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

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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), (Nodzyňska, 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.

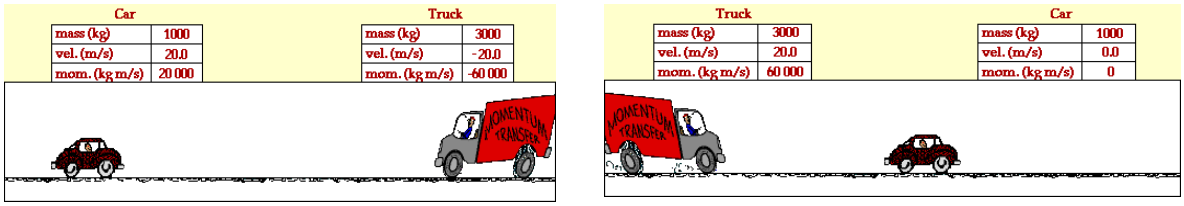

Fig 1. Applet of the elastic and inelastic collisions

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 Radiologyand 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 countermotion 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.

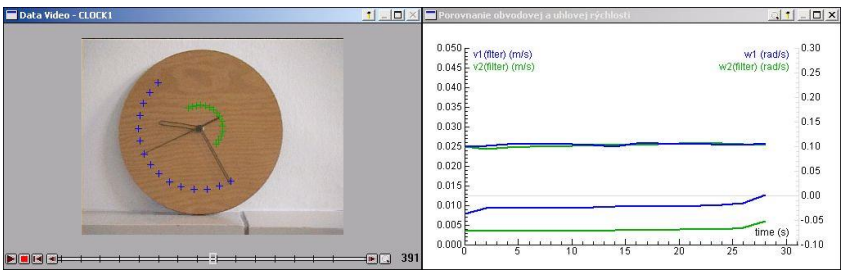

Fig 4. The motion of wall-clock hands - scientific video analysis by Coach

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"

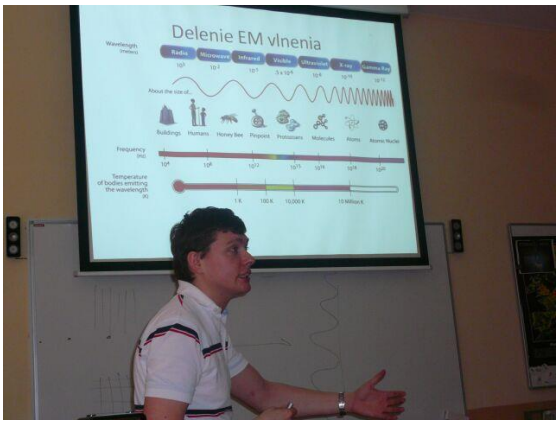

Fig 7. Topic "Light"

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

Subject ***Liquids at rest and in movement***
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?
Subject ***Light***
1. What is light?
2. Which natural light sources do you know?

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?
Subject ***Radioactivity – bugbear of mankind or our fellow*** 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.
Subject ***Chemical reactions known and unknown*** 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).

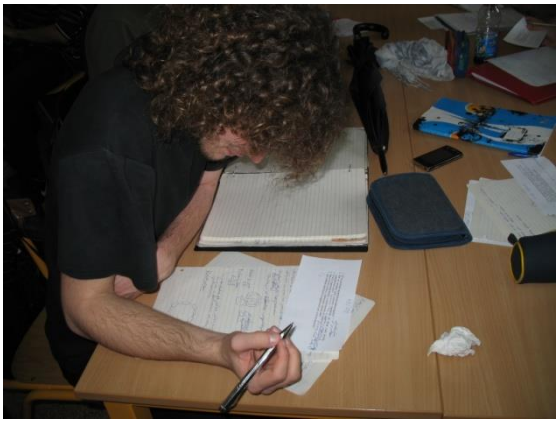

Fig 13. Problem solving

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

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