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The Impact of Implementation of Simple Experiments on the Pupils' Positive Attitude in Learning Science Contents in Primary School

Abstract

This paper presents research that has been carried out to analyze a relation between implementation of simple experiments in teaching sciences, and pupils' positive attitude towards learning physics. Investigation was conducted on a random sample of 495 sixth – and seventh-grade pupils from primary schools in Novi Sad. The obtained results are statistically treated. Analysis of results shows that the use of simple experiments for a particular case is related to pupils' attitude toward learning physics. Also, it is shown that approximately twice higher percentage of pupils that were taught with the use of hands-on experiments like to learn science than pupils who were taught with the use of demonstration experiments or without experiments. They do not learn by heart, they understand science and it helps them to develop a scientific world view that makes it easier for them to find their way in today's world.

Keywords: *simple experiments, hands-on experiments, demonstration experiments, pupils' attitude, physics teaching.*

Introduction

Results of testing pupils' knowledge in the Republic of Serbia, which reflect the degree of achievement of goals and fulfillment of the tasks of teaching natural science (physics) show that pupils that finish primary school and compulsory education do not have sufficient knowledge. Applicable knowledge test results

obtained by the PISA test in 2009, which included fifteen-year-old pupils (eighth grade), indicate a high degree of inefficiency of learning physics. Contents of science are treated in primary schools within the subject: "The World around Us" (which is derived from two hours per week in the first and the second grades) and "Nature and Society" (with two hours per week in the third and the fourth grades). Implementation of an elective subject "La main à la pâte" ("Hands-on – Discovering World") would significantly change the situation in terms of time devoted to the study of natural sciences (especially physics), but even though this subject was introduced as an elective (from the first to the fourth grades), it is not implemented sufficiently in schools. Also, today's lifestyle, technical and technological development and easy access to information create a necessity to overcome the frontal lecturing approach in physics teaching. The knowledge acquired by the application of simple experiments is more permanent thanks to a higher level of understanding of the material that is more easily applied in practice. The introduction of simple experiments is advisable to increase the efficiency of learning physics (Bosnjak & Obadovic, 2009; Obadovic & Nagl, 2008, 2010).

Successful teaching of natural sciences includes training for lifelong learning. George Sharpack says that French scientists and educators have tried to find a new way of teaching the lowest age pupils, comparable to scientific research. He points out that scientific reasoning is considered as a powerful tool in increasing the capacity of thinking, finding evidence, and decision making. At the same time, in the U.S.and in many countries a hands-on program has been introduced, and parallel to it an inquiry-based method is being applied. Sharpack states that it is a high quality education which should, besides the acquisition of knowledge, enable the progress of writing, language and reasoning skills of pupils (Šarpak, 2001).

The problem of how to best organize pupil education has always attracted the attention of educators. John Dewey, with his motto of "learning by doing," showed the importance of learning through experience, learning on the principle of "Do It Yourself" ("Hands-on") and learning organized by pupils themselves (Dewey, 1902; 1916; Grant, 2002; Merkham et al., 2003). In order to make teaching more efficient, many researchers have studied teaching methodology, didactics, and the problem of active and creative teaching in the educational process in our schools. They point out that the pupils whose teachers have been introducing, together with the traditional approach, some of the contemporary teaching methods, obtain better results – they acquire more permanent knowledge, the pupils assert themselves as active subjects of the teaching process, and the teachers are less teachers and more planners, organizers, and they guide the teaching process (Hajdukovic et al., 2007;

Gordon, 2006; Ivić et al., 2001; Lalović, 2009). Pupil satisfaction in such work is evident. In the recent world literature, the importance of applying very different contemporary science teaching methods (especially a scientific method as a teaching method and inquiry based learning) are especially emphasized and a large number of these methods are based on the implementation of simple experiments (Zimmerman, 2007; Hofstein & Mamlok-Naaman, 2007, Stinner, 2003, Tang et al., 2009).

In their papers, world methodologists show how to implement simple experiments, the purpose of doing experiments and requirements for their implementation. The pedagogical significance of the experiment is that pupils have certain benefits from them, primarily gaining relevant experience and applying it in different situations in their natural and social environment. The purpose of demonstration experiments can be: increased motivation, more evident learning of science materials, more concrete applications of theoretical knowledge, skills, and gaining skills on real examples, increased interest in studying material, causing the observed physical phenomena, an illustration of the principles and laws, developing critical thinking, grading students. In the cases where simple experiments are not performed as a demonstration experiment, but their use introduces a scientific method, inquiry based learning or other teaching method, they can have the same purpose, and further enable pupils to do independent research and come to their own knowledge – construct knowledge system by themselves.

The scientific method significantly makes it easier to understand the essence of issues that are studied in physics and provides the durability of the acquired school knowledge. It also contributes to achieving the didactic principles in physics: the principle of scientific value and systematization, evidence, links theory and practice, activity, durability of acquired knowledge, skills and habits, the individualization of teaching, adaptation of teaching. The scientific method consists of a series of logical procedures. Elements of scientific methods that should be implemented in the classroom are: asking questions – problem definition, formulation of hypotheses, experiment, analysis, conclusion and presentation of results (poster). Pupils should be given specific instructions to be followed in the realization of themes using the scientific method before processing themes on the procedure of scientific method (Obadovic et al., 2007; Nagl et al., 2012). Through hands-on experiments realized with the use of scientific methods, pupils become accustomed to independent research from the first grade of compulsory education, which facilitates the adoption of elementary knowledge of physics higher grades.

Methodology

Educational reform in Serbia comprises almost all segments of education, starting from the lowest grades of elementary school up to the college education system. This process initiated a national program for the development and transfer of contemporary teaching methods which enable pupils to explore activities and the science subjects in the simplest way. This study was performed with an aim to investigate how the implementation of contemporary teaching methods in lower grades (1st to 4th) reflects in pupils' positive attitudes toward learning physics in higher grades (6th to 8th) of primary school. The fifth grade is the lowest one of higher grades in Serbian primary schools. Pupils in higher grades have a different teacher for each subject planned in the curriculum and in this grade the contents of natural sciences are planned only in two subjects: "Biology" and "Geography". Physics contents are not taught in the 5th grade. Because of that, fifth grade pupils were not included in this survey.

The research purpose was to investigate the impact of the implementation of simple experiments with the aim of the realization of the scientific methods in the teaching process at all levels of elementary education on the pupils' positive attitudes to the learning of physics content. Increasing the efficiency of learning physics content requires the application of various methods and work forms, in order to increase the quality and quantum of knowledge. What is significant is the empirical confirmation that there is a difference in the pupils' attitudes, depending on the way experiments are performed and whether the scientific method based on simple experiments is applied.

The research aim was to determine whether the application of scientific method as a teaching method in physics has an advantage compared to traditional teaching, to examine pupils' attitudes in relation to the study of physics contents in science teaching.

The task of the research was to determine whether or not there is a difference in pupils' attitudes in relation to the study of the physics contents if simple experiments and/or scientific methods are implemented in practice from the first grade of compulsory education.

It is assumed that pupils' positive attitudes toward physics are associated with the application of simple experiments and/or teaching methods applied in science teaching. That was the hypothesis of this research.

The study was conducted on a random research sample of 495 pupils of the sixth and seventh grades in elementary schools in Novi Sad.

The study was carried out as a survey. A questionnaire contained questions about simple experiments that the pupils carried out from the 1st to 4th grades, the pupils' attitudes towards learning physics. Statistical treatment of the obtained results made it possible to analyse and test the initial hypotheses.

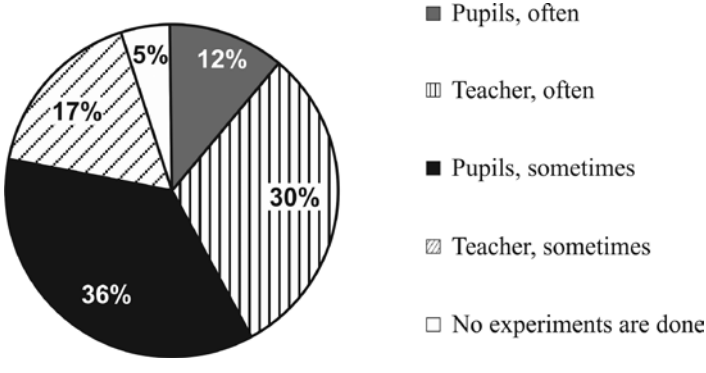
Results and disscusion

The analysis of the results shows a significant difference in the pupils' attitude towards the learning process when they perform simple experiments on the principles of scientific methods and when teaching is carried out traditionally (with or without the use of simple experiments performed by the teacher in order to demonstrate phenomena).

A positive correlation between the pupils' responses to the question of whether they like learnig physics and teaching by implementing the scientific method in class is noticeable at the 95.0% confidence level. There was also a positive correlation between the pupils' positive attitudes towards physics and application of scientific methods, the same level of confidence (95.0%).

Only 5% of the surveyed pupils said that they did not do experiments, but that was because only the teachers who were interested in the implementation of contemporary teaching methods and who were trying to implement the appropriate methods in the teaching process wanted to be involved in the study. When the experiments are performed in the course, the most common is the case that pupils independently perform experiments. Figure 1 shows how often and who does experiments in the science teaching process.

Figure 1. Frequency of certain methods of performing experiments.



The pupils that have performed experiments, starting from the first grade, remember those experiments, as can be inferred from the responses to the questionnaire question concerning the material that was used when performing experiments. On the basis of the fact that the pupils remember different materials (coloured paper, water, salt, egg, lemon, balloons, batteries, light bulbs, magnets, etc.), it can be concluded that the class teachers who have implemented simple experiments in the teaching process worked on their implementation in different areas (motion, air, water, pressure, buoyancy, electricity, magnetism, etc.).

73% of the pupils in whose classes simple experiments have been done (by the pupils or by the teacher as demonstration experiments) think that the experiments help them to understand and learn easier physics contents (Figure 2).

Figure 2. Pupils' answers to the question whether experiments help them to understand physics contents

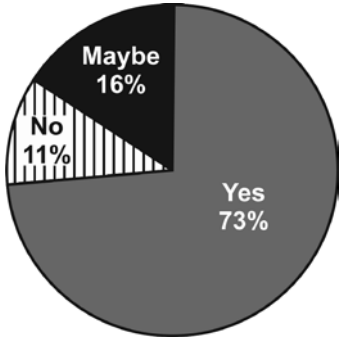


Figure 3 shows the pupils' attitudes towards learning physics depending on the method of conducting experiments used for treatment theme and its frequency (shown on the y-axis) and on the x-axis there is the percentage of the pupils with positive, negative or neutral attitudes. The obtained results indicate the necessity of applying different methods in physics, because more pupils declare that they like learning physics if they sometimes perform simple experiments (35.18%) compared to that pupils often perform independent experiments (32.16%). Depending on how often and who does simple experiments, the highest percentage of the pupils declare a negative attitude towards learning physics when experiments are not performed in the teaching process (63.16%), then if the teacher sometimes, or often performs experiments. The pupils express their negative attitude at least when they perform experiments independently.

Figure 3. Pupils' attudes (positive, negative and neutral) in respect to how often and who does simple experiments

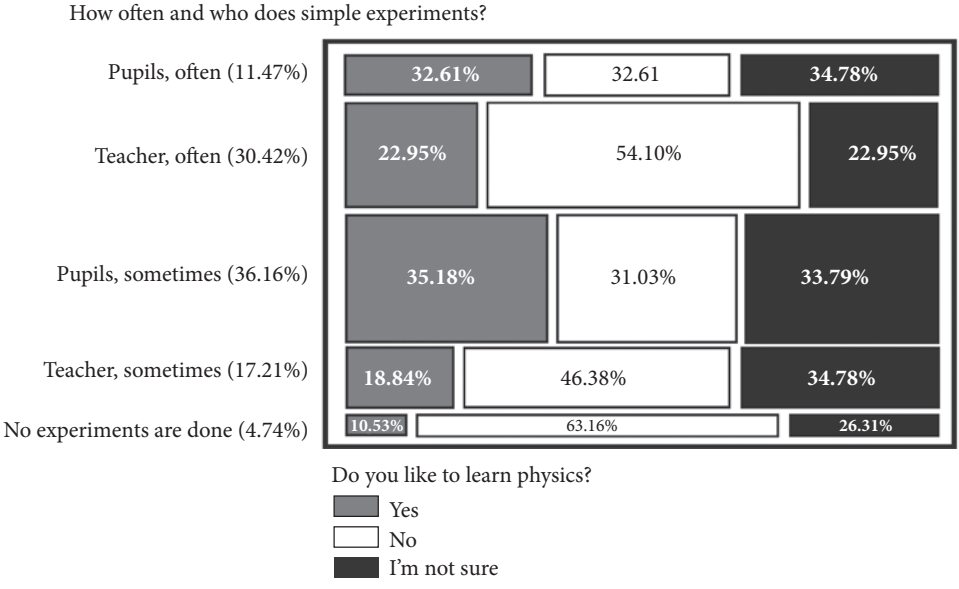
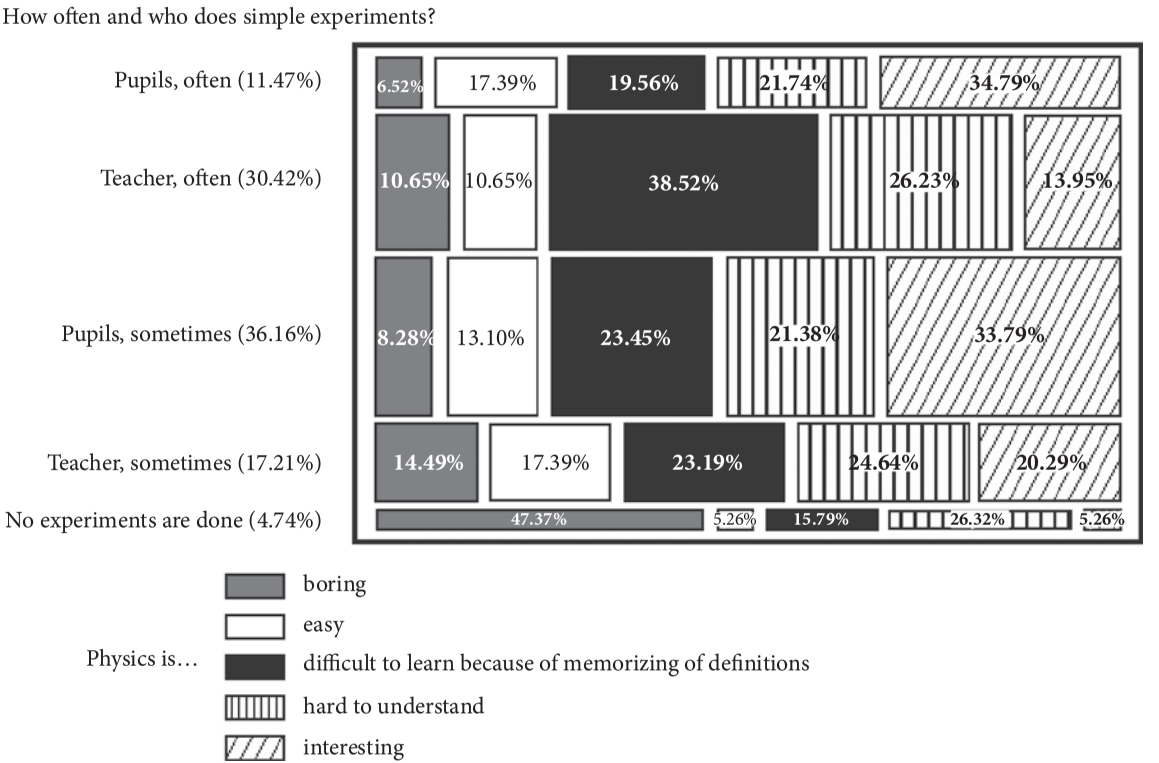


Figure 4 presents a detailed analysis of the pupils' attitudes towards the study of physics in relation to the way experiments are conducted. It is observed that the method of conducting experiments (independently of the pupils' work or the teacher demonstration of a phenomenon) to a small extent affects the pupils' opinions that physics is "easy" or "difficult." However, the method of conducting experiments reflects a significant impact on whether physics is interesting to pupils.

A greater number of the pupils who often carry out experiments independently (34.79%) and the pupils who sometimes carry out experiments independently (33.79%) say that physics is interesting in comparison to the pupils that only observe demonstrations of phenomena while the teacher conducts demonstration of experiments (sometimes or frequently, 20.29 % and 13.95% respectively). When experiments are not performed at all, physics is interesting to a very small number of pupils (5.26%), while a large number of pupils (47.37%) believe that physics is boring.

Based on the analysis of the results, it can be concluded that the pupils who independently carry out hands-on experiments following the principles underlying

Figure 4. Percentage of pupils' opinions about learning physics in respect to how often and who does simple experiments



the scientific methods have a positive attitude towards physics. For those pupils it is easier to acquire the knowledge of sciences. They like learning physics (35.52% of the total number of pupils that do hands-on experiments, Figure 5) and to them the teaching contents are interesting (34.03% of the total number of pupils that do hands-on experiments, Figure 6), unlike the pupils whose teachers carry out

Figure 5. Percentage of pupils' opinions about learning physics in respect to how experiments are done

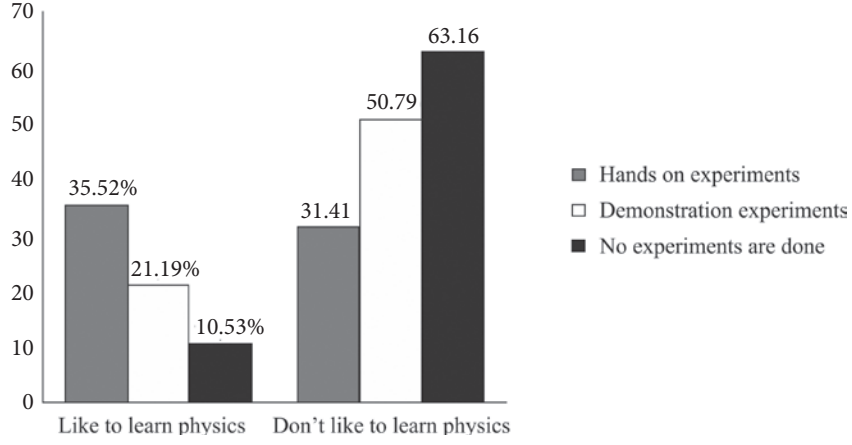
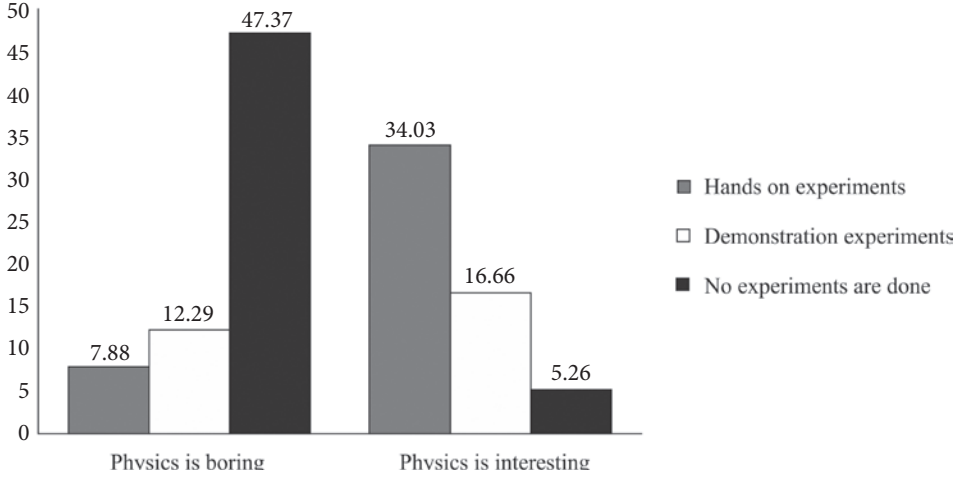


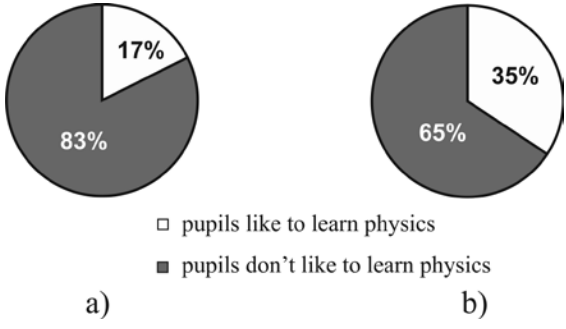
Figure 6. Percentage of pupils' opinion about physics contents in respect to how experiments are done



demonstration experiments (21.19% and 16.66% of the total number of pupils taught with the use of demonstration experiments, respectively). About 30% of the pupils in all three cases, when they do hands-on experiments, when their teacher does demonstration experiments or when no experiments are done could not decide if they liked learning physics and a different percentage of the students did not think that physics was boring or interesting.

The obtained results show that significantly more pupils like learning physics and are of the opinion that science is interesting if they independently perform experiments, in comparison to the pupils whose teacher demonstrates phenomena with the use of simple experiments as demonstration experiments (35% and 17%, respectively, Figure 7).

Figure 7. Student attitudes toward the study of physics content:
a) experiments are not performed, or teacher demonstrates phenomena;
b) Students do experiments by themselves



Based on the results analysis, it can be concluded that the pupils who independently carry out experiments following the principles underlying scientific methods have a positive attitude towards physics. For those pupils it is easier to acquire knowledge and the teaching contents are interesting.

Conclusion

Based on the results of testing 495 pupils of the sixth and seventh grades of elementary schools in Novi Sad, it can be concluded that the introduction of simple experiments to the actual school practice from the first grade of compulsory education encourages pupils to develop positive attitudes to the contents of the study of natural science – physics in higher grades. This study was undertaken to examine

how the introduction of simple experiments to the actual teaching practice impact on pupils' attitudes to the learning of physics contents. In order to completely achieve the objectives and tasks in physics education, as well as in teaching other natural sciences, it is necessary to introduce experiments to the teaching process in lower grades of compulsory education. When simple experiments are used, the teacher should make additional effort in order to choose and prepare appropriate experiments. The problem that can occur when the teacher does demonstration experiments is that pupils do not pay full attention and are not active in the learning process. Because "hands-on" experiments have a greater effect on pupils' motivation, demonstration experiments should be used instead of them only if that is a better way to show phenomena, if there is not enough time for pupils to carry out experiments, if the procedure of an experiment is not safe enough. When hands-on experiments are introduced at the earliest age, following precisely defined instructions in accordance with pupils' abilities at that age, pupils learn phenomena that they induce by themselves. They develop the skills of perception and recognition of cause and effect relationships and recording experiment results.

Learning through independent research by pupils who follow the steps of the scientific methods has resulted in the acquisition of applicable knowledge. Bearing in mind differences in pupils' interests, which are not caused by the use of different teaching methods of great importance in achieving a positive attitude and satisfaction with learning, is a way of teaching. Therefore, it is important to highlight the importance of simple experiments in teaching physics in primary education. Analysis of the research results presented in this paper shows a significant difference in the pupils' attitude towards the learning process when they perform simple experiments on the principles of hands-on experiments and when simple experiments are carried out by the teacher as demonstration experiments.

Significantly more pupils like learning physics and are of the opinion that science is interesting if they independently perform experiments, in comparison to the pupils whose teacher demonstrates phenomena with the use of simple experiments as demonstration experiments. The pupils who independently carry out hands-on experiments have a positive attitude towards physics. They like learning physics (35.52% of the total number of pupils that do hands-on experiments) and to them teaching contents are interesting (34.03% of the total number of pupils that do hands-on experiments), unlike the pupils whose teachers carry out demonstration experiments (21.19% and 16.66% of the total number of pupils taught with the use of demonstration experiments, respectively). It can be concluded that the method of implementing experiments is of great importance because it is shown that simple experiments are more effective when carried out by pupils themselves because it

makes pupils more motivated. Also, it must be pointed out that it is not good to use this method too much because it can have reverse effects. In order to obtain the best results, different teaching methods should be combined. Simple experiments in addition to class lectures are also suitable for a variety of extracurricular activities, workshops, implementation of student mini-projects, or nature exploration.

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