INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

IMPROVING THE QUALITY OF TEACHING BY MODERN TEACHING METHODS

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Abstract

The most important goal of education is improving the quality of teaching. There are several modern teaching methods that can be used in teaching and learning. These methods are focused on students´ active work. In our project we studied some of these methods, for example problem – based learning, didactic games, methods "how to express the idea with a pencil"(mind maps, tasks), discussion (brainstorming, Philips 66, Hobo), brainstormig, heuristic method. The effectiveness, motivation and problems of these methods were tested during high school physics lessons in Olomouc and Skuteč. The methods were used in various classes by in-service teachers and by pre-graduated teachers. Outcomes of this reasearch are discussed in this paper.

Key words: *teaching methods, activity, inductive methods*

Introduction

Our widespread problem is that high school physics seems to be very difficult. Students compare that physics instruction uses to much formalism, mathematics. On the other hand school physics plays a key role for recruitment of people for science and technological professions.

Teaching and learning physics (or science) at high schools in the Czech Republic is still characterized by the chalk-talk method (Dvořák 2008). Lecturing as a method of teaching high school science was find out as one of the less atractive methods (Maňák 2003). Science education research recomended some teaching strategies that are more effective for promoting understanding of science. Results of research in science education and cognition psychology defined that students learn most effectively in interactive classrooms in which

students actively engage in dialog among themselves and whith the instructor while manipulating experimental materials (Wickoff 1999).
Student-centered methods contain a great number of various instructional methods, for example project-based learning, problem-based learning, just-in-time teaching, discussion methods. All these methods are inductive, based on constructivist approach. Constructivism was studied by Nezvalova (Nezvalova 2007a). In the constructivist approach the present instructive teaching practice is completed by chosen learning problems through creating adequate learning environment. It is necessary to know that knowing is not closed, it is forming – it constructs itself individually and in terms of social relationships. Learning is an active process, it realizes in multidimensional relationships. From this perspective the learning process is primarily the matter of construction, learning individuals enter as a co-creators of learning process (Nezvalova 2007b). Students construct their knowledge, activity and motivation are important.
The problem is that teachers in the Czech Republic have not experience with varietes of inductive methods and have not skills to apply these methods in their classrooms.

Research focus

Our research focus is based on the outcomes of two projects – the project of the Ministry of Education NPV II 2E06020 and the project "Přírodovědec" (OPVK CZ.1.07/2.3.00/09.0040) worked out at the Faculty of Science in Olomouc. The evaulation of the projects shows that students are most of all interested in interactive teaching strategies and experimental laboratory tasks.

The use of interactive teaching methods in physics lessons is not very common. Several interactive teaching methods were chosen and used by in-service teachers and pre-service teachers in physics teaching at high schools in the Czech Republic (Olomouc, Skuteč). Properties of the methods will be discussed in the next part of this paper.

Project – based-learning

Project-based learning (PBL) – the most common method. It is an instructional methodology in which students learn important skills by doing actual projects. More about project -based learning will be find in Holubova (2008).
The acquisition and structuring of knowledge in PBL is thought to work through the following cognitive effects (Schmidt, 1993):
• initial analysis of the problem and activation of prior knowledge through small-group discussion,
• elaboration on prior knowledge and active processing of new information,
• restructuring of knowledge, construction of a semantic network,
• social knowledge construction,
• learning in context.

Problem-based-learning

Problem based learning is often referred to as a form of inquiry-based learning (IBL), which describes an environment in which learning is driven by a process of inquiry owned by the student. The problem can be presented in various forms – question, task, experiment.

Some theories suggest that learning occurs as students collaboratively engage with concepts in meaningful problem solving. In this view, knowledge is seen as a tool for thinking and for enabling learners to participate in meaningful activity.

Consensus decision-making

Consensus is a group decision - making process, the resolution is the general agreement. We can find a simple structure of each consensus process:

- discussion of the item - getting information about the topic and identifying opinions,
- formation of a proposal,
- call for consensus,
- identification and addressing of concerns,
- modification of the proposal.

The teacher plays various roles – the teacher is a facilitator, a timekeeper, a vibe watch (he is monitoring the emotional climate), a note taker. To be succesfull with the consensus making, some guiding principles must be applied - inclusiveness , accountability , facilitation , shared control, commitment to implementation. Magic happens when everyone is in agreement.

Brainstorming

Brainstorming is a group creativity technique designed to generate a large number of ideas for the solution of a problem. In 1953 the method was popularized by Alex Faickney Osborn in a book called Applied Imagination. Osborn proposed that groups could double their creative output with brainstorming.

The most important outcome of brainstorming is improving team work. Some dissadvantages of brainstorming, for example not feeling free to present unusual ideas, were elemenated by electronic brainstorming. The aim of brainstorming is to generate a great number of ideas. The teacher has to create a criticism-free environment, to present the problem and organize the discuccion. It must be clear, how to measure progress and success, the way for evaulation of the process. The solution of brainstorming must be clear for all.

Mind map

Mind maps help avoid linearly thinking, the problems are solved more creatively. You can use a sheet of paper, the central idea is written in the middle of the paper. Then you can add new ideas using words, combine them, add a structure. It is a visual method, there are a lot of possibilities, how to create a mind map. Later on you can modify the information.

Heuristic methodology

The heuristic method of learning is based on learning by discovering, on constructivism and on active interaction of teachers and pupils. An outcome based on the heuristic Metod, in the Czech Republic very popular, are the activities of young debrouillards. The common axes of their philosophy are: use of scientific process, leader guided creativity, use of cheap and non-sophisticated materials. The method include entertaining activities to stimulate the kids´ exposure to the scientific phenomena they meet in the every day environment, to develop the child´s curiosity and analytic mind, to have training effects on the family, scholar and social scales. The Heureka project is running in the Czech Republic for more than twelve years.

Seminars and workshops for teachers are organized, materials and worksheets for interested teachers are prepared.

The effectivness of lectures with interactive activities

Interactive methods mentioned above were used as teaching methods in physics teaching at high schools in Olomouc and Skuteč (Czech Republic). Methodology materials for teachers and worksheets for students were prepared. Recommended methods were attached to the materials. Methods that were recommended for use: heuristic method, brainstorming, mind map, Phillips 66, project-based learning and problem-based learning, black box, consensus. The topics according the kinematics and dynamics of the mass point and an object were tested. The methodology materials for teachers contain the list of equipment, the method, excercises and tasks, information how to organize the lesson, the needed time for the activity. List of tested physics lessons:
Kinematics of the mass point (Velocity, uniform motion, The trajectory of uniformly accelerated motion, Free fall, Acceleration of gravity) , Dynamics of the mass point (Newton´s First law, Newton´s Third law), The principle of conservation of linear momentum, Inclined plane.

I our research we used mostly qualitative methods of pedagogical research (interview, discussion, observation, and case studies). The evaluation of all lessons was focused on these three main questions: 1.how to prepare the lessons, 2. kids´ activity and 3. difficultness of the method. Each method was marked with the mark 1, 2 or 3. The best mark 1 was obtained if the method was leading to active students´ work, to communication, team work. Verz important that the method can be used in all parts of the lesson.

Results of Research

Heuristic method

Based on the teacher´s idea, if he is able to find a problem were students can do their own research and find out the new principle. Untraditional equipment is needed. The method is based on the experimental activity of students.

Evaluation: Very useful, this method really improved the activity of students This method is an important tool for teaching and learning. The method is difficult. It is necessary to prepare the lesson very carefully.

Table1. Heuristic method

Indicator	Mark 1	Mark 2	Mark 3
Acivity	1		
Communication	1		
Difficultness of the method		2	
Team work	1		
Part of the lesson		2	

Black box

A simple method if we can use data from an experiment. For example in one of our tasks during an experiment the motion of an object was studied - the trajectory and time were measured. The data were plot in a graph and students had to find the mathematic model – the function for the velocity of the object.

Evaluation – the method inicited the students´ activity. The main problem of this method was, how to find the mathematic model, the function. It was very difficult for our students. Teacher´s help was necessary.

Table 2. Black box

Indicator	**1**	**2**	**3**
Acivity	1		
Komunikace	1		
Obtížnost metody			3
Týmová práce	1		
Zařazení do výuky		2	

Problem based method - paradoxa

The velocity of a rain drop was calculated. The result of the calculation was the number 200 m/s. The task was to explain the real situation. There are a lot of problems and paradoxa that can be discussed in high school physics. They can be used in various parts of the lesson.

Evaulation – a very useful and active method. Some of the problems can be very difficult. A problem for one student must not be a problem for another one. The assistance of the teacher was needed.

Table 3. Paradoxa

Indicator	**Mark 1**	**Mark 2**	**Mark 3**
Acivity	1		
Communication	1		
Difficultness of the method			3
Team work	1		
Part of the lesson	1		

Tasks

Very interesting is the method when tasks are formulated by students themselves. Methods when tasks from textbooks are solved are boring and uninteresting for our students. When students formulate the tasks themselves, it is more interesting for them and students are very active.

Evaluation – demanding, but interesting. The main problem of this activity - students are able to think out the tasks but they do not solve them in a right way. This method can be applied even if the topic of the lesson was comprehended.

Table 4. Tasks

Indicator	Mark 1	Mark 2	Mark 3
Acivity	1		
Communication			3
Difficultness of the method		2	
Team work			3
Part of the lesson		2	

Didactic game

It is a problem, how to find interesting didactic games for high school students. We can find very simple games and very complicated games too. They can be very difficult for students so as for teachers to prepare the game. Time by time it is useful to play some games. Two types of games were tested, a puzzle and how to get a millionaire.

Evaluation – the lesson with games was interesting, the students were active. Dissadvantages – the teacher must prepare the questions for the game, it is time consuming. Time consuming is also to play the games in the lesson. For the future we recommend to play games with GPS sensors.

Table 5. Didactic game

Indicator	Mark 1	Mark 2	Mark 3
Acivity	1		
Communication			3
Difficultness of the method	1		
Team work		2	
Part of the lesson		2	

Mind map

Worldwide very popular, in the Czech Republic used very rarely. Students were asked to put down a mind map according to acceleration. The students were not successful in this activity.

Evaulation – a great problem, students never worked with a mind map. A deeper instruction was necessary. Teachers did not know how to work, prepare and evaluate the mind maps. Further activities are organized to improve the knowledge about the method.

Table 6. Mind map

Indicator	Mark 1	Mark 2	Mark 3
Acivity	1		
Communication			3
Difficultness of the method		2	
Team work			3
Part of the lesson	1		

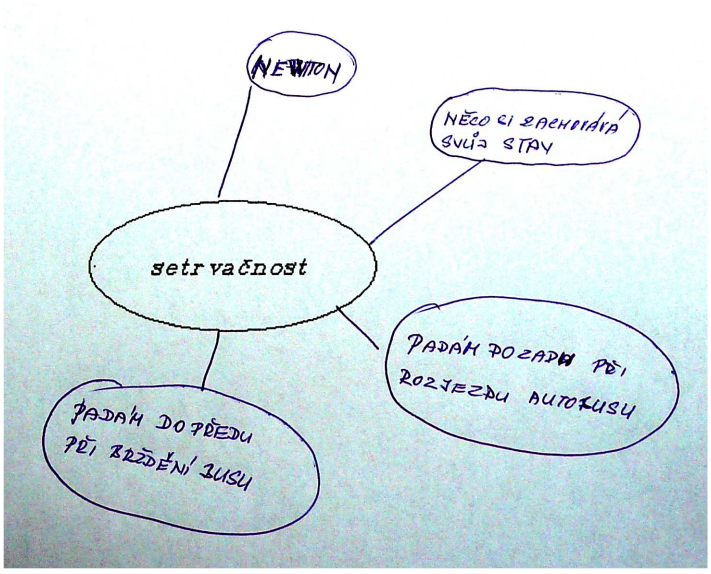

Figure 1. Example of a mind map

Brainstorming

We found out that this method was very difficult for our students. They never practiced this method before. The main problem was with telling the own ideas aloud.

Evaluation – a time keeping method, for common use in physics teaching not very suitable.

Table 7. Brainstorming

Indicator	Mark 1	Mark 2	Mark 3
Acivity	1		
Communication	1		
Difficultness of the method			3
Team work	1		
Part of the lesson		2	

Conclusion

In our research several interactive teaching methods were explored. The findings of in-service teachers so as pre-service teachers are the same. Interactive teaching methods can help us to teach science for understanding. But it is necessary to change the role and position of the teacher in the classroom. The physics teacher in the 21st century have to be a classroom manager. The teacher has new basic competences, for example an organizer, a content expert, a team builder, a facilitator of learning and development processes. (Prince 2007)

Traditional teaching methods are not effective. The goal of the innitiative is to apply new methods based on the constructivist learning theory. The learning and teaching process is more effective, when students can construct their knowledge by their own.

According to the report Learning for the 21st Century (in the Czech Republic The White Book), today's education system faces irrelevance unless we bridge the gap between how students live and how they learn. A growing number of initiatives can be seen in our schools, but the majority are concentrated only on project-based teaching and learning. For our teachers it is the most important interactive method. Another wide spread method is the heuristic teaching method. Other variations of interactive methods are not used. Teachers complain that they do not know the methodology of these methods and that they have not enough time to teach in the new way. At our department pre-service teachers are taught these new methods and its methodology and in-service teachers are invited to seminars and workshops where they get informed about the methodology. I tis necessary to prepare more instructional materials for teachers – in-service teachers complain that it is time consuming for them to prepare a lesson with interactive methods. The research has shown that interactive teaching methods can improve the quality of teaching. The main problem is how to get more interested and skilled in-service teachers. Our further activities will be concentrated not only on our university students – pre-service teachers but also on in-service teachers to improve their knowledge about the methods mentioned above.

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