

PHYSICS TEACHING AND TEACHER TRAINING

IMPLEMENTING EDUCATIONAL CONSTRUCTIVISM IN MODEST WORKING CONDITIONS

Vlado Halusek^{a)}

Elementary school "Kloštar Podravski", Kloštar Podravski, Croatia

1 INTRODUCTION

Successful Physics teaching is one of the largest challenges which lie ahead of modern education in the world. Additionally, it has special meaning at the beginning of the 21st century because Physics is the essential subject for orientation of the young generation toward scientific-technological development which is the basis for the progress of modern economy. Novodvorsky [1] believes that implementing educational constructivism is a critical change in improving Physics teaching. Constructivistic approach to teaching means changing the role of the teacher in the sense «sage on the stage to guide on the side». Such an approach to the learning process includes the exploratory activity of students and, thus, it enables deeper understanding of what is being learned [2]. It can be realized by designing the educational environment where children will be stimulated to study by individually activating their cognitive abilities. Forming a stimulating teaching environment enables students to create their own ideas during individual or group work. A stimulating teaching environment implies that schools should be equipped with good personnel and necessary technical equipment. This in particular implies to constructivistically-oriented Physics teaching based on experimenting, researching and debating.

In Croatia, schools are very diversely equipped. Some schools are equipped in a modern way, but, as the author himself is aware, there are schools which can not be called schools by the criteria necessary. One of such schools is the school where the author works. If talking about modern conditions for teaching, it would be inappropriate to talk about this particular school. There are no specialized classrooms, no additional space for equipment, and no draining systems. Basically, everything is missing. The teaching system is that students of one class spend four years in the same classroom and there they listen to all subjects. After the working conditions have been described, a logical question arises:

Is it possible to qualitatively teach Physics in modest working conditions and what results should be expected?

Due to that, a long term project has been started, whose purpose was to prove that is possible to achieve very good results in comparison with highly-equipped schools.

^{a)} Corresponding author's e-mail: vlado.halusek@kc.t-com.hr

2 CERTAIN ASPECTS OF TEACHING IN MODEST WORKING CONDITIONS

- The teaching process is mostly performed frontally, combining the methods of demonstration and discussion. In the process of setting up an experiment, measuring and giving conclusions various students are participants, so it can be stated that it is a group effort with the class being one group.
- While performing an experiment, the simplest instruments are used, and occasionally there is improvisation which is sometimes the only possible course of action due to modest working conditions. When performing a more complex experiment the device should be set up in front of the students whenever possible.
- At the beginning of each lesson problem reinforcement is applied and previous lessons are summarized so that the problem is presented through methods of discussion or demonstration.
- Questions from students are held in high regard. Student's questions are used to determine their interests and misconceptions, which are important for the adjustment of the teaching process to the demands of the students, instead of making the students adjust to the teaching process.

2.1 Resolving the problem of lack of equipment

Resolving the problem of lack of equipment depends on the inventiveness of the teacher and his readiness to improvise and adjust momentarily to the situation. This involves the adaptation of various near-at-hand instruments for teaching purposes, as well as being prepared for any surprise events. Concretely, to solve the problem of lack of equipment various ways can be applied, as follows:

- Creating problem situations with a well aimed dialogue (discussion).
- Performing thought-experiments in which students imagine the experiment with inventive and flexible guidance of the teacher.

Example The thought-experiment connected to teaching or repeating the lesson *Pressure*. Imagine that in one situation a female student in high heels stands on your foot, and in the other situation she is wearing running shoes. Which would hurt more? Why? What conclusions can you make based on these responses?...

- Appealing to the student's experience so that the students remember everyday situations.

Example Using a discussion and student's experiences while teaching or repeating *Density*.

Does water or oil have a greater density? Oil.

Why? Because it is dark, greasy, thick...

What happens to oil which spills over water (tankers, tank trucks...)? It swims on water.

This means that a greater density has... Water.

- Students bring various equipments from home, with the parent's permission. This pertains mainly to student's individual projects. In regular classes it can be: a leaf of a plant used to measure the area of an irregular object; various boxes used for measuring volume of regular geometrical bodies; measuring devices for measuring length, volume, time, temperature etc.; different mirrors for optics; various tools used to demonstrate devices based on a lever-principle, etc.
- Using near-at-hand equipment when performing experiments: chalk, sponge, chair, bench, writing implements, ruler, water, etc.

Example You take a sponge and squeeze a bit of water out.

How is this possible? Where was the water? What conclusions can you make about the structure of the sponge? The water was in the holes. The sponge is thin...

Can we do the same with the chalk? The answer is usually negative. Some students remember that the chalk absorbs water, because they can't write with it when it is wet.

Let us try. We can not squeeze the chalk, but we can put it in a glass of water.

What do you see? Bubbles are coming out.

Why is this happening? Where were these bubbles? Why are they not coming out all the time, but only in the beginning? The chalk also has holes.

Where are the holes bigger? Does the chalk or the sponge have greater density?

3 METHODOLOGY

3.1 Purpose of the project

The primary purpose during the realization of this project is to prove that constructivistically-oriented Physics teaching can be very efficient in very modest working conditions.

3.2 Methods

A long-term project has been started which refers to standard Physics teaching being done in a constructivistic way. During teaching actualization, students are encouraged to make their own experimental work. Works of the highest quality are publicly presented and are recommended for the state school competition for independent work done by students. State competition has been chosen as the outer form of evaluating students' achievements, and, by doing so, for evaluating the complete process of teaching.

3.3 Time and place for realization of the project

The project has been realized during September 1998 until June 2006. It took place in the Regional school "Podravske Sesvete" which is a part of Elementary school "Kloštar Podravski".

3.4 Working conditions

The Regional school "Podravke Sesvete" is a small primary school with an average of 180 students. Each class has from 15 to 30 students. Students are mostly from families which work in agriculture and farming. The vocation of parents is so low

that only five parents of all students have a university degree, two have finished a two-year college, while the rest have finished only primary or secondary school. Some parents never went to school.

The school is very poorly equipped so that the standard working conditions for experimental teaching practically do not exist.

4 RESULTS

4.1 Results achieved in competitions

The only way of comparing the effects of teaching on the state level in Croatia, are competitions for students. Therefore, it has been decided, together with students, to verify the effects of constructivistically-oriented Physics teaching. Considering the school's equipment, it would be presumed that the students can compete equally only in solving theoretical tasks. Given the purpose of the project, it has been decided that they should compete in the category for students' experimental works.

Achieved results are as follows:

- Elementary school "Kloštar Podravski" is the only school in Croatia which continuously participates in the state competition in Physics in the category for independent experimental works from 1999 until 2006.
- The following results have been achieved during that eight-year-period of participating in the state competition in Physics:
 - 1999 - third place;
 - 2000 - first place;
 - 2001 - first place;
 - 2002 - second place;
 - 2003 - participation in competition;
 - 2004 - third place;
 - 2005 - participation in competition;
 - 2006 - first place.
- Participation in the state competition in astronomy from 2001 until 2004. In 2002 and 2003, two students have publicly presented their works.
- Students have made several innovations and one of them is registered with the State Intellectual Property Office of the Republic of Croatia. The title for the registered innovation is "Holder for chalk", registration number: HR P20020463A A2.
- Two formal receptions for the students and the mentor with the Minister of Science, Education and Sport in 2000 and 2001.
- The students and the mentor have been awarded several times by Koprivničko-križevačka County and District of Podravske Sesvete.

4.2 Students' experiences of Physics

At the beginning and the end of every school year, the author talks to students about their experiences of Physics, and occasionally carries out anonymous surveys about their experiences. This is necessary for improving the teaching

process, as well as establishing an interaction with pupils. Here is a segment of one such survey (part of the research for a master's degree [3]). The results of survey are shown in Table 1.

The purpose of the survey Obtaining feedback information about students' experiences with Physics classes.

Instruments of survey The students have been surveyed anonymously, and willingly. The survey is composed so that the students can choose from double choice answers the one which applies to them. The survey has been carried out by form-masters in order for it to be as objective as it can be.

Sample 59 students of the 7th grade and 65 students of the 8th grade of the Elementary school "Kloštar Podravski" participated in the survey. In other words, students from three 7th and three 8th grades have participated.

Period The survey has been carried out during the second half of October, 2004. It was at the beginning of school year, after approximately ten working hours in Physics classes.

Table 1 Analysis of the part of survey.

Question	7 th grade	8 th grade	Total
Physics is an understandable subject.	89.8 %	90.8 %	90.3 %
Physics classes are interesting.	81.4 %	95.4 %	88.7 %
I like going to Physics classes.	89.8 %	90.8 %	90.3 %

5 CONCLUSION

The fundamental assumption during the realization of this project was that constructivistically-oriented teaching can be very efficient in very modest working conditions. This is of high importance for Physics teaching which is based on experiments.

By summarizing results from eight years of constructivistically-oriented Physics teaching it can be deduced that the initial assumption has been confirmed. With a constructivistic approach to teaching, the deficiency of teaching tools has been compensated and Physics teaching is understandable and interesting to students. Due to the constructivistically-oriented teaching, students have had the possibility to indulge their curiosity and to develop creativity. Effects of their creativity are comparable with highly equipped schools. Furthermore, during those eight years, they have achieved the best results in the state competition in the category of students' experimental works. By doing so, it has been proven that the quality of experimental projects is not necessarily related to the school's level of

equipment, but that the teaching methods are exceptionally important. Constructivist-oriented teaching proved to be a good choice for the realization of students' experimental projects in terms of quality.

Although the above mentioned results in competitions are exceptionally respectful and are the only way of comparison with other schools, the effects of teaching related to all students are also extremely substantial. The survey among students showed that 90% of students consider Physics classes to be interesting and understandable. The same percentage expressed that they like attending Physics classes. So it is confirmed that the constructivist-oriented Physics teaching is acceptable for all students.

Based on the constructivist-oriented teaching, it has also been proven that students in primary schools have innovating abilities which, by further stimulation and systematic development, can provide significant results.

REFERENCES

- [1] Novodvorsky I 1997 *Constructing a Deeper Understanding*. The Physics Teacher **35** 242
- [2] Driver R, Newton P, Osborne J 2000 *Establishing the norms of scientific argumentation in classrooms*. Science Education **84** 287
- [3] Halusek V 2006 *Učinci konstruktivistički usmjerene nastave fizike*. (Croatia: Sveučilište u Splitu / Fakultet prirodoslovno-matematičkih znanosti i kineziologije)