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The Effect of Conceptual Change Approach to Eliminate 9th Grade High School Students' Misconceptions about Air Pressure

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Abstract

The aim of this study was to determine the effectiveness of teaching based on conceptual change overcome misconceptions of 9th grade high school students about the subject of air pressure. The sampling of the study was formed with two classes of 9th grade students from a general high school in the city-center of Trabzon. A quasi-experimental method was used in the study as a research design. One of the classes that was selected for the study was chosen as a control group (n=45), and the other class was chosen as an experiment group (n=45). While conceptual change texts and concept maps were used to teach air pressure subject to the experiment group, traditional teaching methods were used to teach the same subject to the control group. For the purpose of collecting data, Success Test and Concept Test were implemented. The control and experiment groups' pre-test and post-test scores were analyzed by t test. Analysis of the data showed that there was not a statistically significant difference between the control and the experiment group in the pre-test in terms of the concept understanding achievement. However, post-test results showed that there was a significant difference in favor of the experiment group. It was concluded that teaching methods and materials based on conceptual change were more effective than traditional teaching methods to teach air pressure subject.

Key Words

Geography Education, Air Pressure, Misconception, Conceptual Change.

Students develop meanings in their minds from their daily experiences for various concepts before the education period (Platten, 1995). These thoughts that are formed in students' minds are considered as misconceptions because they can differ from scientific facts (Büyükkasap, Düzgün, Ertuğrul, & Samancı, 1998; Driver, 1989; Lane, 2008). Misconception is mismatching of the scientific definition of concept and the definition formed in students' minds and it conflicts with the expert opinions in related areas (Gilbert & Watts, 1983; Lane, 2008). It is a known fact that students' misconceptions cause negative results for them to understand scientific facts correctly. The studies that are subjected students' learning capabilities of geographical concepts and the misconceptions related to these concepts reflect the fact that students are facing difficulties in understanding various geographical topics and concepts and they have considerable misconceptions (Aksoy, 2003; Alim, 2008; Aron, Francek, Nelson, & Biasrd, 1994; Başıbüyük, Doğar, Gürses, & Yazıcı, 2004; Baysen, Temiz, Baysen & Yağbasan, 2004; Doğar & Başıbüyük, 2005; Lane; 2008; Quintero, 1996; Trend, Everett, & Dove, 2000). Defining students' ideas, pre-knowledge, misconceptions and alternative structures or separating these into categories does not result with eliminating these. Because of that, it is required to find out the root causes behind these misconceptions and develop appropri-

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ate teaching tools to correct these misconceptions (Broughton, Sinatra, & Reynolds, 2010; Canpolat, 2002; Hewson & Hewson, 1983; Sungur, Tekkaya, & Geban, 2000; Reinfried, 2006; Ünal, 2007).

Conceptual change methodology, which is developed based on constructive approach and widely used in teaching-learning activities recently, considers students' previous knowledge and plans teaching activities based on this (Canpolat & Pınarbaşı, 2002; Dhindsa & Anderson, 2004; DiSessa, 2002; Mason, 2002; Uzuntiryaki, Çakır & Geban, 2001; Yürük, 2000). Conceptual change methodology represents an alternative approach that encourages students' to change their ideas from misconceptions to scientific correct facts (Broughton et al., 2010; Canpolat & Pınarbaşı, 2002).

Conceptual change approach that is commonly used in education recently takes students' previous knowledge into account and education program is planned based on these (Canpolat & Pınarbaşı, 2002; DiSessa, 2002; Dhindsa & Anderson, 2004; Mason, 2002; Uzuntiryaki et al., 2001; Yürük, 2000).

Posner, Strike, Hewson, and Gertzog (1982) first introduced conceptual change model, then researchers developed teaching tools and strategies to be used in classes from this model (Hewson & Hewson, 1983). Thoughts that lead to misconceptions are deeply founded in students' minds, since they seem reasonable from students' point of view despite the fact that they are not scientific accepted and students resist changing their ideas with correct concepts, they are conservative with their previous knowledge (Cin, 1999; Driver, 1989; Harwood & Jackson, 1993; Platten, 1995).

Various separate methods are used to realize conceptual change process based on conceptual change model. Conceptual change texts and concept maps are from these tools (Balcı, 2005; Köse & Uşak, 2007; Tekin, Kolomaç, & Ayas, 2004; Toka & Aşkar, 2002; Uzuntiryaki & Geban, 1998; Yılmaz, Tekkaya, Geban & Özden, 1998; Yürük, 2000). Conceptual change texts written documents that help students' to explore their misconceptions and show them provides them the scientific accepted facts (Ölmez, Geban, & Ertepınar, 2001; Uzuntiryaki et al., 2001; Ünal, 2007). Concept maps, being an effective method that directs students to conceptual change, are training tools that visualize the relationship and hierarchy between concepts (Kılıç & Sağlam, 2004; Köse & Uşak, 2007).

Purpose

The purpose of this study is to define 9th grade students' misconceptions about air pressure and show the effectiveness of using conceptual change texts together with concept maps to eliminate these misconceptions in comparison with traditional educating methods. To achieve the aim of the study, following issues are questioned:

Research Questions

- Is there a meaningful difference between traditional education methods and conceptual change approach to eliminate students' misconceptions about air pressure?

- What are the students' misconceptions about air pressure?

Method

Research Design

In this study, quasi-true experiments research is used. It is observed that in literature, generally experimental approach is used in similar type of studies (Niaz, Aguilera, Maza, & Liendo, 2002; Özmen & Demircioğlu, 2003; Reinfried, 2006; Sevim, 2007; Ünal, 2007). Semi-experimental approach has some different research designs. The most common one used one in education researches is non-equivalent control group design (Cohen & Manion, 1994, p. 169; Kaptan, 1993). Non-equivalent control group design was used in this study.

Sample

The sample of this study is formed by 9th grade students from two different classes in a high school in Trabzon city center. The study is implemented in second semester of 2006-2007. One of the classes is selected as experiment group (n=45), and the other is selected as control group (n=45). In general, students in different classes are similar in terms of age, gender, and grades.

Instruments and Data-Collection

Two separate tests were used for data collecting; a success test, to define students' knowledge level about concepts and discover their misconceptions and a concept test, to define the level of students' misconceptions before and after the study, were employed as pre- and posttests involving multiple choice questions. Reliability factor was calculated as 0.72 after performing subject analysis in Concept Test, which was corrected with Sperman-Brown to r = 0.84.

Analysis of Tests

In this study, Success Test results are separately analyzed and allocated into different categories as may be observed in the literature (Akbaş, 2002; Alim, 2008; Ekiz & Akbaş, 2005; Platten, 1995). SPSS, statistical software package, is used to make comparisons between and within groups in Concept test. The differences between groups are anaylzed with t-test. In Concept Test, the values calculated in comparison of pre and final test scores are evaluated in p=0,05 significance level.

Process

(i) Common misconceptions observed both in the literature and success test results were listed. Teaching materials and concept tests are prepared based on these misconceptions.

(ii) Air pressure was taught to experiment group using conceptual change texts and concept maps, and for control group, traditional methods were used for the same purpose. Before the lessons, concept test was performed to both groups as a pretest.

(iii) After completing the lessons, concept test is performed to both groups as a final test.

Results

Concept test is implemented to the control and experiment group as a pretest before the study. There is not a meaningful difference between control and experiment group in pre-test results ($p >$ 0,05). Test results show that students' knowledge about pressure is similar to each other. Concept test is implemented to the control and experiment group as a post test. The experiment group students' test score average is X exp = 7.15, control group students' test score average is $X_{control}$ = 2.97. Also there is a meaningful difference between the groups based on test results ($p <$ 0,05). It is observed that the difference is for the benefit of experiment group when the average scores are analyzed. Detailed findings can be obtained about students' misconceptions about the subject and how well these are eliminated after the study from students' answers in pre- and posttest.

At pretest, most common misconception about of formation of air pressure is: "Gases in atmosphere can form pressure if they suppress gravity" (experiment group 28,9%; control group 24,4%). Another common misconception is: "Gases in atmosphere can only form pressure if they are applied a force" (experiment group 17,8%; control group 24,4%). As of a result of posttest, *particularly misconception of Gases in atmosphere can only form pressure if they are applied a force* is mostly still present in even with increased achievement ratios of both group (experiment group, %20; Control group, %17,8). At posttest many of the misconceptions are eliminated or considerably decreased in both group.

The most common misconceptions about effects of atmospheric pressure are: pressure is a factor that forms temperature conditions (experiment group 22,2%; control group 17,8%) Atmosphere gases in upper layers squeezes gases in below layers (experiment group 22,2%; control group 13,3%) At posttest, experiment group students' misconceptions about "Pressure is a factor that forms temperature conditions" decreases from 22,2% to 4,4%. In control group, this increases from 17,8% to 26,7%. For the other misconceptions, there is not a significance change compared to the pretest in both groups.

At pretest, most common misconceptions about factors that affect atmospheric pressure are: *Altitude affects daily pressure changes (*experiment, 37,8%; control 33,3%). *Rain affects daily pressure changes* (experiment, 31,1%; control 4,4%). *Pressure increases when attitude increases* (experiment71,1%;control 73,3%). At post test, success ratio in experiment group students is observed to be higher than control group. In experiment group, apart from the misconception "*Altitude affects daily pressure changes",* misconceptions are considerably decreases compared to the pretest. In control group, misconceptions are limitedly eliminated. As an example, misconception "*Rain affects daily pressure changes*" is eliminated in experiment group, but in control group this misconception is still present with 24,4%. Similarly, at posttest, misconception "*Pressure increases when attitude increases*" is decreased from 71,1% to 17,8% in experiment group and 73,3% to 48,9% in control group.

Common misconceptions about reasons for formation of center of pressure are: *Center of pressure is thermic based if temperature is high, dynamic based if temperature is low* (experiment group: 31,1% control group: 4,4%). *Center of pressure is ther-*

mic based if pressure is low or ineffective, dynamic based if pressure is high. At post test, misconception "*Center of pressure is thermic based if temperature is high, dynamic based if temperature is low*" increased from 4,4% to 22,2% in control group . This misconception is the most common one in experiment group, but after the study, this is completely eliminated. However, some misconceptions are still present in experiment group with decreased ratios. As an example; misconception "*Center of pressure is thermic based if pressure is low or ineffective, dynamic based if pressure is high*" is still present with 6,7% in experiment group (decreased from 22,2%).

Common misconceptions about high and low pressure concepts are: *Low pressure is formed where temperature is high* (experiment group, 35,6%; control group, 15,6%). *High pressure occurs in areas where temperature is high* (experiment group, 22,2%; control group, 37,8%). *Air temperature decreases because air is getting higher in high pressure areas* (experiment group, 28,9%; control group, 28,9%). *Pressure rapidly increases where weather gets more cloudy* (experiment group, 42,2%; control group, 40%). As of a result of post test, many of the misconceptions are eliminated or considerably decreased in experiment group. Despite this, misconceptions are mostly still present in control group, even with increased ratios. As an example, misconception "Low pressure is formed where temperature is high" increased 15,6% to 35,6% in post test. The same misconception decreased from 35,6% to 11,1% in experiment group. This is also similar in misconception *"High pressure occurs in areas where temperature is high*" (control, 35,6%; experiment, 17,8%).

Discussion and Conclusion

Based on the tests implemented during the study, it is observed that students have many misconceptions about pressure and these are similar to misconceptions found in the literature (Alkış, 2006; Dove, 1999; Henriques, 2002).

The results of study show that education methods based on conceptual change texts and concept maps are more effective than traditional methods. These results are similar to the literature. Many studies reflect the fact that conceptual change texts and concept maps are effective to increase students' ability to understand and to eliminate misconceptions (Koray & Bal, 2004; Köse, 2004; Özkan, 2001; Özmen & Demircioğlu, 2003; Palmer, 2003; Reinfried, 2006; Yürük, 2000).

Although misconceptions were considerably decreased in experiment group, these are still present in some students. This negative result is also emphasized in the literature (Altun, Turgut, & Büyükkasap, 2007; Coştu, 2006; Hewson & Hewson, 1983; Palmer 2003). Main reason for misconceptions for keeping their presence is students' resistance to change, as mentioned in literature (Cin, 1999; Driver, 1989; Novak, 2002; Platten, 1995; Tyler, 1998).

Education can lead to formation of new misconceptions if distinctive properties of concepts are not emphasized and correct examples are not shared in classes. During the research, it is observed that some new misconceptions occurred after the study or some of the misconceptions increased at posttest. This is more common in control group. As an example, misconception "Low pressure occurs when temperature is high, high pressure occurs when pressure is low" is more common in experiment group in pretest, but it increased in control group in posttest from 15% to 35%.

It is observed that students' misconceptions can lead to other misconceptions. Students try to understand new concepts using their misconceptions. As mentioned in the literature, this shows that misconceptions are part of students' thought structure and these are constantly in an interaction with other concepts (Çalık, 2006; Özsevgeç, 2007). As an example, it is observed that misconceptions about gravity can lead to misconceptions about pressure.

Students' previous knowledge about the concepts and their misconceptions about these are needed to be defined before teaching basic concepts. Conceptual change text preparation and using these together with concept maps in other subjects of geography will considerably supplement education. Other methodologies like problem solving methods, shows, computer-based education and analog should also be used to eliminate misconceptions and the results should be compared with the use of conceptual change texts together with concept maps.

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