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CONCEPTUAL LEARNING OF PHYSICS IN SLOVENIAN PRIMARY SCHOOLS

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Abstract

Teaching and learning with computers (ICT) encompasses her help in educational process everywhere there where is this perhaps and reasonable. Using ICT as educated accessory mean search of optimal elements for teaching efficiency and for better achieving teaching objectives. Learning process of science, mathematic and technical subjects in elementary school in many situations demands practically and problem solved work. Conceptual learning of physics is computer based and its strategies lead pupils to a better understanding and use of more difficult processes (thinking, inferencing, using the knowledge). By conceptual way of learning we used „fizlets"as simulatory models. They are interactive materials, where processes happen in certain intervals and there is interaction between the model and the pupil.

The main goal of study was to research the effects of conceptual way of learning in comparison with traditional classroom education when teaching the topics "Pressure and lifting power" in the eighth class of primary school. We tested four thinking processes of pupils (knowledge, analyses, inference and comparison). The main expected ascertainment of research was that the pupils, who were taught through the conceptual way achieved better results than those who were taught traditionally in the classroom. Hypotheses were confirmed. In general this article will show other users of teaching physics and science some didactic manners of preparing interactive educated materials.

Key words: *educational system, computers in education, science, physics, information and communication technology (ICT).*

Introduction

Computer assisted or ICT assisted teaching provides educational support were ever it is feasible of reasonable. The objective of ICT and computer in the educational process is constant search for improvement. This also encompasses searching for the optimal solutions for pedagogical effectiveness of educational goals (Gerlič, 2000). One of the advantages of appliance of computer and/or ICT in the education is software. Software is capable to vividly present and simulate different phenomenon without the need of expensive equipment which is beyond the reach of educational institutions. Software can also enable virtual execution of dangerous experiments and above all it can introduce research and problem solving approach to the education. Natural science, mathematics and technical science teaching is based on team work or individual practical work. Method of practical work has dominant role in problem solving education. It demands student's active involvement in new knowledge acquisition. Individual's practical work and problem solving education (Strmčnik, 1992) in the teaching of natural sciences, mathematics and technical sciences are the fundamentals for all other teaching and learning activities. But this approach is not the only intuitive instruction. It has its specific operational demands and it is not always feasible. For example teacher is unable to prove the physics or chemistry phenomena experimentally. This cannot be done because of material, safety, didactics and time schedule aspect. In those cases he/she uses elements of instructional technology where computer and ICT plays a major role.

Motivation is one of the key problems in the natural, mathematics and technical sciences education. In the education in general the motivation and active knowledge of the students is of a paramount importance. Unmotivated, template of pattern solving principles and minimal creativity learning has no future in contemporary education. Computer and ICT have ability to incorporate motivation and research problem solving approach into the education. Incorporated teaching strategies in the software demands student's constant active involvement, knowledge processing, and new knowledge acquisition at all time during the education process. Those in favor of the computer and ICT in the education are right when they state that technology opens the new way in the education. But even those who oppose using of computer and ICT are right when they state that technology breaks proven traditional educational practices and every day's work. Both sides have ability to find pluses and minuses in the application of computers and ICT in the education. But this does not changes the fact that we need further research and scientifically proven answers about the benefits of using the computers and ICT in education. Our experiences show, computers and ICT open new types of pedagogical activities and agitate curiosity and creativity of students (Gerlič, 2006). Computers and ICT are proven to be very motivating factors and therefore highly valuable in the education. Even students express they like lectures more if they use ICT and computers. It would be a waste if we do not use them in the education. Using computers students have ability to solve much more complex problems than using the traditional approaches. But we still need to be cautious. It is wise to use the technology only where it assures the optimum pedagogical, technical and professional demands of the education (Gerlič, 2000).

Lately in the world and in Slovenia we promote the conceptual learning approach in natural and technical sciences (Wolfgang and Belloni, 2004), so-called COLOS - Conceptual Learning of Science. Basic and primary goal of conceptual teaching is experience adventure. Student should become familiar with the effects of natural of technical law before they receive it's theoretical and mathematical background. This is the way to narrow the distance between physics and "real" physics or any other natural or technical scientific discipline. Students can see the effects of the science in the every day's life and can explain every day's experiences with the scientific background. This bond is usually not so evident (or even cleared) in the traditional frontal approaches. Conceptual learning enables the integrated and global view to the learning material and better understands the abstract mathematical models and real world events. Interconnection between abstract mathematical models and real world phenomena is very important in the learning of natural and technical sciences. Traditional approaches use too much time to establish this bond between two views to the same problem. Nice example is the physics presentation of forces on the slope (Gerlič, 1991). In the traditional approach the teacher draws the right-angled triangle on the blackboard and a rectangle on its diagonal. Then he/she adds vectors of forces on rectangular and writes mathematical equations. This topic ends with the one or two examples to present and consolidate the new knowledge. The problem in this approach is that student does not know that the right-angled triangle is actually hill outside the classroom and the rectangle may be the car driving up or down the hill or him walking to school. This is a drastic example but such topics are not rare in the education process. We have not mentioned that physics in such approach looses all its meaning. It becomes bored and self-sufficient. Conceptual learning with its simulations is one of the ways to prevent these unwanted results.

Project COLOS (Wolfgang and Belloni, 2004) uses models, animations and simulations for problem solving approach and logical active approach in the education from its start. At the beginning simulations required expensive graphics workstation (e.g. SUN, HP, Silicon Graphics ...) but the advances in the computer technology and World Wide Web enables personal computers to become powerful enough to run simulation. Simulations are now available on the all levels of education. In the last decade we start using java programs - applets in the combination with the hypertext to present modern form of interactive textbook. Another technology that enables web interactivity is also the JavaScript. JavaScript introduces the client processing and change

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the static web pages into a dynamic. Cooperation of hypertext and dynamic elements led to the development of applets. Applets (Figure 1) are controlled by the scripts and can coexist with the hypertext.

Let end the introduction and focus on the content which teacher need the most. We decide to use the physics for our explanation but this could be extended to any other profession. Prof. Wolfgang Christian (Davidson College, North Carolina) introduces the concept of physlet. Physlets (figure 2) are Java applets developed for physics education and can be controlled with the JavaScript.

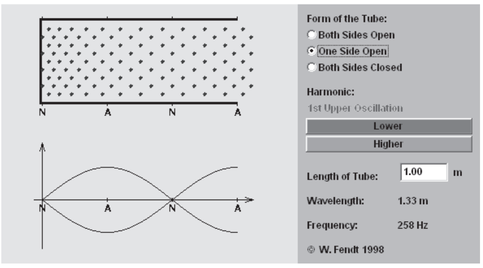

Figure 1. Applets

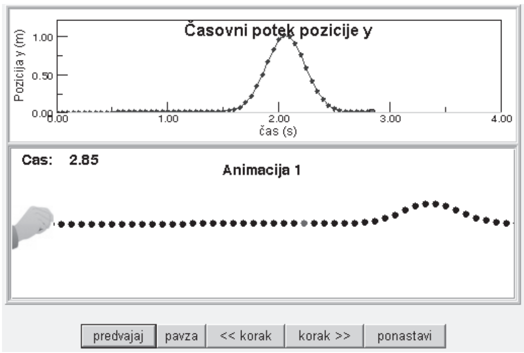

Figure 2. Physlets

Interactive Materials for Teaching and Learning

Physlets - “physical applets” are small, adoptable Java applets we can use as simulation models in the web applications. In the world physlets are successfully used in the physics education for years. Physlets have many attributes that gives them special educational values. They are simple and they use uncomplicated graphics. Each physlet addresses one physics phenomenon and it does not deal with the analyses of the data. Since they are small in size they can be easily downloaded from the web. They do not have details which can be more misleading then helpful.

Physlets can be used as construction elements in almost every teaching plan and in almost any teaching approach. Despite we believe that teaching methods requires interactivity we can use them in the classical demonstrations, defining home works, knowledge diagnostics etc. The technology of physlets is didactically adjustable. Their behavior can be set and controlled with the JavaScript. With the minor changes in the script we can set arbitrary content from mechanics, electrostatics, etc. We do not need to change the Java code of the applet. Inter-applet communication can transfer data and even provide data analysis.

Creative teacher is not satisfied using the existing didactical examples even if they can pick from large number of examples (Wolfgang, 2005). He/she wishes to adjust them according to his/her own idea or create their own examples. Examples can be used in interesting problem oriented solving principles including interactivity and accessible on the internet. This approach enables students all day work in school or at home. Simulations can also be used in test systems.

Effects of Conceptual Learning of Physics in Primary School

The main goal of our study (Jakob, 2007) was to research the effects of conceptual way of learning in comparison with traditional classroom education when teaching the topics “Pressure and lifting power” in the eighth class of Slovenian primary schools. We tested four thinking processes of pupils (knowledge, analyses, inference and comparison). 100 eight grade pupils from two primary schools took part in the research. 50 pupils were taught physics traditionally and 50 through a conceptual way. Two teachers were teaching them in February and March 2008, altogether for five weeks.

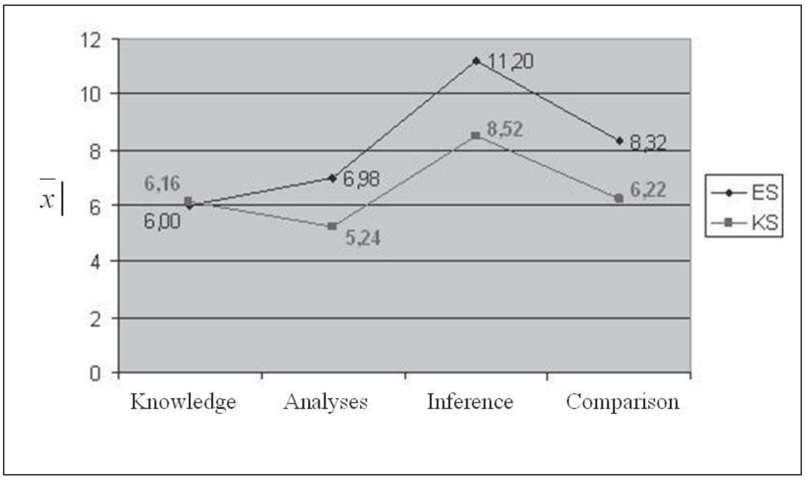

Figure 3. Arithmetic mean of achievements of students (ES – experimental group, KS – control group) in individual assemblies of task of test of knowledge round experiment (Jakob, 2007)

The main expected ascertainment of our research was that the pupils, who were taught through the conceptual way achieved better results than those who were taught traditionally in the classroom. We anticipated that there would be statistically important difference between the pupils who were taught through a conceptual way and those who were taught traditionally. These theses were confirmed (Figure 3). There's no doubt in Slovenia, whether we should use conceptual way of teaching or not, but **where, when and how we should use it**, so that its use would provide a better quality and better effects of learning and teaching (Jakob, 2007).

We have to emphasize that we used a model of conceptual way of teaching a topic in physics and that we planned, carried out and evaluated the educational work with modern concepts and strategies of learning and teaching physics – which is also carried out in the curricular renovation in Slovene primary schools.

Conclusion

Conceptual learning of physics brings modern ways of learning and contributes to better understanding and popularity of physics. When teaching physics, we are interested in physical side of natural phenomena. That is the reason, why a teacher should provide a subjective and entire experience of these phenomena. Already in primary schools the lessons should be planned problem-based, experimentally and IT elements should be incorporated. New media and modern methods lead teachers and pupils to a deeper insight and better understanding of the phenomena that pupils learn about. This kind of understanding influences the quality of teaching, improves pupils' ability to abstract, understand and help solving problems.

The principal role of this approach is the empirical experience of a naturalistic law, rather than its theoretical understanding. In traditional, classroom education this is often put in the background.

Conceptual learning of physics is computer based and its strategies lead pupils to a better understanding and use of more difficult processes (thinking, inferencing, using the knowledge). By conceptual way of learning we used „fizlets" as simulatory models. They are interactive materials, where processes happen in certain intervals and there is interaction between the model and the pupil. Two way interaction and the constant possibility of changing the conditions, observing the impact, problem-based approach and didactic evidence, dictate the most common use of this strategy in physics education.

There are no reasons not to use conceptual learning approach in other studying programs. We can track use of physlets in chemistry and we could easily use them in the mathematics and the rest of natural and technical sciences. The charm of the physlets in physics can be seen in the number of didactical examples which authors prepare when they systematically cover the education of physics. Empirical data of our research are confirming accuracy and successfulness of this way!

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