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Misconceptions of science teacher candidates about heat and temperature

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Abstract

In this study, the misconceptions that the students have about heat and temperature and the reasons behind it have been focused. Members of study group include 60 second grade students of the Faculty of Education of Ahi Evran University during 2009-2010 school year. Multiple-choice tests have been used to be able find out misconceptions. In this test, also entitled as "*Diagnostic Test*", there is a space where students are expected to write why they have chosen that particular option after a number of items including the right answer along with confounding options. In addition, the misconceptions of teacher candidates have been put forth as an outcome of the analysis of data about heat and temperature.

Key words: Science, Heat and Temperature, Misconceptions.

1. Introduction

Research on conceptual change has been a central topic in science education literature for the last 25 years. It proceeds from the insight that learners bring their own conceptualizations of the natural world to the science classroom which are usually incommensurable with scientific one (Bevir, 2003; Georgiades, 2000; Hayes, Foster, & Gadd, 2003; Kang, Scharmann, & Noh, 2004; Macbeth, 2000; Venville, 2004). Purportedly, students have to replace and re-organize their central concepts within a teaching procedure which is viewing learning as a process of conceptual change (Abd-el-Khalick & Akerson, 2004; Carey, 2000; Merenluoto & Lehtinen, 2004; Sanger & Greenbowe, 2000; Wickman & Östman, 2002). Misconceptions are a worrying situation for students and teachers in science teaching. This problem, especially due to its abstract nature, is a commonly faced problem in physics (Aydoğan, Güneş & Gülçiçek., 2003). Students come up with a variety of impressions and concepts about their own life. Many of these impressions and concepts might be misleading. For an influential science teaching, it is initially required that prior knowledge of students must be activated and new information must be linked to students' prior knowledge. Thence, the importance of the level of student information and the misconception that students have arises. In addition to this, it should not be overlooked that the failure of teachers and course books in configuring the targeted conceptual changes might lead to different kinds of misconceptions in students. When students begin to discover their environment, they attempt to explain what they have coincided in the context of their own learning

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and they share these explanations with the ones around them. When students internalize what they have acquired through their intuitions and impressions, these intuitions and impressions have already become a misconception. When this formation of misconceptions is analyzed; it is possible to define misconceptions as such: It occurs when the way that someone defines a particular concept shows difference in comparison with that of the scientific way which is accepted by everyone (Marioni, 1989; Tery, Jones and Hurford, 1985; Riche, 2000; Stepans, 1996). When concepts, keystones of the scientific information, are given or interpreted in a wrong way, this might cause learned information to be used in an improper way by leading to a conceptual confusion and misconception (Demirci & Sarıkaya, 2004). Misconceptions in science teaching have been searched for a long time and many solutions have been put forth, however these misconceptions do not lose ground during education continuum. Thence, in our study, it has been aimed to develop a test to be able to find out the misconceptions of teacher candidates about heat and temperature as well as the evaluation of the applicability of these tests.

2. Method

2.1. Research Model

In this research, descriptive study in terms of *scanning model*, it has been aimed that the misconceptions of science teacher candidates about heat and temperature could be identified.

2.1. Population and Sampling

The population of this research includes students of the Faculty of Education of Ahi Evran University during 2009-10 school year. Sampling includes 60 second grade students of the science education department.

2.2. Data Collection Tools

Multiple-choice tests have been used to be able find out misconceptions. In this test, also entitled as "Diagnostic test", there is a space where students are expected to write why they have chosen that particular option after a number of items including the right answer along with confounding options. While developing "*Diagnostic Test*" scale about heat and temperature, some common misconceptions have been identified through a literature scanning. In the study, the other tests, which have been prepared during the development process of the test, have been thoroughly analyzed. Items about heat and temperature have been interpreted by the researcher and rewritten in an open-ended way so that teacher candidates can better grasp. There are 10 open-ended items in the test to be able to find out the misconceptions about heat and temperature. In some items, students were asked to draw essential illustrations and explain them. Then, open-ended items were applied to science teacher candidates outside of the sample. By making use of the answers of the students as well as the misconceptions in literature, test has been transformed into a multiple-choice test, in which each item includes five options. Furthermore, an explanation part has been added to the ends of each item so that students might illustrate why they have chosen that particular options. While grading the test, the options except for the right one have been marked as the wrong option.

A pilot study has been carried out with science teacher candidates who are outside of the sample in order to be able find out reliability of the multiple-choice test. Besides, reliability calculations have been made and reliability coefficient has been found as 0,76 according to Kuder-Richhardson (KR-20) formula.

2.3. Analysis of Data

In scales developed to find out the misconceptions of students, frequencies and percentages have been calculated in accordance with students' correct, incorrect answers and unanswered questions along with their answer justifications. As a result of the analysis of these data, misconceptions, frequencies and percentages have been converted to table (Table 1). General situation have been interpreted through its evaluation.

3. Result and Discussion

The frequencies and percentages of the students in accordance with their correct, incorrect answers and unanswered questions along with their answer justifications to find out their misconceptions about heat and temperature have been given in Table 1.

Table 1. Misconceptions about heat and temperature and rates of these misconceptions

Item No	CA f	CA %	IA f	IA %	Unanswered f	Unanswered %	Student Answers Including Misconceptions
1	37	**62**	23	**38**			"Heat is the expression of a temperature in terms of energy. Heat is the total number of the particles." "Heat is the amount of temperature change, which is different for each substance." "Heat is the energy that exists in a substance, it cannot be measured and does not depend on the amount of the substance." "Temperature is the collision energy of the particles." "Temperature is the interaction of substance with the particles." "Temperature is a criterion for substance and might change from substance to substance." "Temperature is the energy given to substance to change state of matter."
2	18	**30**	21	**35**	21	**35**	"Erg, I heard it for the first time."
3	32	**53**	28	**47**			"The temperature of a boiling liquid will increase since it will take the heat." "Since every substance has a certain density, density will not change even if the temperature changes." "As long as the state of matter does not change, density will not change even if the temperature changes." "The density of water does not change since it is water even when it is boiling and it is 1." "Density will not change since it depends on the type of liquid."
4	27	**45**	33	**55**			"Particles of substances and liquids transmit energy by collision." "Since substances and liquids have a certain shape, they transmit heat." "Since gas has a density, they do not transmit heat through transmission." "Since the gap between particles is not much, heat is transmitted through transmission." "When the temperature of gas molecules increases, molecules transmit heat by collision."
5	50	**83**	10	**17**			"When the temperature of water increases, it turns into gas. Water turns into gas at 100^{o}C." "The temperature of the state of matter of every substance is different." "During the state of matter, the change in heat and temperature do not stay at the same level"
6	30	**50**	30	**50**			"When the pressure increases, only the melting time changes." "Water keeps boiling even over 100^{o}C" "Water boils at any temperature, but does not evaporate at any temperature." "Since substance take heat during the state of matter, its temperature changes." "Even if the pressure changes, the state of matter does not occur before a substance reaches its temperature of state of matter."
7	15	**25**	45	**75**			"When two objects are put side by side, they keep exchanging heat will their temperature is equal." "The transmission of heat and temperature is from the highest to lowest." "The last temperature of two substances, between which there is a heat flow is equal to each other."
8	50	**83**	10	**17**			"Since the gap between the molecules of substances is not much, heat is transmitted through transmission."
9	53	**88**	7	**12**			"Water evaporates at any temperature, but we cannot often see this. Since water freezes at 0^{o}C, there is no evaporation." "The most intense moment of evaporation is the moment of boiling."
10	32	**53**	28	**47**			"Every substance has its own density and this does not change." "When water takes heat or gives heat, that does not mean that its density will change" "Since liquids are not compressed, the volume of water does not change."
11	23	**38**	37	**62**			"Since the specific heats of three different substances taken from a refrigerator are different, their temperatures are different, as well." "When the same amount of heat is given to different substances, their last temperature becomes the same."
12	35	**58**	25	**42**			"Since the sizes of one glass of water and a bucket of water in the same atmosphere are different, the temperature of a bucket of water is more." "If the heat of a substance is more, its temperature is more, too." "Even if the bulks of the same types of substances in the same atmosphere are different,

					their temperature is the same."
13	17	**28**	43	**72**	"Temperature does not influence the height of liquid in a container." "Despite the same amount of temperature increase in different container where there are different types of liquids, since there will be more evaporation in liquid whose surface areas is wider, the change in liquid height will be the least." "Since the expansion amount of the liquids, whose volumes are big, will be large, their liquid height will increase more."
14	22	**37**	38	**63**	"In an ice-water mixture, when ice melts, the total density of the mixture decreases." "When ice melts, since its density does not change, its volume does not change, as well." "In ice-water mixture, when ice melts, the last temperature of ice-water mixture does not change."
15	40	**67**	20	**33**	"Since temperature depends on bulk amount, the temperature of the one whose bulk is more is less. The type of the substances in the same environment influences their last temperature."

*CA: Correct Answers IA: Incorrect Answers Unanswered: Unanswered questions

When table 1 is analyzed, it is seen that %62 of the students answered correctly to the first item of the test while %38 of them chose the incorrect answers. Students, who have misconception and thus chose the incorrect answer do not know the concept of heat and temperature and thinks that those concepts might be used interchangeably. Also, according to many researches, it is seen that students are inclined to use heat and temperature concepts interchangeably (Ericson and Tiberghien, 1985; McDermott, 2003). The second item of the test was answered correct by the %30 of the students whereas %35 of them chose the incorrect answers and %35 of them did not answer the question. The reason behind this might be linked with the fact that students are coinciding with a number of concepts for the first time or cannot remember these concepts properly. It is seen in the third item that %45 of the students chose the correct answer while %55 of them gave an incorrect answers. What lie behind the incorrect answers are the misconceptions that students have about how heat is transmitted in material environment. Ayas and Çoştu (2001), according to the consequences of the study they carried out to find out the grasping level of students' boiling and condensation concepts, put forward that students constrain concept of boiling and condensation with water and suppose that this act will not occur in other liquids and temperature will increase during boiling.

When we take the seventh item into consideration, it is possible for us to see that %25 of the students have chosen correct option while %75 have chosen incorrect answers. The reason why students have such a high level of misconception may be that they think that heats of substances become equal rather than their temperature as a consequence of heat flow. It has been found out that students are going out their depths in particular when they attempt to differentiate the concepts of heat and temperature. According to the results of some studies, some misconceptions like "the total amount of temperature of two substances which are exposed to each other is equal to the total amount of temperature at the end of the exposition", "heat is transmitted from the hottest to the coldest", "it is temperature, not heat, which is transmitted from a hot system to a cold system", "heat flow is from higher temperature to lower temperature", "heat does not depend on the amount of substance", heat depends on the amount of substance" have been found out (Gönen and Akgün, 2005; Aydoğan, Güneş,& Gülçiçek, 2003; Kesidou and Duit, 1993). %38 of students chose correct answer in eleventh item whereas %62 of them chose incorrect answers. On the basis of these misconceptions lies the belief that the temperatures of the substances in the same environment will be different due to differences. Then, when we focus on the thirteenth item, we can see that %28 of them chose correct answer while %72 of them chose incorrect answers. What lies behind the high average of the incorrect answers might be that: Despite the same amount of temperature increase in different container where there are the same types of liquids, since there will be more evaporation in liquid whose surface areas is wider, the change in liquid height will be less. In his study, Ericson (1979) revealed that children have a number of misconceptions as such: heat is a substance like air and stream, heat is the opposite of cold, temperature of a substance depends on its size and gross. Finally, when we analyze the fourteenth item, it is seen that %37 of students have chosen correct answer while %63 of them chose incorrect answers. What lies behind the misconception that children hold in this item is that: they think that there will be no change in the size of a substance since there is no a change in the bulk of a substance after the state of matter.

Teacher candidates are required to configure what they have learned during courses in a proper way and maintain the continuity of this. Thence, they are expected to participate in the process of education in an efficient way, repeat what they have learned on regular basis and achieve permanent learning along with retention methods by making use of learning strategies with memory supporting. According to Kartal (2007), active learning strategies, ensuring students' taking active role in class atmosphere have a positive impact upon the permanency of what has been learned.

4. Conclusion and Suggestions

In the light of the findings about the misconceptions of science teacher candidates about heat and temperature along with the reasons of these, those suggestions might be given: Science teacher candidates should attempt to increase the level of interest by eradicating the negative attitudes of students towards heat and temperature. Thence, a kind of case study should be carried out. After doing that, some activities to make this course more interesting and attractive should be employed. In addition, the content of the course should be linked with the happening so that a more permanent and meaningful understanding could be achieved.

While starting a new subject, some tests should be employed to find out the misconceptions that students have. In this way, new strategies and methods can be implemented through a process in which the content of the courses might be reconstituted.

While focusing on a subject in whom there are many terms and concepts, educational technology and laboratories might be used. As a consequence of this, subjects could be more comprehensible, tangible and interesting. Thus, it might be the center of attraction.

Teacher should know the methods and strategies of how conceptions which are used in science teaching and employ them in a useful manner. When it is taken into consideration that teacher come up with a number of misconceptions while starting their undergraduate education and are inclined to misunderstand these concepts, the importance of the reconstitutions of information reemerges.

References

Abd-el-Khalick, F., & Akerson, V. L. (2004). Learning as conceptual change: factors mediating the development of preservice elementary teachers' views of nature of science. Science Education, 88, 785-810.

Ayas, A. & Coştu, B. (2001). The level of the First Grade High School Students' Understanding of Evaporation, Condensation, Boiling Concepts, in the Declaration of Science and Technology Education Symposium (p. 270-280). Istanbul: Maltepe University.

Aydoğan, S., Güneş, B. & Gülçiçek Ç. (2003). The Misconceptions about Heat and Temperature. Journal of Gazi education faculty. 23, 2, 111-124.

Bevir, M. (2003). Notes toward an analysis of conceptual change. Social Epistemology, 17, 55-63.

Carey, S. (2000). Science education as conceptual change. Journal of Applied Developmental Psychology, 21, 13-19.

Demirci, M.P., & Sarıkaya M. (2004). Misconceptions of the Classroom Teacher Candidates and the Influence of the Structuralist Theory upon These Misconceptions' Eradication. XIII. National Educational Science Congress. 6-9July, Malatya.

Ericson, G. & Tiberghien, A. (1985). Heat and Temperature. In R. Driver, E. Guesne, & A Tiberghien(Eds.), Children' s ideas in science. Philadelphia, PA: Open University Press.

Georgiades, P. (2000). Beyond conceptual change learning in science education: focusing on transfer, durability and metacognition. Educational Research, 42, 119-139.

Gönen, S & Akgün, A. (2005). An Analysis of the Feasibility of Worksheet Developed as a Result of the Interaction between Concepts of Heat and Temperature. Electronic Social Science Journal. 3(11), 92-106.

Hayes, B., Foster, K., & Gadd, N. (2003). Prior knowledge and subtyping effects in children's category learning. Cognition, 88, 171-199.

Kang, S., Scharmann, L. C., & Noh, T. (2004). Reexamining the role of cognitive conflict in science concept learning. Research in Science Education, 34, 71-96.

Kartal, T. (2007). The Effect of The Method of Active Learning of Elementary Science Teaching Success, Attitudes, of The Students' and Keeping in Mind. Selcuk University, Graduate School of Natural and Applied sciences, MS Thesis. Konya.

Kesidou, S. & Duit, R. (1993). Students' conceptions of the second law of thermodynamics-an interpretive study. Journal of Research in Science Teaching, 30(1), 5-106.

Macbeth, D. (2000). On an actual apparatus for conceptual change. Science Education, 84, 228-264.

Marioni, C. (1989). Aspect of Srudent's Understanding in Classroom Setting: Case Studies on Motion and Intertia. Physics Education. 24, 273-277.

McDermott, L.C. (2003). Improving student learning in sciences. Physical Science News, 4(2), 6-10.

Merenluoto, K., & Lehtinen, E. (2004). Number concept and conceptual change: towards a systemic model of the processes of change. Learning and Instruction, 14, 519-534.

Riche, R. D. (2000). Strategies for Assisting Students Overcome Their Misconceptions in High School Physics. Memorial University of Newfoundland Education. 6390.

Sanger, M., & Greenbowe, T. (2000). Addressing student misconceptions concerning electron flow in aqueous solutions with instruction including computer animations and conceptual change strategies. International Journal of Science Education, 22, 521-537.

Stepans, J. (1996). Targeting Students' Science Misconceptions: Physical Science Concepts Useing the Conceptual Chance Moldel. Riverview, Fla: Idea Factory.

Terry, C. Jones, G. ve Hurford, W. (1985). Children's Conceptual understanding of Forces and Equilibrium. Physics Education. 20, 162-165.

Venville, G. (2004). Young children learning about living things: a case study of conceptual change from ontological and social perspectives. Journal of Research in Science Teaching, 41, 449-480.

Wickman, P., & Ostman, L. (2002). Learning as discourse change: a sociocultural mechanism. Science Education, 86, 601-623.