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Vyučovanie fyziky v kontexte záľub študentov

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Abstrakt

Každý mladý človek má veľa záľub. Podobne ako vo všetkých činnostiach, aj tu využíva fyzikálne zákonitosti, či už cielene, alebo mimovoľne. Článok sa zaoberá jednou z možností ako využiť poznatky získané v mimoškolskom prostredí vo vyučovaní fyziky na gymnáziu. Študentom sme zadali úlohu: napísať referát a pripraviť si prezentáciu o ich voľno časovej aktivite. Záľuba zohrávala úlohu sprostredkovateľa medzi fyzikou a príjemne stráveným voľným časom. Po skončení všetkých prezentácií bol zadaný dotazník. Ten poukazuje na fakt, že študentov bavilo pripravovať si vlastné referáty, bol to obohacujúci proces pre nich, avšak študenti si nie sú istí, či ich referát bol užitočný aj pre ostatných spolužiakov.

Klíčová slova: voľno časové aktivity, poznatky získané v mimoškolskom vzdelávaní, vyučovanie fyziky.

Students' Hobbies as a Context for Physics Teaching

Abstract

Every young person has a lot of hobbies. There, like in all everyday activities, he/she applies physical phenomena — either intentionally or unwittingly. The article deals with one of the possibilities of how to include students out-of-school knowledge in formal school education in physics at high school. Students were given an assignment: to write a report and prepare a presentation about their free time activity. The hobby played the role of a mediator between physics and relaxed free time. The questionnaire given at the end of all the presentations points out the fact that the students enjoyed preparing their own reports, it was an enriching process for them, but they were not so sure whether their reports had also been beneficial for the others.

Key words: free time activities, out-of-school knowledge, physics education.

1 Introduction

Physics as a school subject has not belonged among favourite ones among students at high school for a rather long time and not only in Slovakia. The same situation can be seen in physics education from the point of view of students and their parents from primary school to university (Demkanin, 2008). Most of students do not choose physics as a subject for final examinations at high schools.

Students usually claim that physics does not describe the real world and deals only with situations in idealized conditions. When something does not work in the lesson (e.g. an experiment) they make fun of it and ironically comment on it, e.g., of course, we did not have absolute vacuum or motion without friction. Many curricula all over the world stress the role of context learning (Aroca, 2008); proper context can indeed lead to increased interest of students (Waltner, 2007). There are many ways to contextualize physics content. It is useful when we connect physics education to everyday situations, when we emphasize the social relevance of physics and its findings. It has been found that students like interdisciplinary connections, e.g., with medicine and human body (Jenkins, 2005; Hoffmann, 1996).

Even if students do not like physics in general, the situation changes when it is somehow related to their out-of-school interests. In our former research, we tried to find out how adults perceive their science education at primary and secondary school. The stress was put on physics education. The respondents were people without university physics courses. There was one very interesting reaction of a 35-year-old woman with liberal art education. "I have one of a few positive memories from physics at that time. I volunteered to prepare an introduction to physics lesson about wavelengths… I brought a violin and a guitar as teaching aids and the lesson was well taught, I think. The teacher seemed to be fascinated. The relationships were easier to learn then. The schoolmates saw how the string tension or length was being changed when tuning the musical instrument. And as a consequence a new sound with higher or lower frequency was created, what means higher or lower tone, etc. (I hope, I do remember it well). The relationships could be easily derived and were easier to remember." It can be seen that the previous experiences were useful in science education. The teacher as well as students both contributed to the construction of their schoolwork (Lundin, 2005).

2 Physics in free-time activities

However, teaching science only in school settings is not enough to give students a contextualized view of science (Braund, 2006). We cannot forget that students are not educated only at schools; they have many possibilities how to get knowledge and experience from other sources. Students, apart from attending school can join sport clubs, attend science centres, etc. They have TV at home and internet is a normal part of everyday life. All these information sources can supplement (but not replace) formal school physics education. And the teacher is the one who can make use of it to fulfil her/his goals of school (formal) physics education. When we use the out-of-school knowledge of students, education can become context-based. Students learn about something that is interesting to them. Motivational effect is a great positive of contextual learning (Bennett, 2003).

The teaching about wavelengths made big impression upon the woman — the violinist mentioned in the introduction. Similarly each student possesses some special knowledge and skills, so why not to use it! We started to examine the possibilities of this educational topic with a goal to later develop a teaching method (better to say, cluster of methods). Firstly we decided to encourage students to prepare reports on topics of their favourite out-of-school activity. Students were given the following assignment: "Elaborate the report about physics in your free time! Outline how you make use of physics and how it helps you." The participants were students of the last year of high school (age 19). They all were taking only a general compulsory physics course, not a course for final exam in physics. Students had some basic knowledge from general physics course (except for atomic and nuclear physics). They had enough physics background to be able to explain to their schoolmates how they used physics in their free time activities which were to a great extent different from those they had met as a context for physics education at school.

Students prepared reports about some activities or hobbies which they enjoyed during their free time. The hobby played the role of a mediator between physics and pleasantly spent free time. The assignment consisted of 3 main stages: A. choice of a topic, B. elaboration of reports and C. presentation of findings. The time schedule of the activity is in Table 1.

At the beginning, the students had to think about their hobbies and to write down the top three. Then they were asked to choose just one of them. The one they were able to talk to their schoolmates about. The most important thing was to talk about something familiar, however, also from the physics point of view. They could work separately or make pairs when the selected activity was common to both.

Table 1: Time allocation

Stage of assignment			*Time*
A.	**choice of topic**		**1 lesson**
	a.	introduction of assignment	15 min
	b.	brainstorming	15 min
	c.	creating of groups	5 min
	d.	choice of final topic	5 min
B.	**elaboration of reports**		
	a.	consultation with the teacher	1 lesson
	b.	homework	unlimited
C.	**presentation, evaluation**		**6 lessons**

An output of students' work was a text in a form of a report and a presentation in any form. It could be a PowerPoint presentation, a video sequence, animation, etc. Students were given the following assessing criteria related to the report: a) elaboration (details, whether the text is comprehensible and interesting to others), b) originality (the choice of resources, interesting facts, originality of the text, no plagiarism), c) physics content, d) deadline for submitting the paper; and criteria concerning the presentation: e) impression from presentation, f) keeping time limit and g) cooperation in a group. Each of the criteria had the same weigh and the assessment was done by teacher just after each presentation. The mark from the report represented around 30 % from the final grade at the end of half term.

One of the aims of the assignment was to train students in working with information resources. As the chosen topic was a part of their free time activities, we expected carefully worked-out presentations and the choice of the best and most interesting facts for their schoolmates. A few minutes devoted to the presentation should not only enrich the lesson, but also make impression upon the audience.

Figure 1: Students' presentations

3 Presentation of reports

There were 18 different presentations of out-of-school activities in a group of 24 students. Most of them were devoted to sports and games, like: ice skating, swimming, tennis, floorball, cycling, football, running. Some had also chosen not very typical activities like shooting from an airsoft gun, flying, break-dance, kite-flying. Some of them also reported on their free time with motorbikes, cars and their aerodynamics, billiard, classical music; harmony of tones.

Some demonstrations were very interesting. For example, a group of two girls brought a bike to school to talk about its components. It included the explanation of functioning of brakes, what types of brakes there exist, how we use bumpers, how bikes for men differ from those for women, etc.

A student, break-dancer, showed to schoolmates how to find the centre of mass of the body, how to keep stability, how to rotate and not to fall on the ground.

Another presentation concerned playing the guitar. Students saw how the changes of string's length influence pitch. The guitar player played the lowest, and the highest tones, he explained the composition of frets. It was interesting to think about playing the same tone by different strings, what is the basis for tuning string instruments.

The next group of reports was devoted to ball games. It is natural that young people spend a lot of time with sports and games. Each game requires a specific ball. Its design, size, mass and other physical properties play a given role, e.g. to make its flight as effective as possible for the purposes of the game. The Magnus effect was the most frequently mentioned phenomenon. Floorball players brought a hockey stick and a floorball with 26 holes in it for demonstration. They illustrated that the speed of the ball depends mostly on the elasticity of the hockey stick, because there occurs transformation of hockey sticks' elasticity to the kinetic energy of the ball. The performance of each game brings some difficulties, e.g., while judging it. The group of tennis players pointed out problems in refereeing of outs. For example, the camera system Hawk-eye has the maximum resolution 3,6 mm, which represents 5 % of the ball size. It was found out that referees misjudge 8,2 % of balls which fall less than 10 cm off the line.

Some contributions could not be presented in real situations in class, so students had opted for suitable animations. An example was firing of a ball from an airsoft gun. It was nice to see how by the system of geared wheels the ball was fired after

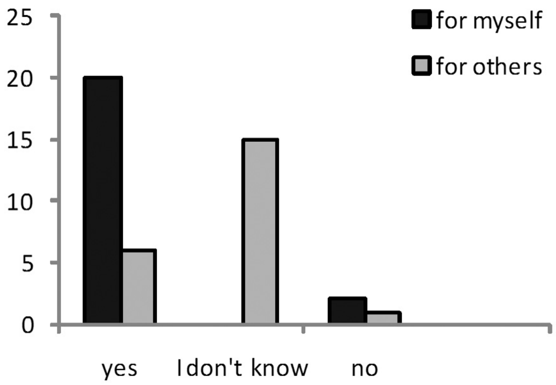

Figure 2: Benefits of reports — reporter view

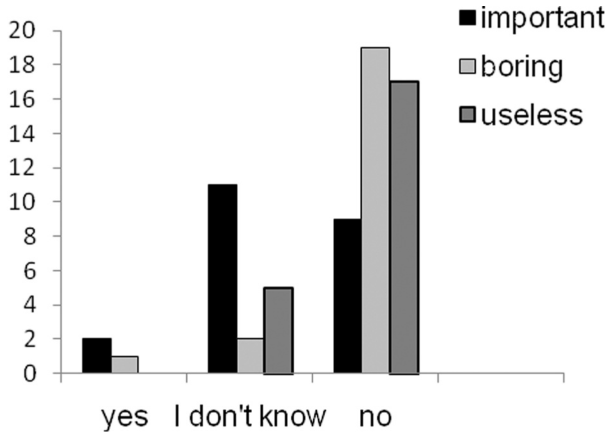

Figure 3: Relevance of reports to students, listeners — reporter view

compressing a spring. Besides showing the animation, the student also explained the practical use of the gun and he did not forget to supplement his talk by a physical description of the gun functioning. Another nice and visual animation was connected with cars and an aerodynamic tunnel.

4 Questionnaire for students

Each student fulfilled a short questionnaire after all presentations. The questionnaire concerned his/her opinion on his/her own presentation, in particular whether he/she liked the fact that he/she could make use of his/her own knowledge and experiences — and the relation of this knowledge and experience to physics.

The student should express his/her opinion on whether the report was beneficial for him/her, whether it was important for others or whether it was boring and useless; students could also write their own observations. There were the following options for answers: *yes*, *I don't know* or *no.* Twenty of 22 students claimed that their report was beneficial for themselves, 6 of them thought that the report was also beneficial for his/her schoolmates; the next 15 did not know how to judge the situation (Figure 2).

Only two students thought that their presentation was important for others, but 9 people did not consider their report as important for classmates (Figure 3). But the students did not find their work on preparing the presentation boring (1 yes, 2 I don't know, 19 no) or useless (Figure 3).

The results again point out the fact that when a student devotes his/her time to something interesting to him/her, he/she has more positive relationship to it

(Chalupková, 2009), than when he/she is learning some facts which are of almost no interest to him/her. At the same time a student realizes that something beneficial for him/her does not need to be interesting to others; as can be seen from Figures 2 and 3.

The aim of reports was to show that physics is everywhere around us. Each student can work as an expert in some field (Chalupková, 2009). He/she is able not only to present some practical information, but also to indicate its connection to the laws of physics. The teacher can also take advantage of the specific expert knowledge of such a student, e.g. when talking about different areas of school physics. It seems to be very useful not to neglect knowledge and skills of students gained out of school (Demkanin, 2008; Braund, 2006; Chalupková, 2009).

It was therefore interesting to see whether the students would welcome including such reports during their study of physics at high school. As seen in the Figures 2 and 3, the answer is positive.

As it was said before, the specific knowledge of students can be efficiently used by the teacher. He/she can use the knowledge of a student — parachute-jumper when talking about the free fall. Or a student — musician would bring a musical instrument and talk about physics and acoustics. 18 of 22 students declared that they would accept such a way of teaching, three students did not know. The students also suggested some improvements. For example, the presentation of a student should be complemented by the teacher. And as one student said: "This way of learning is OK, but it is difficult to present the topic in a way that is interesting to schoolmates."

The next item in the questionnaire was to express the benefits for a student when preparing the report. Most of students (17) underlined the gain of new information. Although they had spent a lot of time when preparing the activity, they had obtained physics information that, for example, could improve the technique in a sport or could help in the creating of flying kites in the future. Moreover, students improved their communication and presentation skills. As one student wrote: "I took it more from physics point of view and I had never thought about such things under normal circumstances, but maybe I can enrich the tactics in sports." Or "I have learned something more about the sport I like. I plan to upgrade the airsoft gun. Now I know how this gun works and why – thanks to the gained information." The rest of reactions have different nature. One type of motivation was the gain of a good mark, or "I‘ve talked about something interesting to me to the whole class, it is different from writing physics tests."

And which report was the best according to classmates? They expressed their opinions in the next question of the questionnaire. Students chose the kite-flying. It was interesting to notice the reasons of their choice. The kite-fly report caught attention by a clear, brief, interesting presentation and by illustrations on the blackboard. The students appreciated when the student was an expert in the given area and when he was able to answer not easy questions from classmates.

At the end of the questionnaire there was an item devoted to using out-of-school knowledge by the teacher at formal school education. Students expressed their attitude to this type of activities. There were 12 pairs of opposite adjectives. The evaluation was done with the help of 5 degree Likert scale. The positive adjectives were assessed by one, the unwanted by five (Table 2).

It can be seen from Table 2 that such lessons have been perceived as varied, comprehensible, interesting and attractive. Also in other adjectives, the students perceived this activity more positively than negatively.

Table 2: The use of out-of-school knowledge in physics education

positive		*Negative*	*average*
varied	1 2 3 4 5	monotonous	1,55
comprehensible	1 2 3 4 5	incomprehensible	1,73
interesting	1 2 3 4 5	boring	1,82
attractive	1 2 3 4 5	repulsive	1,86
simple	1 2 3 4 5	complicated	1,86
active	1 2 3 4 5	inactive	2,05
easy	1 2 3 4 5	difficult	2,09
important	1 2 3 4 5	useless	2,09
relaxing	1 2 3 4 5	exhausting	2,18
popular	1 2 3 4 5	unpopular	2,32
pleasant	1 2 3 4 5	unpleasant	2,45
enriching	1 2 3 4 5	not enriching	2,59

5 Conclusion

From the implemented questionnaire we can see that students enjoyed preparing their reports. It was an enriching process for them as individuals. But as students stated, they were not sure whether their reports had been beneficial also for others. Also Table 2 points out the fact that the elaboration of reports is good for the author, but not so much for other members of the class. Therefore it will be better to give students two assignments in the future. The first one: "Write a report about your favourite out-of-school activity. Stress the role of physics in it. The paper can contain more technical information, which needn't be understood by everyone. The teacher will be the only one who will read it and assess it." The second assignment: "Prepare a popularizing presentation about the chosen activity. Remember that the audience consists of your classmates who are not experts in the selected problem. Present it in the way understandable for most of the schoolmates."

It will be better to distribute preparing and presenting such reports over the whole physics course/school year in order to avoid the overload from the great number of presentations in a short time period. Students will appreciate when they can talk about something they understand, of course with the view of getting a good mark.

It is possible that, in general, students can have the feeling that this method of education is good "because we are not learning", "we are not under a pressure of a teacher", but from the atmosphere we see that they will gain much more experience as opposed to the usual, even if context based methods. Moreover, even if they had known a lot of information about the selected hobby, they learned something new.

From the presenter's point of view: Except of gaining new facts, the students learned how to work with information resources as they had to choose the most important facts from them. They improved their presentation and communication skills. They could talk about something interesting for them to the whole class.

From the listener's point of view: The students saw that everyone could be an expert in some field of physics and on the other hand, that physics is very important in our lives and everyone uses it. School physics is therefore not useless; it really describes the world around us. But not only that. The physics content is not the most important. The context in which the physical topic is taught, the way of presenting the problem, the competencies which are developed play unsubstitutable place in education of a young person. So the teacher should try to involve students in the described way as much as possible. And let us hope that when somebody asks the middle-aged generation in 20 years how they enjoyed the physics lessons at primary and high schools, he/she will obtain positive answers.

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