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Physics and Everyday Life—New Modules to Motivate Students*

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The question "how to improve the interest of students to study physics" has been discussed in the author's previous papers too. Within the framework of the project, the author prepared various new interdisciplinary projects to demonstrate how inventions in physics are used in everyday life. Now, about one year later, the author found out that students were most addressed with the modules physics and crime scene investigation physics in the kitchen, as usually with non-traditional simple experiments. The aim of this paper is to introduce the modules and discuss possible reasons of this situation.

Keywords: physics, modules, interdisciplinary, motivation

Introduction

The framework educational programme for basic and high school education is based on a new education strategy, stressing the application of acquired knowledge and skills in practical life. It is important that the programme promotes the educational autonomy of schools as well as teachers' professional responsibility for the outcomes of the educational process. The programme offers a broader range of obligatory optional subjects for the development of pupils' interests and individual potential.

The educational area humans and nature includes a range of topics associated with the study of nature. It streams pupils to learn the tools and methods for a deeper understanding of natural phenomena and natural laws. It also gives them the necessary foundation for a better understanding and use of contemporary technology and helps them better orient themselves in everyday life. The aim is to help students to learn asking questions "how?", "why?", and "what will happen if?" and to seek to answer them, to explain observed phenomena, to seek out and solve cognitive or practical problems, and to use their knowledge of the laws of natural processes in order to predict or influence them.

Science educators have focused much energy on developing high-quality curricular materials that science educators will adept them. The adoption is problematic, the process is complicated and the majority of teachers is not able to use the advantages of new materials. Misunderstanding of basic phenomena leads to developing negative attitudes towards science.

The task of the research activities can be formulated: How can we change the course to promote students

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understanding and motivation in physics.

The questions are: how to change the course content, what instructional methods can be used, how to teach problem-solving, and how to create the relation to the outside world.

Strategy of our projects was based on the outcomes of the research of the Department of Didactic of Physics, Charles University Prague, project No. 2E06020 and findings of David Pritchard and Analia Baranttes (2009) and the works of Renata Holubova (2011a; 2011b).

Research Focus

It was found that there are some subjects in physics of low preference, on the other hand, some subjects are interesting for students. Low preference has subject molecular physics, waves, about molecules and atoms. On the top of interest are subjects, such as optics, astrophysics, sound, and energy. Students are interested in problems of how mobile phones works and why a steel boat can float and questions about the universe. Lack of interest were shown to information about eminent physicist living in the Czech Republic, how can be physical problems described with mathematic formulas?

It is very important that how the problem is presented by the teacher in the beginning of the lesson, motivating can be the formulation of an unexpected conclusion.

As documented earlier (Jeřábek & Holubová, 2011), solving numerical tasks is the most boring activity during physics lessons. On the other hand, what most motivating are experiments that students are doing by own and using computers and the Internet in physics lessons. It was also found out that the structure of physics lessons is still mostly the same—The main part in most lessons is the presentation of the teacher. About 70% of lessons contain revision, and about 50% of lessons of the first part of the lesson are followed by solving tasks. More common (about 50%) are now demonstrations of the teacher and about one third of lessons contain experiments performed by students. Video and the Internet are used rarely.

The aim of this research was to prepare new modules for teaching and learning physics with the focus on problems related to common life, modern technology and findings, and the own activity of students.

The list of these modules is presented as follows:

(1) Hands on experiments;

(2) Nanotechnology;

(3) Electronics;

(4) Physics experiments with dataloggers;

(5) Physics and forensic;

(6) Physics in the kitchen.

All these modules were offered to secondary and high schools in Moravia. School classes had the opportunity to come and learn the theory and do some experiments in laboratories at the Department of Experimental Physics or teachers of the department were prepared to visit schools and present the modules directly in the classroom.

From all these modules, the author mostly presented physics in the kitchen, physics and forensic, and hands-on experiments. In the next part of the paper, the first two modules will be shortly described.

Physics in the Kitchen

The module has two parts. In the first one, some information about devices in the kitchen is given—How the fridge, the microwave own, and the inductive cooker work. Some facts from the history are mentioned too.

The second part consists of experiments. As most interesting experiments were found: the CD in the microwave, a water balloon, or soap in the microwave. What found useful is the possibility to measure the speed of light in the microwave and show some properties of standing waves (See Figure 1).

Figure 1. Physics in the kitchen—experiments.

Physics and Crime Scene Investigation

Forensic science includes many areas of study, such as criminalistics, engineering science, and pathology and biology. The most reliable application of physics is when biomechanical analysis is used to explain injury mechanism, such as how an injury may have occurred. It is very important that the application of the free fall mechanics which originates as a result of mechanical interaction of the system "human and surrounding". Another topic, very interesting for students, is dactyloscopy. In this topic, various experiments can be done. Students can use the dactylographic suitcase and investigate the crime scene. Students learn the fingerprint patterns—arches, loops, whorls, and compounds. The students learn factors that affect the quality of latent prints (amount of fat and water, temperature, humidity, and exposure to sun) (See Figure 2).

Figure 2. Fingerprint and fingerprinting suitcase.

One topic among the forensic scene investigation in schools is leading in curiosity—the forensic entomology. The forensic entomologist estimates the postmortem interval based on the age of the insect present. This entomological-based estimation is most commonly called the "Time Since Colonization". The forensic entomologist can use a number of different techniques, including species succession, larval weight, larval length, and a more technical method known as the accumulated degree hour technique which can be very precise if the necessary data are available. The insects recovered from decomposing human remains can be a valuable tool for toxicological analysis. Toxicological analysis can be successful on insect larvae because their

tissues assimilate drugs and toxins that accumulated in human tissue prior to death. This topic demonstrates interdisciplinary relations—physics, biology, chemistry, and geography.

Methodology of Research

The outcome of this research was based on PER (physics education research), known as a field of research focused on understanding how students think about physics and how to teach physics more effectively. Over the last few decades, researchers in PER have made enormous advances in understanding how students learn physics most effectively and in developing teaching methods that apply this understanding to achieve improved student learning. That to find the answer of the research question "why the modules mentioned above" was chosen most often. This problem could be studied by using different research methods.

To get research data, the method of an interview was chosen. An interview is one of the methods of collecting data. The main characteristic of this method is that a researcher is asking questions of one person, or a group of participants. Because of the number of students, the author used a semi-structured interview. The questions were focused on topics of interest of the subject, difficulty to understand the problem (unknown terminology), interdisciplinary relations, relation to everyday life, and gender.

The interviews were recorded through the use of handwritten notes. Secondary school students (15 pupils), high school students (21 pupils), and nine teachers were interviewed. The students were representatives of their classes that took part in the presented modules.

Results of Research

From all new modules, most interesting and amusing for students are hands-on experiments (see Figure 3). That module was realized at the author's department and repeatedly at schools—The author was invited not only to secondary schools but also to high schools. The most important characterization of that module, as mentioned in interview, was the own activity of students—All experiments they did by their own. The other two modules that students found as interesting and motivating were physics in the kitchen and physics and forensic science. The most important aspect was the relation to everyday life and curiosity. From the teachers' point of view, most interesting was the module nanotechnology. The module offers a lot of information that cannot be found in textbooks. The other interesting module was physics and forensic science. Only one high school used the module electronics.

Figure 3. Hands-on experiments.

Conclusion

Main outcomes of the research can be summarized as follow. Students' preference is the relation of physics to everyday life, when the relevance and utility of physics to their lives and careers were demonstrated. They will not study new topics but they will see how the knowledge in physics can be used in real world. In all steps of education, it is important to show the application of physics in everyday life, how staff works.

Most interesting and most important are achievements of skills useful for life—That is why hands-on experiments are so popular.

What can be done by the educational change—The curriculum, teachers, and the structure must be changed. The amount of new material presented during physics lessons is far more than a typical student can learn and understand. In lessons, there is not enough time for application, experiments, and discussion. It is necessary to teach interesting—This is one of the reasons, because modules presented by instructors of the Department of Experimental Physics were more interesting for students then when the topic was presented by their own teacher. It is important to understand that students are not interested in various topics, because at the actual age, they are not important for them. Students do not like mathematisation of problems—In the modules mentioned above, there was no mathematics (only the formulas for speed of light and the free fall of a point of mass). When the modules contain a lot of demonstrations and experiments, the relation to common life is taught, then students are interested in the topic. According to this research so as to PER, the best way to teach physics is through "interactive engagement" methods, hands-on activities with application to everyday life, and the opportunity to discussion with other students and teachers.

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