

Students' understanding of selected aspects of electricity and magnetism

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Abstract. Two pilot studies concerning understanding of some aspects of magnetism (and also electricity) will be presented. The first study is focused on misconceptions in connection between magnetism and other topics; the second one is focused on ideas concerning values of some electric and magnetic quantities. Both studies are focused on topics which are not usually directly taught during physics classes at schools, their aim is to map how perception and understanding of these aspects of electricity and magnetism evolves with age.

1 Introduction

It is well known that students of various ages have problems in understanding some basic concepts of electricity and magnetism. This fact has been verified repeatedly by conceptual tests like CSEM (Conceptual Survey on Electricity and Magnetism, Maloney et. al., 2001), BEMA (Brief Electricity and Magnetism Assessment), DIRECT (Determining and Interpreting Resistive Electric Circuit Concepts Test) and others. To reveal conceptual understanding of Czech high school students in the area of electricity and magnetism, a test CCTEM inspired by CSEM but adapted to a high-school level was developed some time ago [1]. This test is focused on electric and magnetic field, electric and magnetic force, electromagnetic induction etc.

There are two other topics in electricity and magnetism which are not usually taught at school but students have some ideas about it. So, we prepared surveys which we would like to help us find out what ideas students have.

2 About surveys

2.1 *Magnetism and other topics*

The goal of this survey is to identify what students know and what their ideas are about connection between magnetism and other topics. There are three basic concepts the survey is focused on: Magnetic field of Earth, Magnetism and gravitation and Magnetism and vacuum. Firstly, according to our experience the idea about falling things down because of Earth's magnetic field is relatively common at the age about 12 years. Secondly, according to our previous experience, it seems that wrong ideas about whether magnets work in vacuum are still present at the end of high school. (Some students think that magnets "do not work" in vacuum.) Also, even undergraduate students (future physics teachers) sometimes exhibit some misconceptions concerning Earth's magnetic field – the most common wrong idea is that magnetic lines go from one pole to the second and there are no magnetic lines going through Earth's surface between poles (see the fig. 1).

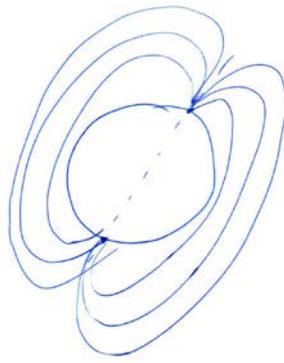


Fig. 1 Earth magnetic field (example of wrong idea drawn by one future physics teacher)

Because these topics are not usually explicitly taught at schools in the Czech Republic it is interesting to try to map how these ideas change during life. Therefore, we plan five target groups for this survey: students at the beginning of secondary school (age about 12), at the beginning of high school (age about 15), at the end of high school (age about 19) and university students - future physics teachers. The last target group will be physics teachers (both secondary and high schools level).

2.2 How students can estimate values of some quantities

The goal of the second survey is to explore, whether students and future physics teachers can estimate at least very roughly values of some common physics quantities connected with electrostatics and magnetism (for example charge on a plastic straw or rod charged by rubbing, electric voltage of a man who took off his sweater, magnetic field in the vicinity of common neodymium and ferrite magnets, horizontal component of Earth's magnetic field and magnetic inclination). What all these quantities have in common is the fact that they are not directly perceivable by our senses. Our previous experience showed that people who are not experts in the field often have no idea about their values or their estimates are wrong, for example in case of charges, by even orders of magnitude.

Target groups of this survey will comprise students at high schools (after lessons about electricity and magnetism), future physics teachers and also physics teachers from different schools (mostly high schools).

3 Conclusions

Tests developed to investigate the above mentioned problems and results of pilot studies will be presented at the conference and various aspects of both the tests, the results and experience gain in piloting the studies will be discussed.

References

- [1] V. Koudelkova, L. Dvorak, *High school students' misconceptions in electricity and magnetism and how to diagnose them*. ICPE-EPEC 2013. Conference Proceedings. MATFYZPRESS publisher, Prague 2014
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