ICT in Physics Teaching for Secondary Schools and Colleges

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Abstract

In my research work I studied the students' attitude to physics, their motivation and their IT skills by a wide poll made by questionnaires. As a result of the survey it has become clear that science classes should be made more colourful and interesting, if we want to let our students leave the secondary school with adequate level of knowledge and with applicable skills in physics, chemistry and other natural sciences. To turn classes more interesting it is necessary to take advantage of the opportunities offered by ICT and multimedia [1].

In this process the use of an interdisciplinary approach is highly desirable. It is not easy to reach the target but it is possible by applying complex methods.

As a practicing teacher, college associate professor I had introduced the project method as a qualitative method of pedagogy, and as a demonstration of and motivation for the scientific research activity. In order to change the attitude of the students I organized and also took part in national and international collaborative projects where the use of ICT was and is required. The successful previous projects were e.g.: The Solar constant measurement, Observation of the Venus transit, XPERIMANIA [2] and SPICE, SCIENTIX projects.

The new initiative, called “Electric motors” will be presented during the conference, with five hands-on experiments, in which the participants can also construct very simple electric motors. This project is my contribution to the SPICE, SCIENTIX project launched two years ago by European Schoolnet.

Additionally, the initiative will be completed by worksheets, video, and interactive crosswords, built in an e-learning Moodle course.

The Moodle course served as specific media to implement the learning process. The Moodle system is a very useful tool, because it enables the use of e-learning application, Web-based learning, computer-based learning, virtual education opportunities and digital collaboration. This can be used as well in secondary schools as in colleges [3].

I am confident that these initiatives, e-learning material prepared on MOODLE course, combined with project method have certainly raised students’ interest in and increased their motivation towards studying Physics and Science.

1. Introduction

The popularity of natural sciences and technologies - especially physics - as well as the interest in those fields are being declined in the schools worldwide from year to year – as reflected by research studies in pedagogy. The main contradiction is however, that the world of the 21st century can not be understood and governed, the main global challenges cannot be handled well without a basic knowledge of natural sciences.

In the first part of my previous research activity I studied the students’ attitude to physics, their motivation, and their IT knowledge. Therefore I verified 9 hypothesis by questionnaires. 17 schools in
Hungary and 2 abroad with altogether approximately 900 students have filled out the questionnaires between 2002-2003. As a result of the survey it has become clear that physics classes have to be made more colourful and interesting, if we want to let our students leave the secondary school with high level and applicable skills in physics, and with an advanced knowledge in natural sciences. To turn classes more interesting it is necessary to take advantage of the opportunities offered by IT and multimedia. In this process it is highly significant to use an interdisciplinary approach. Reaching the target is not easy but it is possible by applying complex methods.

In the following we give an overview of methodology and ICT tools used to turn classes more interesting, and to increase motivation of the students.

1.1 Multimedia and its elements
“Multimedia is any combination of text, graphic art, sound, animation, and video that is delivered by computer. When you allow the user – the viewer of the project – to control what and when these elements are delivered, it is interactive multimedia. When you provide a structure of linked elements through which the user can navigate, then the interactive multimedia becomes hypermedia” [4].

Optimally all physics classes should include the following: real hands-on experiments, demonstration experiments performed by the teacher, simulations, embedded videos, or other new technologies.

1.2 Multimedia and ICT used in education
Nowadays there is an enormous pressure on the schools from the society, and from the media to ensure that students are competent in the area of learning technologies. The majority of the teachers tend to change their attitude and introduce new ICT tools and technologies into their physics classes. Many international projects, - several ones coordinated by the European Schoolnet - aim to give teachers a big help to use digital materials prepared and tested.

The European Schoolnet (EUN) is a network of 30 Ministries of Education in Europe and beyond. EUN was created 15 years ago to bring innovation in teaching and learning to its key stakeholders: Ministries of Education, schools, teachers and researchers [5].

In this paper I also describe a good resource created by myself, for teaching Electricity in the secondary or primary school. The presented resource can also be used by teachers at colleges, even in the BSc education program. Usually in a BSc program students should learn some fundamentals of physics, but unfortunately majority of them do not have the basic knowledge in electricity, since they come from different schools. Therefore, I think, that the presented digital material can also be used for the reinforcement of BSc level students’ knowledge.

The following Good Practice (called GP in the following) includes basic multimedia elements and online quizzes created by Web 2.0 technology. Multimedia elements related to the topic have been built together using a free online course management system (MOODLE). Some multimedia elements, like video recording, presenting hands-on experiments or quizzes, etc. have been created in different groups of students, who were divided in little groups in advance. During the test of the GP the well known project method has been used.

2. Used method: project method
The project method is an educational enterprise in which students solve a practical problem over a period of several days or weeks. The duration of the project is defined by the teacher, or by the project manager, who controls the whole project.
The first appearance of this method can be dated back to about 1800, but its more frequent use occurred only in the 20th century. The main advantage of the method is that the participating students can carry out activities which correspond to their interests. The student's activity can be controlled during the whole project, which also means that they can be better motivated.

As a practicing teacher in the described project I also have used the project method as a qualitative method of pedagogy, and as a demonstration of and motivation for the scientific research activity. The method is complex enough to efficiently mobilize masses of students to meaningful learning and to help them acquire knowledge that they can use effectively.

Beside the project method I also applied enthusiastically the cooperation learning - Dr. Spencer Kagan's method - to change the attitude of the students towards physics. None of these methods could be assessed, and worked out without the use of the ICT techniques.

3. SPICE, SCIENTIX collaborative project

In December 2009 a consortium consisting of the European Schoolnet (EUN, Belgium), Dumnazzhamic sluceb MSMT (DZS, Czech Republic) and Dirección Geral de Inovação e Desenvolvimento (DGIDC, Portugal) launched SPICE, a 2-year project funded by the European Commission’s Lifelong Learning Programme (DG Education and Culture). The aim was establishing a Science Pedagogy Innovation Centre for Europe. The experts came from all member countries of the project, public schools (usually a person / country) who are current [6].

The created new initiatives have been implemented in 16 European countries, by teachers and experts.

The aims of the project were the following:

- to create interesting, easy-transferable good practices: GP
- to create teaching materials in mathematics and sciences and technology,
- to predetermine criteria selected from other teaching materials,
- to test the created GP by the participants of the countries,
- to use Moodle (http://moodle.org/) free online course management system for developing of the material,
- to create a curriculum that is taught in other European countries.

Before the definition of the project criteria the teachers involved had face-to-face meetings but afterwards they communicated using “Basecamp” online project collaboration tool: http://basecamphq.com/

In the beginning of the project every teacher had to define the general characteristics of the chosen GP, and the subject area. I choose physics and ICT in education. The GP I created can be used for students aged 12 -14 or above.

The digital material Electricity and Magnetism created in the MOODLE course can be used by all teachers and students registered at http://moodle.scientix.eu/auth/openid/login.php site, and who created an open ID. Students, and teachers with registration, can see the whole digital material from MOODLE course, not only one of them. The created material is online available also at http://www.scientix.eu portal. The resource can be reproduced and can be translated into any languages.

The aim of my project was that students be motivated to learn basic principles of electric motors, and to apply theory to everyday uses of electric motors.

During the project students have been working in teams, followed instructions described in 5 well-defined worksheets prepared for approximately 5 working groups. Students were also inquired about
the real experiments performed by themselves, were trying to interpret the watched video from the Moodle course (http://moodle.scientix.eu), and predict the outcomes. This material helped the students to form independent opinions, develop their creativity, their problem solving and correlation finding skills, and also to develop their ICT literacy.

During the project each group performed 5 different experiments, using 5 worksheets. All students before the experiments were asked to fill in a pre-questionnaire related to the topic. The preliminary questionnaire was designed to test the students’ prior knowledge.

The idea of the activities described on 5 different worksheet was to build easy hands-on experiments with very cheap and simple materials like strong neodymium magnet, Cu wire, safety pins, rubber band, coil, several feet of insulated wire, nail (or a bolt) and small metal objects. As an example we cite here one of the experiments, the “safety pin motor”. The students could watch the experiment before starting the construction:
http://videa.hu/videok/tudomany-technika/1st-experiment-clip-motor-paper-oyn7khJjAbf9DqSy

A brief description of the task from the worksheet

1. Wrap approximately 7 turns of wire around the battery. This makes up a small coil.
2. Remove the battery and twist 10 to 15 turns of the remaining wire through the coil to secure the 7 turns.
3. Remove all insulation from one conducting lead. Scrape only the top half of the insulation from the other conducting lead.
4. Unfold two large paper clips. The unfolded paper clips should connect to the battery. Clamp the smaller part of the safety pin to the poles of the battery using a rubber band.
5. Stick two button magnets on the side of the battery.

After performing the experiment students had to discuss with the group what they have observed. They also had to record their experiment using a digital camera. Finally all photos, and video files had to be uploaded to a data storage server, and they also had to use them for preparing a small report. Each group created a Powerpoint presentation, uploaded at http://www.slideshare.net/ site and in the end of the project they presented it in front of the colleagues.

During the project I observed that students’ interest was really raised up while working in teams. The following activities were the most effective: hands on experiments, thinking about the questions in the worksheets, preparation of the presentation, video recording and photo making. Students also improved their ICT and communication skills. The details of the project are described in the Moodle course: http://moodle.scientix.eu. The duration can vary from 60 minutes to 5 times 60 minutes depending on the depth of the aimed knowledge. Teachers can split the class in little working groups with 4-5 students/group, depending of the total number of students in a class. The teacher has to pay attention that every group should include very active students, with good intelligence and also with different competencies.

After completing the first activity the students had to perform the next 4 activities. During those experiments they changed their roles in the group. Therefore every student had the opportunity to play several roles.

Finally, all students were invited to fill in the post-questionnaires related to the topic, and to play with an online crossword. From this crossword they could get the English name of some new Physics terms related to the topic. For the right solution students had to search the web and find the specific academic terms in English related to the topic. During the project students also improved their social and communication skills, because they were working in teams, where they had to share their ideas, had to discuss their hypothesis and conclusions. They also were under control of another student, or had to call the project leader, who was responsible for the work.

4. Moodle course
Moodle is a Course Management System (CMS), also known as a Learning Management System (LMS) or a Virtual Learning Environment (VLE). It is a free software package. Educators can use this web application to create effective online learning sites [7].

This global development project is designed to support a social constructionist framework of education use in:

- Primary education
- Secondary education
- Tertiary education
- Adult education and training

Moodle is a Course Management System that can be used as a tool to create reproducible educational resources. Using this LMS system in secondary school and in higher education teachers can very effectively verify their students’ work and progress. Students can be enrolled manually by the teacher, or automatically by the administrator, or they can be allowed to enrol themselves. Students can also be added to groups if they need to be separated from classes, sharing the same course or if tasks need to be differentiated.

5. Future of the project

The project method described here can be applied in any field of science education. The topic should be chosen by the teacher. The main goal of the project is to apply and use the new free technologies like: Moodle platform, or any other web 2 platform. I am confident that the use of these new techniques can contribute to increase the motivation of the students to learn better and to make them like better the science subjects.

6. Implementation of the method

The material briefly described here can be implemented in any countries, and can be translated into any languages, following the detailed instructions described in the Moodle online course. In the Moodle platform, students can be enrolled to the course, and the course can be completed with new topics, and new multimedia elements.

7. Conclusions

Use of the ICT in Education combined with the project method could be a promising asset to modernize the teaching of physics and make natural sciences more attractive by engaging multimedia and Internet communication.

With the help of the innovation – the attitude improving projects – we have come closer to the goal of having students who are autonomous, have a creative way of thinking and by integrating their experimental, theoretical, mathematical and IT skills they are able to have proficiency of knowledge that is universal and useful.

References


