ICT use in science Education

B. Jarosievitz[*1]

[1] SEK Budapest International School, 1021 Budapest, Hűvösvölgyi út. 131., Hungary

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 [1-4]. To turn classes more interesting it is necessary to take advantage of the opportunities offered by IT and multimedia. 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 [5-8].
As a practicing teacher I had introduced the project method [9-13] 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 took part in national and international collaborative projects where the use of ICT was required [14]. The successful projects are e.g.: The Solar constant measurement [15-16], Observation of the Venus transit [17-18], and the XPERIMANIA [15] project.

Keywords ICT, project method

1. Introduction

Globalization and technological change processes have accelerated enormously in the past fifteen years; therefore the use of ICT in education became a common requirement.
The effective integration of ICT into the educational system is a complex process that involves the followings: curriculum and pedagogy, institutional readiness, teacher competencies, and long-term financing, among others.
The effective use of Information and Communication Technology (ICT) in Hungarian secondary schools has been started in 1998, when majority of the schools has been connected to the internet (The idea of the school connection – the first Hungarian Schoolnet project – has been announced in 1996).
During my educational career I also became confident that it is impossible to adequately teach some parts of physics (e.g. chain reaction [12]) and related natural sciences without the use of computers, video files and simulation programs. Some say that computers are not necessary if you have a decent teacher. Others fear that teachers will no longer instruct but, rather, leave everything to the student and the computer. These objections are understandable, but it can no longer be misunderstood: computers are essential to even moderate levels of instruction in the world at this time [1-4].
Computer simulation programs offer a unique opportunity for students to see and work with systems and substances that they would rarely, if ever, be able to actually practice with in reality. Dangerous substances and situations, expensive equipment, and theoretical, even fantastical, ideas can be explored in a way that is more thorough than practical teaching has ever been able to do before. Never before has there been a situation in which the creative mind could be so safely and precisely indulged in this most important area of education.
These benefits of computer simulation programs must not be misunderstood to mean that a computer can be the sole provider of instruction for students of physics and natural sciences! Nothing can replace the experience and the personality of a good physics teacher [12, 19-20]! However, a physics teacher is human and subject to the laws of space and time. Students, who are slower or faster, have the benefit of working on more, or less, advanced experiments regardless of the pace of the class. This is particularly helpful for students who need to practice material in which the class has already covered. Slower learners can continue to explore previous experiments without needing the classroom instruction to be repeated again and again. They can replicate experiments until they actually see the correct results. Likewise, advanced learners have the freedom to experiment on subjects that may not be understood by the majority of the class yet. In both cases the slower, and the faster students of a class benefit from the new methodology of combining the power of the computer with the wisdom of the teacher.
We are confident that the role of the teachers and students should be changed. Using cooperative learning and also project method all students are equal partners with teachers, and teachers become mentors who will guide their students. Everybody in a team is a learner, and everybody has a responsibility, and also teachers and students can learn from each-other [5-7].
Practising the method I also understand that behind any cooperative activity there should be both an academic and a social task in all cases. Both skills are very important, but the social task became more important than the

[*] Corresponding author: e-mail: bjaro@goliat.eik.bme.hu

academic task. The academic task is concentrated more to the lexical knowledge which can be learnt from the book or from the internet, but the social task could not be learnt, but can be achieved and expanded only in real practice. Using collaborative learning method we all can help our students or colleagues to develop their social skills and to become successful learners, confident individuals and responsible citizens.
With the help of the innovation – the attitude improving projects – we can 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 are able to have proficiency of knowledge that is universal and useful.

2. The Solar constant measurement project

The Physics Department of the Virtual Section of the European Schoolnet and the Hungarian Physics Team of the Schoolnet (Sulinet) has launched together an international, common project for students and teachers.
The aim of the project was to measure the solar constant at the same time in Europe *http://sunday.sulinet.hu/*, using the same experimental set-up, instruments at different places and by different weather conditions. Finally with the use of ICT all participants were invited to share their experience, opinions. All measured results had to be uploaded to the project website and were compared with the theoretical values from literature. The real measured differences were discussed between the teams by email and chat.
The purpose of the project was:

- to involve as many European schools as possible and to submit their experimental results via online,
- to collect the measured results online,
- to discuss the relevant information through internet,
- to construct an experimental device and to develop the resources available for students,
- to analyze the obtained data and discuss the results.

In the days after the registration period the students and the teachers were building up the experiment. They did their best even in the preparation work. Students improved very well their computer skills, beside improving their knowledge in physics, they learned new communication and media techniques in teams. For many of them it was a good practice to search on the web to get more information regarding the SOLAR CONSTANT, or upload their own pictures in the projects' database. There were also groups who prepared posters, or PowerPoint presentations for their colleagues during the preparation of the experiment. Many students answered the quiz questions online, and lot of them improved their knowledge reading different articles, journals regarding to the topic. The evaluation of their quiz answers happened online, so they got their results immediately.
Comparing and analysing the measured values obtained by the first method (mentioned in the official website), we can conclude, that in majority of the places the colleagues succeeded in measuring the solar constant with between 2-20% relative deviation from the published "official" values in literature.
At some schools the groups used the second method, previously described on the website. In this case usually larger errors occurred in the experiment. None of them could get the relative error below 20 %. This means that this method was not as precise as the "first" one. The Solar constant measurement emphasized international communication, the deepening of international cooperation and application of complex knowledge (preparation of a tool for measurement, measuring, interpretation).
The project was successful. The action had been reached the objective of the project. Many schools, students and teachers have been involved in the project.
We learn the following from the teachers' report:

- the students enjoyed the project
- students took part enthusiastic not only in the experimental work but also in the preparation phase
- the teams felt that their work was a first, successful pilot project, which should be continued in the future
- the project hopefully created a tradition in international collaboration work in science learning in Europe

This project has the following novelties:

- the measurement has been done with the same arrangement at the same time in Europe
- schools who intended to participate in the project had to register themselves previously
- the students were involved even in the construction of the experimental equipment
- the constructed equipment can also be used in the future
- differential teaching methods were used (all teams depending on the tutor got different task to work out) and they could be compared for effectiveness
- students have been invited to work in teams
- the role of the communication has been increased

- this work could not be done without the internet (to collect all measured data, to keep contact with the schools)
- evaluation has been done with the help of an online network
- teachers got opportunity to take part in an international project, to keep contact which each others and exchange ideas about Physics

We can conclude that the first project was successful as well didactically as methodologically, therefore similar projects have been lunched later.

3. Observation of the Venus transit

In 2004 a rare astronomical phenomenon gave us the chance to arouse students' interest in natural sciences and use of ICT skills. After 122 years Venus passed again in front of the Sun. Since 1610, the invention of binoculars, this has been the first occasion to observe this rare phenomenon. from Europe. On 8th June Venus has been observed moving in front of the Sun. From the literature we find that in Hungary the next transition of the Venus can be seen only in 2247.

Joining the European Venus Transit *(http://venuszatvonulas.csillagaszat.hu/)* Watch Movement, Hungarian Astronomical Association and the Physics Department of Hungarian Schoolnet (Sulinet), have launched a joint project in which they asked the Physics teachers to observe the Venus transit together [17].

The aim of the project was to have more schools join the initiative. Our school was very enthusiastic, and beside the real observation students designed posters and drawings about the Solar System. These were displayed at a national exhibition at the Planetarium of Budapest, and took part in a countrywide competition.

The subject of the competition: was

- Our home, the solar system.
- The transit of Venus in front of the Sun.

The project included:

- a practical part: observation through telescopes (application of Physics and Astrophysics knowledge), designing a poster (use of the ICT skills and Art).
- Learn about the safety measures (not to observe the Sun directly through the telescope without appropriate shields).
- Writing an article, a report and giving feedback (ICT skills required).
- Problem solving related to the topic (thinking, discussions, using cooperation method).
- Getting new information (quiz questions, crosswords through the Internet).

Methodological goals:

- how to teach students with different levels of knowledge in the same class,
- how to co-operate,
- interdisciplinary approaches(Astronomy, Physics, Arts, History, and Informatics),
- to get students ready for individual team work and study,
- to know ways of communication on the Internet,
- how to compare and discuss results,
- how to draw conclusions.

Our school (*http://www.sek.hu/sekhtma/2003_2004/jun/jun.htm)* was lucky to have telescopes set up on campus; therefore all students watched the transit of Venus. Beside online observation majority of the students were able to watch the transit of the Venus online on the Internet. From the Technical University of Budapest we had online broadcast of the Venus transit through the web. All the photos made during the observations and the new experiences were summarized and shared on the web with everyone who was interested. After the evaluation of the project we find that in Hungary 4338 people (students, teachers and others) were mobilized to get involved in the project. We find this project very successful, and a good motivation of the public to open their doors for science. I believe that without the ICT and new high tech resource and good pedagogical methods applied during the project, this success never have been done.

I think that all of these little steps can help us to build up again the reputation of natural science.

4. XPERIMANIA I project

As a Hungarian National coordinator I had opportunity to involve my students (and also other students and teachers from my country) to another big international project called XPERIMANIA, launched by the European Schoolnet (*http://www.eun.org)* [15]. Another advantage of the project was that any of the EU official languages (except Irish), plus a translation of the title into English could be used.

The Xperimania project was organised by the Association of Petrochemicals Producers in Europe (Appe), and coordinated by European Schoolnet on their behalf. All schools in the European Union, candidate countries and EFTA countries were invited to join in. The aim of this project was to help students in lower and secondary school classes (covering pupils aged 10-20) and their teachers to understand the wide variety of applications of physics and petrochemistry and how this relatively new and fascinating science has contributed to the evolution of many day-to-day items. It is well known that this project could not be assessed, and worked out without the ICT techniques. Students can choose between two different categories where to participate:

Timeline Competition *(http://www.xperimania.net/ww/en/pub/xperimania/timeline.cfm)***:** Teachers and students were invited to explore a scientific discovery in the field of materials from 1800 to the present day. The objective was to investigate a discovery and try to imagine what an application looked like when it became available. Teachers and pupils needed to produce a digital resource describing what they have found out about the discovery. The entry had to include a short text and a picture. They could also make a film, audio file, visual resources or text-based document to illustrate their work. Once uploaded to the website the entry became part of an interactive timeline of discoveries in materials (from pvc to nylon and Kevlar).

Experiment Competition (*http://www.xperimania.net/ww/en/pub/xperimania/competition.cfm*)**:** Teachers and students were invited to set up an easy and fun experiment in science to investigate the properties of materials. The lab report then had to be uploaded together with a video, or photographs on the website. All the submissions of the competition were displayed in an online gallery. Students with the help of their teacher had to set up an easy and fun experiment relating to petrochemistry and materials. The competition was focused on classroom and laboratory activities, therefore after announcing the competition some examples of experiments and requirements has been showed for the participants. All experiments had to have material properties (chemical or physical) and / or the chemistry of modern products as a focus. The topic engage pupils in an inquiry-based learning approach, which was shown to have a highly positive impact on their motivation. In the experimental part of the project, participation of teams of maximum 3 students was expected. In this case the use of the project method was very useful, because students having good multimedia skills were mixed with students who had good experimental competencies. All students were able to do the activities that they enjoyed the most. I would like to mention that this project gave us a very good view about the role of the teachers. The teachers did not make frontal classes! Teachers assisted their pupils to get prepared for the activity by following these steps:

- Engaging pupils in preparatory discussions about the experiments proposed for two age groups: age group 1 (10-14 years) and age group 2 (15-20 years).
- Identifying a topic to work on.
- Referring to relevant organisations like Science Museums or companies, making contacts and arranging local activities such as field trips or presentations at school.
- Running the experimental activity.
- Preparing the contribution with the appropriate software.
- Uploading the contribution to the Xperimania competition website.

All students were invited to upload their lab report (in pdf format) and other files (picture in jpg format, PowerPoint presentation or video file converted to swf format) on the official competition website (*http://www.xperimania.net*). All the submissions of the competition were displayed, and it is still visible in an online gallery and the best entries were rewarded by a prize.

Conclusion

In the 2007/2008 school year 1000 secondary school students from 18 European countries participated in the XPERIMANIA I project initiated by EUN (European Schoolnet). Totally 447 submissions (154 Hungarian submissions – the most) have been uploaded. An international team of teachers made a pre-selection of finalists, while an expert panel selected the overall winners. The panel consisted of top level representatives from the European Chemical Industry Council (Cefic), European Schoolnet experts and a representative of the Flemish Ministry of Education in Belgium. The winners and runner-ups were awarded in a prize ceremony organized in Brussels, Belgium on 16 September 2008 at the Museum of Natural Sciences, where all of the winners had the opportunity to visit the world's most famous dinosaur gallery.

As a Hungarian National coordinator I am very proud, because two of the six European prizes, plus a special mention, belong to our small country. The jury selected the experiment of two Hungarian students, Péter Holányi and Hajna Takács as the first runner up: "Surprise, Investigation and Research in connection with the Polyethylene".

The "Timeline" competition invited students to explore a historical discovery in the field of materials and petrochemistry. As the first runner-up, the jury selected the entry "Bitumen" provided by Mátyás Molnár from Hungary. In addition, the jury gave two special mentions. The Hungarian project: "Tyre", was nominated with the "Special mention for link to daily life".

Beside the experiments and research activities, the communication skills of the students were also developed. During the project four possibilities have been offered to participants who registered before, to take part in

online chat and ask their questions formulated in advance. During the chat the discussions were moderated, and well known experts have been invited to answer the students' questions.
The success story of XPERIMANIA I. will continue this school year, since Xperimania II was already launched at the end of September with new activities.

5. XPERIMANIA II project

The "Check out the property!" competition is open for secondary school students aged 10-20 years. In groups of maximum 2 or 3 they need to research a property – such as lightweight, water resistance or energy efficiency (a list of properties is provided on the website) - find out a way to test it and explain the results in a clear and structured way in a lab report. The lab report uploaded on the XPERIMANIA online gallery should be accompanied with an image, video or other multimedia documentation of the test process.
All the submissions uploaded on the website before 30 April 2009 will be evaluated, and the best entries will be awarded with a personal media player for each student and a stipend for their school to be spent on scientific classroom resources [15].

6. 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. I am confident that the applied method and described projects highly changed the attitude of the students for the natural sciences and their mind start to open the doors for science.
"Effective learning in the classroom depends on the teacher's ability ... to maintain the interest that brought students to the course in the first place" [13]

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