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Teaching innovations in the chosen fields of physics

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TEACHING INNOVATIONS IN THE CHOSEN FIELDS OF PHYSICS

Abstract

The aim of this contribution is to familiarize the reader with a method of using classical experiments in nuclear physics at secondary schools. The article shows how carrying out experiments during the Physics classes increases student's knowledge in this field. Moreover, it makes them consider this subject as more interesting and makes it closer to the average student.

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Streszczenie

Celem poniższego artykułu jest zaznajomienie czytelnika z metodą przeprowadzania klasycznych eksperymentów w dziedzinie fizyki nuklearnej w szkołach ponadgimnazjalnych. Artykuł pokazuje jak przeprowadzanie eksperymentów podczas zajęć z fizyki podnosi wiedzę uczniów w tej dziedzinie; ponadto pomaga to w postrzeganiu przedmiotu jako bardziej interesującego i przybliża go przeciętnemu uczniowi.

Introduction

In the report, we focus on nuclear physics area, which is taught in the fourth year of study at grammar and secondary schools (at some schools, it might be taught in the third year of study). Despite the seriousness and excessive theoretical background of this area of physics, there are no experiments found in this chapter which would allow students to understand such a difficult problematics the physics certainly is. One of the possible ways to remove these factors is to include the experiments into a given chapter, specifically the pupils and demonstrational experiments, as well as laboratory measurements [1]. These types of experiments may increase the visuality of physical phenomenon that is taught at the lesson. In addition to this, they can contribute to the students' interest in Physics, motivate them to a higher activity and contribute to their creativeness development. The usage of this kind of

experiments also helps students to prepare them for solving the tasks they can encounter in their everyday lives [2,3].

Pedagogical experiment

At the beginning we have analyzed the teaching of nuclear Physics in Slovakia and some EU countries (England, Austria, Germany, Czech Republic and Switzerland). From this stage we have come to the analysis we later worked with. The analysis clearly resulted in the necessity of including the experiments into the teaching process. To realize this, first it was necessary to prepare certain changes in the curriculum that arised from including the experiments into the teaching process. Then we have suggested and developed a series of classical experiments that are connected with the content and aims of the thematic unit „Atomic nucleus and elementary particles" including the methodology and didactics of the usage these experiments in the teaching process. We have chosen such type of nuclear physics experiments that would not significantly influence the content of the thematic unit „Atomic nucleus and elementary particles." We have made a working sheet for students and methodical sheet for teachers to each experiment. We have also made compatible, real computer-controlled experiments from a given thematic unit as an alternative, including the working sheets for students and methodical sheets for teachers. We have prepared a CD with the revised teaching texts, methodical and working sheets to all classical experiments and methodic and working sheets to real computer-controlled experiments. In the next step, we have realized the pedagogical experiment to discover to which extent has the usage of experiments from nuclear physics (we have used the classical experiments for pedagogical experiment) helped to increase the active knowledge at Physics lesson, to which extent has it contributed to the improvement of knowledge level from given Physics area and, last but not least, to which extent has this usage contributed to the improvement of students – Physics relation. The experiment was realized with the students of the third and fourth year of study. The pedagogical experiment consisted in the comparison of achieved educational results where these experiments, together with the laboratory measurement, were used (8 experiments) with the results where it has been taught the classical (for us) typical teaching method, i.e. theoretically, without any use of experiments. The knowledge level from the curriculum was compared, i.e. students were given a didactic test from this thematic unit after the Nuclear Physics thematic unit. We have also used the pre- and post- test in the form of a questionnaire to evaluate the students – Physics relation. The pedagogical test was realized at two grammar schools during two years – in the school year 2005/2006 and 2006/2007 in Banská Bystrica, and in 2006/2007 in Zvolen [4,5]. In the experimental groups (E1, E2, E3) there were 57, 55, 57 students and in the checking groups (C1, C2, C3) there were 57, 55, 58 students. A non-standard didactic test (the same for al groups) was used. The memory level, conception of the curriculum and the ability to solve the tasks of different difficulty level were tested. We have used a composite

marking in the test, especially with the wide open tasks. Instead of the average score we have used a scale score of the test [6,7].

The evaluation of didactic tests

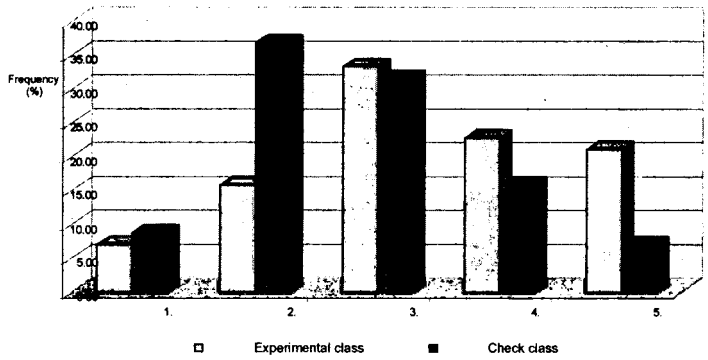
a) Grammar school in Banská Bystrica 2005/2006

Table 1. Statistical characteristics of the test – BB 2005/2006

	E1	C1
The number of students solving the test	57	57
Relative score (p^x average)	64.72	53.52
Median (p)	66.66	53.33
Standard deviation (s)	16.3	13.6
Variation range	70.2	80.7
Variation ratio	25.18	25.43
Scale average of distortion tolerance(s_v)	15.01	
Test quantity (t)	3.98	
Critical value ($t_{\alpha,f}$)	1.97	

Table 2. Frequency table for the didactic test – BB 2005/2006

	Score [%]	E1	C1
1.	19.3 – 35.4	7.02	8.77
2.	35.5 – 51.6	15.79	36.84
3.	51.7 – 67.7	33.33	31.57
4.	67.8 – 83.9	22.80	15.79
5.	84 - 100	21.05	7.02



Graph 1. Results of the didactic test in the checking and experimental group BB 2005/2006

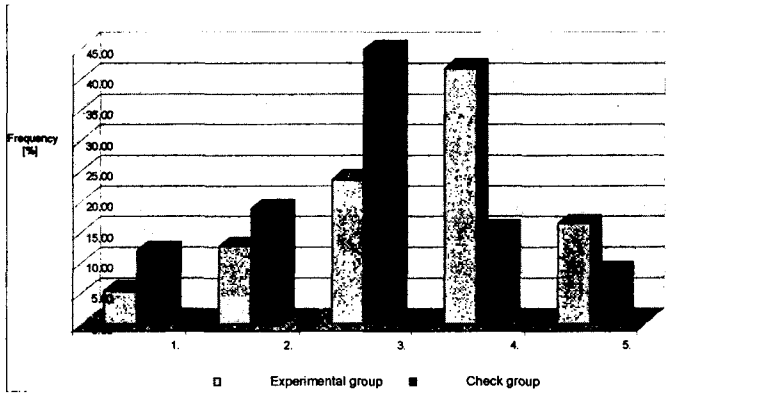
b) Grammar school in Banská Bystrica 2006/2007

Table 3. Statistical characteristics of the test – BB 2006/2007

	E2	C2
The number of students solving the test	55	58
Relative score (p^v average)	67.21	51.49
Median (p)	73.33	50.00
Standard deviation (s)	16.2	14.8
Variation range	84.2	87.7
Variation ratio	24.05	28.75
Scale average of distortion tolerance (s_v)	15.50	
Test quantity (t)	5.39	
Critical value ($t_{\alpha,f}$)	1.97	

Table 4. Frequency table for the didactic test – BB 2006/2007

	Score [%]	E2	C2
1.	10.5 – 28.1	5.45	12.07
2.	28.2 – 45.6	12.73	18.97
3.	45.7 – 63.2	23.64	44.83
4.	63.3 – 80.7	41.82	15.52
5.	80.8 - 100	16.36	8.62



Graph 2. Results of the didactic test in the checking and experimental group BB 2006/2007

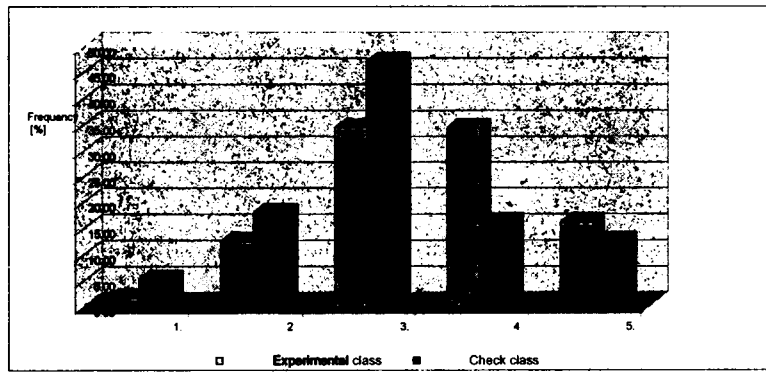
c) Grammar school in Zvolen 2006/2007

Table 5. Statistical characteristics of the test – ZV 2006/2007

	E3	C3
The number of students solving the test	55	55
Relative score (p^v average)	66.38	59.36
Median (p)	70.00	61.66
Standard deviation (s)	14	14.1
Variation range	71.9	87.7
Variation ratio	21.16	23.79
Scale average of distortion tolerance (s_v)	14.05	
Test quantity (t)	2.62	
Critical value ($t_{\alpha,f}$)	1.97	

Table 6. Frequency table for the didactic test – ZV 2006/2007

	Score [%]	E3	C3
1.	12.3 – 29.8	1.81	5.45
2.	29.9 – 47.4	12.72	18.18
3.	47.5 – 64.9	34.54	47.27
4.	65.0 – 82.5	34.54	16.36
5.	82.6 - 100	16.36	12.72



Graph 3. Results of the didactic test in the checking and experimental group ZV 2006/2007

Based on the frequency tables and corresponding graphs we can state that relative scale score in all three experimental groups is higher than in the checking groups. The shift of a curve which characterises the pupils' effort layout in experimental groups compared with the curve characterizing the effort in checking groups occured in all examples to the higher values of attained score. From this fact we can observe that the usage of experiments had a very positive impact on students' knowledge level in the checking groups. In our work we decided not to link all groups into one experimental and one checking group. However, we evaluated them separately. There are several reasons to do this. At first, while during the first year the students of the fourth year of study were tested, in the second testing year students of the third year at the grammar school were tested, as the schools changed their teaching system. The four-course study of physics is taught during the first three years and in the last year students may choose physics as their elective subject.

Conclusion

The results gained during the pedagogical experiment after the evaluation of the didactic tests and questionnaires together with the consultation with the teachers can be summarised into these points:

1. The usage of the experiments in nuclear physics in the teaching process contributed to the higher knowledge level of students in the experimental classes. This resulted from the pedagogical experiments made with 337 students at two grammar schools during two years term.
2. After the experiments from nuclear physics in the experimental classes have been finished, students consider Physics as more interesting and comprehensible school subject. For this purpose we have used a questionnaire, which every student filled in before and after the thematic unit "Atomic nucleus and elementary particles". We speak about the questionnaire in which students demonstrate their attitude towards Physics. Three questions concerned the popularity of Physics, the other

three its difficulty and the last its importance. From the results of this questionnaire is obvious that experiments from nuclear physics increase students' interest in Physics.

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