal computer to the auditorium. Moreover, during the last year the on-line connection to Internet was put in action in this hall. It opens new possibilities to exploit Internet directly to show also such physical animations and video-clips that could not be freely downloaded.

At FCHFT we have used miscellaneous multimedia tools in physics lectures (Hola, O.& Hola K., 2005; Hola, O. et al. 2005). It is a commonplace now in all our lectures to present a given phenomenon by ***Power-point presentation*** with 3D projection. 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 demands. Let us mention some of 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 or free fall have counted to the most interesting ones.

From other software successfully applied in lectures in recent memory we can state also ***Famulus*** used for the demonstration of a wave reflection from a free or fixed end, for the demonstration of interference and formation of standing waves (Dillinger, 1999).

Video-clips provide an illustrative approach to the investigated physical phenomena for students. We have used during lectures many video-clips originating from various physical web sites as well as our own video-clips. For example many video-clips related to hydrodynamics of ideal as well as real fluids have been used.

We have used also the system environment of ***Coach,*** which enables us to perform quite expert scientific video analyses providing tools for measurement of position of several data points in different frames of the clip. It has proved to be useful to introduce such video analyses into lectures of physics after the ending of thematic units. We applied blocks of video-clips analysed by Coach twice in a term - which illustrated kinematics and dynamics of motion in the course Physics I. and once in Physics II. in the section of the electricity. We co-operated with colleagues from the Faculty of Mathematics, Physics and Informatics of Comenius University,

who participated in the creation of video film and video-clips as well as at their analyses by Coach. The particular usage of Coach in education of physics also at our faculties is dealt within our contribution (Hola, K., Hola, O., Haluskova, 2004).

Two years ago we began to prepare our own video-clips at our Department of Chemical Physics of FCHFT (Hola, O. & Hola, K., 2006). These video-clips record various real situations of our life as well as the laboratory experiments. We created also some instructive video-clips that were dedicated to measurements methods, and video-clips recording the unique workplaces. Afterwards we began to record the clips of the experimentally prepared situations in our laboratory. Finally we combined video-clips of these activities of everyday life with analogical ones prepared experimentally in our laboratory. It was the first step to realise an idea of our ***video films*** – the higher form of video clips. So last year we began with the creation of our own video films in physics. Their common leitmotif is „Video films from the world of Physics or Physics in the world around us". Until now we have created (Hola, O., 2006) about eight short video films with the voiceover providing physics comment and we included them immediately in physics lectures.

We have also participated in the creation of an electronic multimedia textbook of physics (Ožvoldova et. al., 2006) which is available for students of different forms of study at web sites of various technical faculties. The mentioned e-multimedia textbook contains besides the textual studying material, physics problems, exercises and their solutions, a lot of illustrative figures and some animations and applets. There are e.g. applets of simple harmonic motion, damped and forced harmonic motion, superposition of harmonic motions, etc. At present we are continuously extending the contents of this book also with respect to its usage as a multimedia tool in the teaching-learning process, therefore more applets and video-clips are being included.

In our lectures we have used some animations from other ***multimedia CDs,*** for example CD: "Animated Physics" (Neubauer, 2001) which we used mainly to demonstrate electric and magnetic forces.

Internet brought plenty of other possibilities to mediate new information from the physics field to students. In lectures we used on-line applets to explain some physical principles of e.g. microwave oven, polarizer, electron microscope, X-ray fluoroscope, cyclotron, etc. In most cases we showed students very interesting effects from modern physics that have applications in our common life.

Feedback

What were the goals we wanted to achieve by usage of personal computers and various multimedia didactic tools in teaching-learning process in physics? Generally we can say that the function of the personal computers is to facilitate the treatment of experimental data and solving of physical problems. But personal computers allow us also to create as well as to use the various multimedia didactic tools, e.g. animations, applets, video-clips, video films, Internets web sites directly in the teaching-learning process. Such an approach accords with our idea and concept of modern education. Our objectives are: to enhance students' awareness and ability to recognize natural science' connections. More over we want to evoke their imagination and to offer other, more attractive approach to learning.

We prepared student's opinion survey to find out a feedback and monitor if our aims and intentions were fulfilled. This questionnaire was anonymous and was presented to students in the last lecture of the winter term in the academic year 2006/7. We studied the interest rate of multimedia didactic tools as well as the contribution of the tools to the better understanding of the subject matter. The main part of questionnaire consisted of the five scale answer's options e.g.: "Do you consider the use of data video projector for the presentation of video- clips as":

uninteresting, little interesting, medium interesting, interesting, very interesting.

The results can be summarised as follows. The number of respondents was 58. The evaluations of the individual above mentioned activities are shown in Tab.1. In column A there is the sum of answers in the categories "interesting and very interesting" expressed as a percentage of all answers obtained. In column B there is the result of the two scale answers' options: "Has the usage of…contributed to the better understanding of the subject matter?" (yes or no):

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Table 1. Results of student's opinion survey.

No	Presentation of:	Interesting and very interesting [%] A	Contribution to understanding of matter [%] B
1	Images, scans, photos, graphs	91	91
2	Animations	88	86
3	Applets	83	86
4	IP Coach	65	83
5	Multimedia CD	85	88
6	Video-clips	91	95
7	Video films	78	83
8	Classic demonstrations	78	78

The students evaluated the video-clips, images, animations, multimedia CD, as the most interesting from all didactic means. On the whole students expressed that all didactic tools used in lectures contributed to the better understanding of the subject matter.

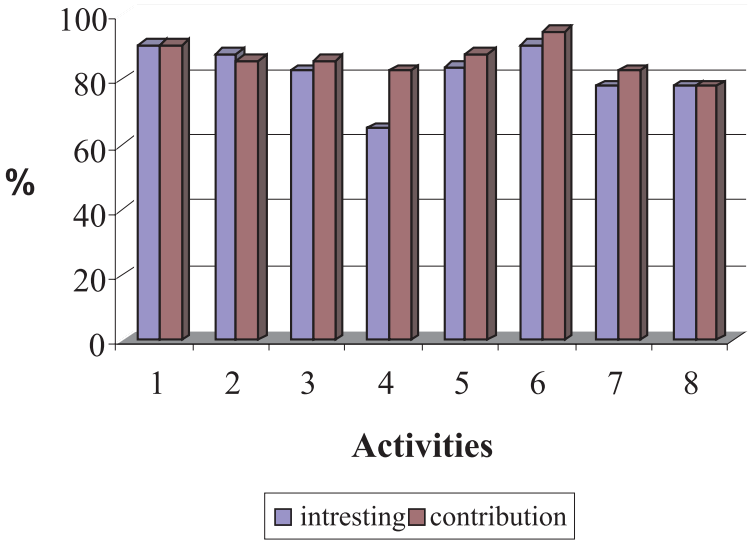

Figure 1. Evaluation of the various multimedia tools used in lectures.

In Figure 1 there are demonstrated the results of the anonymous survey presenting the contribution of the various multimedia tools used in lectures expressed as a percentage.

In Figure 2 there is depicted the interest in video-clips, video films and classical demonstrations expressed as a percentage in more details. Asset of video to understanding of subject matter is drawn in Figure 3. The 89 % of respondents declared that video programs added to the better understanding of subject matter, about 3 % declared - no, and 8 % of students did not answer. Generally, we can say that the response of students on the use of multimedia didactic means, on demonstration of simple experiments during the lectures and calculation of interesting examples from everyday life, is very well as it is seen in Table 2.

Let us specify some of other answers:

- The calculation of interesting physics problems in lectures contributes to the better understanding of the subject adequately and to a large degree (84%).

- Lectures:
- offered students more than literature (81%),
- helped to clarify and explain everyday life phenomena (84 %),
- improved to develop analytical thinking (79 %),
- awoke an interest in physics (79 %).

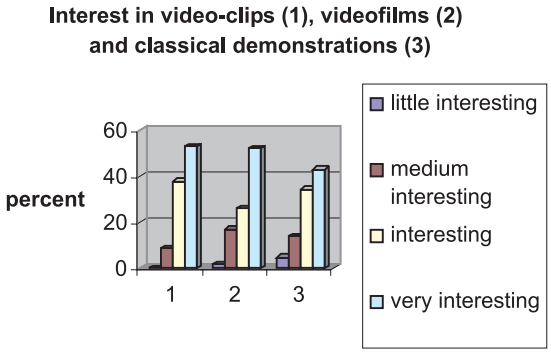

Figure 2. Interest in video and classic demonstrations.

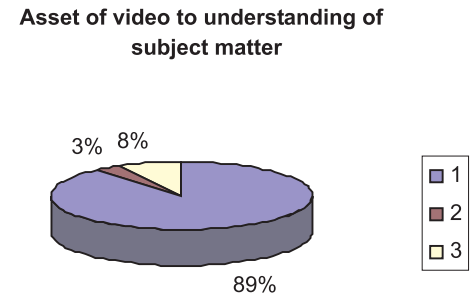

Figure 3. Asset of video to understanding of studied phenomena.

Table 2. General view of an asset of the individual didactic means to the physics education.

Summary questions	Assume to be an asset (%)
Use of multimedia didactic means	100
Demonstration of simple experiments	98
Calculation of interesting examples from everyday life	87

The student's opinion survey proved that multimedia didactic tools as well as classic demonstrations during the lectures but also the calculation of interesting examples from our everyday experience are assets to the physics education as it is expressed in Table2.

Conclusion

The problem of physics teaching at our faculty is connected with the fact that physics is not the major subject of study of our students and hence we often face lack of their interest and sometimes also the weak background knowledge. They consider physics to be a boring and difficult subject, "inescapable evil". Therefore the question "how can we facilitate and motivate students in their physics studies" is the key one. There exists false assumption that students possess great knowledge about the surrounding world. The opposite is true, and we can help explain to students some of everyday situations through physics. The use of personal computers and various multimedia tools in teaching-learning process is one of the ways to reach this goal. The student's opinion survey proved that multimedia didactic tools are assets to the physics education. They led to the better understanding of the subject matter and to higher attractiveness of physics. On the other hand physics is also an empirical science and it

lies in experiments. There is no doubt about the stimulating role of experiments in teaching, so classical demonstrations as well as laboratory works also with the technical PC assistance are not substitutable in physics education.

In future it will be very important to look for optimal measures of the use of personal computers in all forms of physics education.

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