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HIGH SCHOOL STUDENTS' MISCONCEPTIONS ABOUT MAGNETISM

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Abstract. The aim of this study was to investigate the high school students' misconceptions about the magnetism. A diagnostic test concerning this concept was developed and administered to 98 eleventh grade students. Students are 16-17 years old. Students' respondents for the test were analyzed. This study identified a number of misconceptions about the magnetism. We suggest that the results can be utilized in research that develops teaching strategies to overcome students' misconceptions.
Keywords: misconceptions, magnetism

Introduction

Science educators recognize that students have their own ideas about some of the phenomena of interest in science and that those ideas usually differ from scientists' currents views (Cosgorova, 1995). The present trends in education emphasize the students, as opposed to the instructor, as the main object of the teaching process (Pınarbaşı & Canpolat, 2003). Teachers have been well informed by researchers that students often have incomplete or inaccurate prior knowledge that interferes with their ability to learn scientific concepts. As a result, it is known that students of all ages can have inaccurate alternative conceptions in all areas of science. In recent years, research has focused on identifying and characterizing students' understanding and difficulties about many science topics in science education (Janiuk, 1993). Research has consistently shown that students do not come to the classroom as blank slates rather that they come with a well-established understanding about how and why everyday things behave as they do (Posner et al., 1982). During instruction, learners generate their own meaning based on their backgrounds, attitudes, abilities, and experience. According to the cognitive model, students build a sensible and coherent understanding of the events and phenomena in their world from their own point of view (Osborne & Wittrock, 1983). Furthermore, recent studies have revealed that this understanding, whether correct or incorrect, influences how students learn new scientific knowledge. There have been many studies concerning alternative conceptions about science concepts (Pfund & Duit, 2000).

Misconceptions are very common in all topics of physics, such as mechanics (e.g., Clement, 1982; Eryılmaz, 2002; Minstrell, 1982; Towbridge & McDermott, 1980; 1981; Vionnet, 1979; Dilber et al., 2009; Zhou et al., 2015), electricity (Cohen et al., 1983; Dupin & Johsua, 1987; Fredette & Lochead, 1980; Heller & Finley, 1992; Idar & Ganiel, 1985; Maloney et al., 2001; Sencar & Eryılmaz, 2004), optics (e.g., Feher & Rice, 1992; Goldberg & McDermott, 1986; 1987, Favale & Bondany, 2014), and thermodynamics (e.g., Athee, 1993; Bar & Travis, 1991; Ericson, 1979; Shayer & Wyllam, 1981), magnetisim (Yilmaz & İnce, 2012; İnce, 2012; Miokovic et al., 2012; Cheng & Brown, 2015). One of the most important outcomes of research on misconceptions is that educators need to consider students' misconceptions for meaningful learning to take place (Gil-Perez & Carrascosa, 1990; Hewson & Hewson, 1983). Meaningful learning is described as a learner's ability to interpret and use knowledge in situations that are not the same as those in which it was initially learned (Novak, 2002). Misconceptions are very stable, and traditional instruction does not encourage meaningful learning; hence, it is not easy to replace them with scientific conceptions (Clement, 1993; Hestenes, 1987; Novak, 2002). Changing misconceptions is not simply adding new information to an individual's mind, but care should be taken to account for the interaction of new knowledge with existing, provided that the new may be replaced with the existing (Hewson & Hewson, 1983). Replacing the existing faulty knowledge with the scientific one is one of the aims of conceptual change strategies (Hewson & Hewson, 1983; Novak, 2002; Posner et al., 1982). Many researches about students' misconceptions in science state that traditional instruction (transfer of knowledge) is ineffective in correcting misconceptions and does not usually result in meaningful learning (e.g., Dykstra et al.,1992; Hestenes, 1987; McDermott & Shaffer, 1992; Mestre, 1991; White, 1992). Furthermore, all state that most of students' misconceptions exist after instruction. It is not easy to change students' beliefs. After the instruction, students might use scientific knowledge in school and give correct answers to standard questions, but in unfamiliar situations or outside the school they will use their own alternative beliefs (White, 1992).

Students often develop misconceptions about scientific concepts. These misconceptions have serious effects on subsequent learning. Therefore, it is important to identify students' preconceptions in order to plan future teaching activities. This study examined students' understandings of magnetism concepts.

The key research question in this study was therefore determined as: what are high school students' misconceptions regarding magnetism?

Method

The study

The subjects of the present study consisted of 98 high school students (53 boys and 45 girls) from two classes of a physics course taught by the same teacher in a high school in Turkey. Students' ages ranged from 16 to 17 years.

Known and most widely used Force on Force and Motion Concept Test (FCI) which was developed by (Hestenes et al., 1992). At the same time, it is known about magnetism and a widely used test that is not available (Demirci & Cirkinoğlu, 2004). In this study, we searched to student's misconception about the magnetism. The subjects are magnets, magnetic field, magnetic poles, charged particle in a magnetic field, magnetic field of a wire, magnetism properties of the matter, magnetic field effect of electric current concepts. Therefore, a diagnostic test which can measure the magnetism concepts was developed. The questions in this test had three steps. In the first steps, the students are asked to explain what an event is as an achievement. In the second step, the reason of his/her answer to the first step is asked and in the third step, the students are asked to tell how sure she/he is about the answers given to the first step. For the students who have different ideas on the first two steps, a blank box is added (one example see appendix).

All questions were pilot tested and the required modification was made prior to the administration of test. The content validity of the test questions was assessed by one physics professor and two research assistants. This test was administered to 98 high school students enrolled in Electric and Magnetism Unit at 2015.

In this study, the responses of the students who gave wrong answers to the first two steps and marked "very confident" choice were accepted as misconceptions. The responses like "Fairly confident", "Not confident" and "Just guessed" were not accepted as misconceptions because the students who gave such answers may have forgotten the subject or may have given such responses because of the lack of knowledge. Students' responses to the diagnostic test were analyzed.

Findings

Throughout the study process, misconceptions about magnetism are determined as follows (Table 1).

Table 1. Students' misconceptions identified through students' responses to test

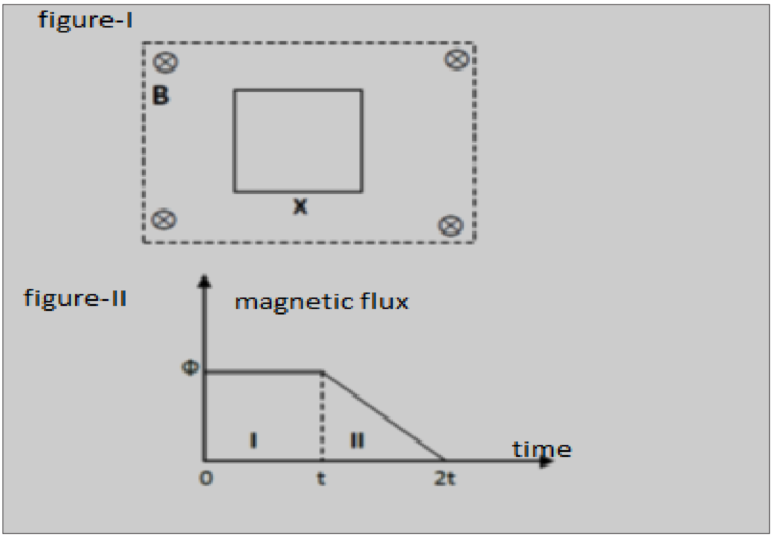
Misconceptions
1. All matters are affected by the magnetic field are classified as ferromagnetic material.
2. Magnet attracts all metals.
3. The attraction or repulsion of the magnet poles, are caused by the interaction of positive and negative charges inside the magnet.
4. Considering the magnetic field generated by a bar magnet, the effect of the magnet everywhere (in all regions) are the same.
5. Earth's magnetic and geographic poles are in the same place and location of the pole is fixed
6. Only magnets generates a magnetic field
7. The magnetic field generated by the current is the same at all distances
8. If the current passing through the two wires parallel to each other with opposite; This magnetic field is zero at all points between the two wires.
9. Neutral rod moves in a magnetic field are not affected by the magnetic field.
10. A cargo moving in a magnetic field, the magnitude of the speed change
11. Presence of the magnetic field in a region generates the eddy current.
12. Same amount of surface area changes will generate the same amount of magnetic flux in all circumstances.
13. The conductive wires having the same length is moved the in a magnetic fields at different speed, equally eddy current occurs between the ends of the conductor.
14. The conductors with different length, is moved with equal speed in a magnetic field; equally eddy current between the ends of the conductor occurs.
15. If the current in a coil circuit is changed, always occurs in opposite directions self-induced current to the circuit.

Conclusion and implications

There are only a few studies on misconceptions about magnetism in the literature. The findings of this research revealed that students have inadequate understanding of the concepts of magnetism. The results of the study revealed that the students did not conceptualize the concepts of magnetism. According to the results, students had 15 misconceptions about magnets, magnetic field, magnetic poles, charged particle in a magnetic field, magnetic field of a wire, magnetism properties of the matter, magnetic field effect of electric current concepts. The findings of this study do yield more insight into how high school students think about the concepts of magnetism, and suggest that traditional teaching methods are ineffective in helping students to learn these concepts scientifically. Teaching strategies and assessment instruments should be developed to engage the students more actively with such concepts.

APPENDIX

Sample questions from the Magnetism Concepts Test



Conductor X frame situated in a magnetic fields perpendicularly as shown Figure-I. Changes according to the time chart of the total magnetic flux from the frame surface as shown in Figure II. According to this, what can we say about the induction current passing from the shape at I and II time intervals?

	I	II
A)	constant	decreasing
B)	increasing	decreasing
C)	zero	constant
D)	increasing	increasing
E)	constant	zero

If you have different ideas, please write into the following blanks with the reasons

How confident are you that your answers to this questions are correct?

• very confident, • not confident, • fairly confident, • just guessed.

REFERENCES

Athee, M. (1993). A survey of Finnish pupils about thermal phenomena (pp. 422 – 425). In: Novak, J. (Ed.). *The proceedings of the Third International Seminar on Misconceptions and Educational Strategies in Science and Mathematics*. Ithaca: Misconceptions Trust.

Bar, V. & Travis, A.S. (1991). Childrens' viewpoints concerning phase changes. *J. Res. Sci. Teaching, 28*, 363 – 382.

Cheng, M.F. & Brown, D.E. (2015). The role of scientific modelling criterian advancing students' explanatory ideas of magnetism. *J. Res. Sci. Teachıng, 52*, 1053 – 1081.

Clement, J. (1982). Students' preconceptions in introductory mechanics. *Amer. J. Phys. 50,* 66 – 71.

Clement, J. (1993). Using bridging analogies and anchoring intuitions to deal with student's preconceptions in physics. *J. Res. Sci. Teaching, 30*, 1241 – 1257.

Cohen, R., Eylon, B. & Ganiel, U. (1983). Potential difference and current in simple electric circuits: a study of students' concepts. *Amer. J. Phys., 51*, 407 – 412.

Cosgorova, M. (1995). A study of science in-the-making as students generate an analogy for electricity. *Int. J. Sci. Educ., 17*, 295 – 310.

Demirci, N. & Cirkinoğlu, A. (2004). Öğrencilerin Elektrik ve Manyetizma Konularında Sahip Oldukları Ön Bilgi ve Kavram Yanılgılarının Belirlenmesi. *J. Turkish Sci. Educ., 1,* 116 – 139.

Dilber, R., Karaman, I. & Düzgün, B. (2009). High school students' understanding of projectile motion concepts. *Educ. Res. & Eval., 15*, 203 – 222.

Dupin, J.-J. & Johsua, S. (1987). Conceptions of French pupils concerning electric circuits: structure and evolution. *J. Res. Sci. Teaching, 42*, 791 – 806.

Dykstra, D.I., Boyle, C.F. & Monarch, I.A. (1992). Studying conceptual change in learning physics. *Sci. Educ., 76*, 615 – 652.

Ericson, G.L. (1979). Children's conceptions of heat and temperature. *Sci. Educ., 63*, 221 – 230.

Eryılmaz, A. (2002). Effects of conceptual assignments and conceptual change discussion on students' misconceptions and achievement regarding force and motion. *J. Res. Sci. Teaching, 39*, 1001 – 1015.

Favale, F. & Bondani, M. (2014). Misconceptions about optics: an effect of misleading explanations. *ETOP 2013 Proceedings*, paper Eth14.

Feher, E. & Rice, K. (1992). Shadows and anti-images: children's' conceptions of color. *J. Res. Sci. Teaching, 29*, 505 – 520.

Fredette, N. & Lochead, J. (1980). Student conceptions of simple circuits. *Phys. Teacher, 18*, 194 – 198.

Gil-Perez, D. & Carrascosa, J. (1990). What to do about science "misconceptions". *Sci. Educ., 75*, 531 – 540.

Goldberg, F.M. & McDermott, L.C. (1986). Students' difficulties in understanding image formation by a plane mirror. *Phys. Teacher, 24*, 472 – 480.

Goldberg, F.M. & McDermott, L.C. (1987). An investigation of students' understanding of real image formed by a converging lens or concave mirror. *Amer. J. Phys., 55*, 108 – 119.

Heller, P. & Finley, F.N. (1992). Variable uses of alternative conceptions: a case study in current electricity. *J. Res. Sci. Teaching, 29*, 259 – 275.

Hestenes, D. (1987). Toward a modeling theory of physics instruction. *Amer. J. Phys., 55,* 440 – 454.

Hestenes, D., Wells, M. & Swackhamer, G. (1992). Force concept inventory. ww*Physics Teacher, 30*, 141 – 153.

Hewson, M.G. & Hewson, P.W. (1983). Effect of instruction using students' prior knowledge and conceptual change strategies on science learning. *J. Res. Sci. Teaching, 20*, 731 – 743.

Idar, J. & Ganiel, U. (1985). Learning difficulties in high school physics: development of a remedial teaching method and assessment of its impact on achievement. *J. Res. Sci. Teaching, 22*, 127 – 140.

İnce, E. (2012). The effectivenes of problem-based learning on students nderstandings of electromagnetic field and magnetisim concepts. *Energy Educ. Sci. & Techn. B, 4*, 2383 – 2390.

Janiuk, R.M. (1993). The process of learning chemistry: a review of the studies. *J. Chem. Educ.*, *70*, 828 – 829.

Maloney, D.P., O'Kuma, T.L. & Hieggelke, C.J. (2001). Surveying students' conceptual knowledge of electricity and magnetism. *Amer. J. Phys., 69*, S12 – S23.

McDermott, L.C. & Shaffer, P.S. (1992). Research as a guide for curriculum development: An example from introductory electricity – part I: investigation of student understanding. *Amer. J. Phys., 60*, 994 – 1002.

Mestre, P.J. (1991). Learning and instruction in pre-college physical science. *Physics Today, 44*, 56 – 62.

Minstrell, J. (1982). Explaining "at rest" condition of an object. *Phys. Teacher, 20*, 10 – 14.

Mioković, Ž., Ganzberger, S. & Radolić, V. (2012). Assessment of the Unıversıty of Osıjek engineerıng students' conceptual understandıng of electricıty and magnetism. *Technical Gazette, 19*, 563 – 572.

Novak, J.D. (2002). Meaningful learning: the essential factor for conceptual change in limited or inappropriate propositional hierarchies leading to empowerment of learners. *Sci. Educ., 86*, 548 – 571.

Osborne, R.J. & Wittrock, M.C. (1983). Learning science: a generative process. *Sci. Educ., 67*, 489 – 508.

Pfund, H. & Duit, R. (2000). *Bibliography: students' alternative frameworks and science education*. Kiel: IPN.

Pınarbaşı, T. & Canpolat, N. (2003). Students' understanding of solution chemistry concepts. *J. Chem. Educ., 80*, 1328 – 1332.

Posner, G.J., Strike, K.A., Hewson, P.W. & Gertzog, W.A. (1982). Accommodation of a scientific conception: toward a theory of conceptual change. *Sci. Educ., 66*, 211 – 227.

Sencar, S. & Eryılmaz, A. (2004). Factors mediating the effect of gender on ninth-grade Turkish students' misconceptions concerning electric circuits. *J. Res. Sci. Teaching, 41*, 603 – 616.

Shayer, M. & Wylam, H. (1981). The development of the concepts of heat and temperature in 10 – 13-year-olds. *J. Res. Sci. Teaching, 18*, 419 – 434.

Towbridge, D.E. & McDermott, L.C. (1980). Investigation of student understanding of concept of velocity in one dimension. *Amer. J. Phys., 48*, 1020 – 1028.

Towbridge, D.E. & McDermott, L.C. (1981). Investigation of student understanding of concept of acceleration in one dimension. *Amer. J. Phys., 49,* 242 – 253.

Vionnet, L. (1979). Spontaneous reasoning in elementary dynamics. *Eur. J. Sci. Educ., 1,* 205 – 221.

White, R.T. (1992). Implications of recent research on learning for curriculum and assessment. *J. Curr. Studies, 24*, 153 – 164.

Yilmaz, O. & İnce, E. (2012). The usage of alternative assessment techniques in determination of misconceptions about electromagnetic field-magnetism contents and effects of video-based experiments on students' achievement at distance learning. *Procedia, 55*, 155 – 160.

Zhou, S.N., Zhang, C. & Xiao, H. (2015). Students' understanding on Newton's third law in identifying the reaction force in gravity interactions. *Eurasıa J. Math. Sci. & Techn. Educ., 11*, 589 – 599.

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