THE INFLUENCE OF ARGUMENTATION BASED INSTRUCTION ON SIXTH GRADE STUDENTS' ATTITUDES TOWARD SCIENCE, CONCEPTUAL UNDERSTANDINGS OF PHYSICAL AND CHEMICAL CHANGE TOPIC AND ARGUMENTATIVENESS

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Approval of the Graduate School of Social Sciences

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ABSTRACT

THE INFLUENCE OF ARGUMENTATION BASED INSTRUCTION ON SIXTH GRADE STUDENTS' ATTITUDES TOWARD SCIENCE, CONCEPTUAL UNDERSTANDINGS OF PHYSICAL AND CHEMICAL CHANGE TOPIC AND ARGUMENTATIVENESS

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The purpose of this study was to investigate the influence of argumentation based instruction on sixth grade students' attitudes toward science, development of conceptual understanding about physical and chemical change topic, and argumentativeness.

This study was carried out during 2010-2011 spring semester at a public elementary school in Ankara. A total of 65 sixth grade students from two intact classes were the participants of this study. The sample was chosen conveniently. Students in the experimental group instructed with argumentation based instruction and the students in the control group received traditional instruction.

The data of the study were collected by quantitave measurements. The Science Attitude Scale developed by Geban, Ertepınar, Yılmaz, Altın and Şahbaz (1994) was administered as pre-test and post-test to examine the impacts of instructional strategies on students' attitudes toward science. The Physical and Chemical Change Concept Test developed by the researcher was administered as pre-test and post-test to examine the effects of instructional strategies on students' conceptual understanding about the topic of physical and chemical change. The data about the influence of the instructional strategies on students' argumentativeness were collected through Argumentativeness Scale developed by Infante and Rancer (1982). The scale was implemented as pre-test and post-test.

The results of the study related with SAS scores were revealed that students in experimental group developed more positive attitudes toward science than students in the control group. The analysis of the PCCCT scores of the students in both groups indicated that students in the experimental group developed their conceptual understanding better than students in the control group. Finally, students in the experimental group were significantly better than students in the control group in argumentativeness scores.

Keywords: Argumentation, Argumentation based Instruction, Attitudes toward Science, Conceptual Understanding, Argumentativeness.

ÖZ

TARTIŞMA ODAKLI ÖĞRETİM YÖNTEMİNİN ALTINCI SINIF ÖĞRENCİLERİNİN FENE KARŞI TUTUMLARINA, FİZİKSEL VE KİMYASAL DEĞİŞİM KONUSUNDAKİ KAVRAMSAL ANLAYIŞLARINA VE TARTIŞMAYA EĞİLİMLERİNE ETKİSİ

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Bu çalışmanın amacı, tartışma odaklı öğretim yönteminin ilköğretim altıncı sınıf öğrencilerinin fene karşı tutumlarına, fiziksel ve kimyasal değişim konusundaki kavramsal anlayışlarına ve tartışmaya eğilimlerine etkisini incelemektir.

Bu çalışma 2010- 2011 eğitim- öğretim yılı ilkbahar döneminde Ankara iline bağlı bir devlet ilköğretim okulunda uygulanmıştır. İki sınıftan toplam 65 öğrenci bu çalışmanın katılımcısı olmuştur. Örneklem kolay ulaşılabilir örneklem yöntemiyle seçilmiştir. Deneysel grupta bulunan öğrencilere tartışma odaklı öğretim yöntemi uygulanmıştır. Kontrol grupta bulunan öğrencilere ise geleneksel öğretim yöntemi uygulanmıştır.

Çalışmanın verileri nicel ölçümler kullanılarak toplanmıştır. Geban ve diğ.(1994) tarafından geliştirilen Fene Karşı Tutum Ölçeği, öğretim yöntemlerinin öğrencilerin fene karşı tutumları üzerinde etkisini belirlemek amacıyla, ön-test ve son-test olarak uygulanmıştır. Araştırmacı tarafından geliştirilen, Fiziksel ve Kimyasal Değişim Kavram Testi, öğretim yöntemlerinin öğrencilerin Fiziksel ve Kimyasal Değişim konusundaki kavramsal anlayışlarına etkisini belirlemek amacıyla, ön-test ve son-test olarak uygulanmıştır. Öğretim yöntemlerinin öğrencilerin tartışmaya eğilimlerine etkisi hakkındaki veri, Infante ve Rancer (1982) tarafından geliştirilen Tartışmacı Anketi kullanılarak toplanmıştır. Ölçek ön-test ve son-test olarak uygulanmıştır.

Çalışmanın, Fene Karşı Tutum Ölçeğini ile ilgili sonuçları, deneysel gruptaki öğrencilerin, kontrol gruptaki öğrencilere göre fene karşı daha olumlu tutum geliştirdiklerini göstermiştir. Her iki grubun Fiziksel ve Kimyasal Değişim Kavram Testi skorlarının analizi, deneysel gruptaki öğrencilerin kontrol gruptaki öğrencilere göre daha iyi kavramsal anlayış geliştirdiklerini göstermiştir. Son olarak, deneysel gruptaki öğrencilerin tartışmaya eğilimleri kontrol gruptaki öğrencilere göre önemli bir şekilde daha iyi çıkmıştır.

Anahtar Kelimeler: Tartışma, Tartışma Odaklı Öğretim Yöntemi, Fene Karşı Tutum, Kavramsal Anlayış, Tartışmaya Eğilim.

Dedicated to

My Parents, My Husband, and My Patient

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LIST OF SYMBOLS

SAS: Science Attitude Scale

PCCCT: Physical and Chemical Change Concept Test

ANOVA: Analysis of Variance

TAP: Toulmin's Argumentation Pattern

NAEP: National Assessment of Educational Progress

CHAPTER 1

INTRODUCTION

In developing world, students when constructing knowledge do not have passive roles (as traditional one) in the science classrooms. They actively participate in debates about scientific topics to be scientifically literate person. This active role is demanded by various methods (e.g. argumentation) that are involved in science learning to construct scientific knowledge about the natural world (Kitcher, 1988). Scientists argue to build explanations, models and theories by relating the claims they find observe or conclude through use of warrants and backings to the evidence (Toulmin, 1958). Students doing science use these patterns of Toulmin (1958) to form scientific knowledge. Therefore, science classrooms in recent years contain many activities for students engaging in debates organized according to Toulmin's Argumentation Pattern (TAP) as done in the present study. The study focused on the conceptual development, argumentativeness trait and attitudes toward science of students in this learning environment.

Because argumentation has an important role in science education, it has a great place in the literature from the 90s (Jimenez- Alexiandre &Erduran, 2007; Driver, Newton & Osborne, 2000; Lemke, 1990; Newton, Driver & Osborne, 1999). The researches in this area mainly focused on the process of argumentation. Teachers' and students' arguments were investigated qualitatively and quantitatively by using mostly Toulmin-like schema. Furthermore, some investigations also focused on students' understanding of science by using pre-post-test design in order to examine the increase in students' knowledge (Jiménez-Aleixandre, Rodriguez & Duschl, 2000; Mason, 1996; Zohar & Nemet, 2002). Also, investigating appropriate strategies for promoting discussion and argument to develop students' conceptual understanding are placed in the literature on constructivist teaching (Driver et al., 2000). There are some researches on the relationship between the quality of argument and conceptual understanding (Sadler, 2004; Sadler & Fowler, 2006; Lewis &Leach, 2006). However, less research were conducted on the impact of argumentation on conceptual understanding in the literature (Dawson & Venville, 2010). Dawson and Venville (2010) emphasized that improvements of conceptual understanding occurred after a short intervention of three hours containing argumentation skills. Von Aufschnaiter, Erduran, Osborne, and Simon (2008) found reasonable this positive relationship, that is, students engaging in argumentation improve their conceptual understandings. Cross, Taasoobshirazi, Hendricks, and Hickey (2008) analyzed students' discourse from a group of three students and showed that involvement in argumentation has a great impact on learning and development of conceptual understanding. Sadler and Zeidler (2004) investigated the importance of genetics content knowledge for the informal reasoning of undergraduate students on six cloning scenarios. They concluded that there is likely to be greater impact from involvement in argumentation on learning gains for students with more knowledge than those with less knowledge. Zohar and Nemet (2002) examined the teaching of argumentation skills in the context of dilemmas in human genetics. The authors concluded that integrating explicit teaching of argumentation into the teaching of human genetics enhanced performance in both biological knowledge and argumentation. Based on the same idea one of the aim of the present study was to examine determination of the impact of argumentation based instruction on development of students' conceptual understandings about physical and chemical change topic.

Another construct investigated in the present study is the influence of argumentation on students' attitudes toward science. The factors influence the students' attitudes toward science were stated by Osborne (2003) as gender, environmental factors (e.g. teachers), cultural, curricula and other variables. From these factors, argumentation, as being an instructional strategy has an impact on students' attitudes toward science. Erduran (2007) indicated that there is a significant deficit in the literature about the role of argument on teachers' and students' attitudes and beliefs about science and in science education. There are few studies focusing on argumentation and attitude toward science in the literature (Sağır, 2008; Siegel & Ranney, 2002). The results of the studies showed that there is no differentiation on attitudes of students to science between traditional and argumentation based instructions. There is an improvement in attitudes toward science after the implementation processes of argumentation. Due to limited studies on argumentation and attitudes toward science in the literature, and the current study aimed to examine the impact of argumentation based instruction on students' attitude toward science.

Another aspect searched in the present study is argumentativeness. Argumentativeness is defined by Infante and Rancer (1982) as a trait that it is difference between tendency to approach argument and tendency to avoid argument. Infante and Rancer (1982) developed a scale named as Argumentativeness Scale to measure students' argumentativeness. This scale was used in the present study to show the effect of argumentation based instruction on students' argumentativeness. Infante and Rancer (1982) mentioned three main levels of argumentativeness: high, low and moderate argumentative. Semic and Canary (1997) exhibited in their study that pairing of individuals with various argumentative levels had an influence on amount of arguments. Similarly, Levine and Boster (1996) pairing students according to high and low argumentative levels improved the arguments constructed. Kazoleas and Kay (1994) found that group meetings in discursive environment provided students to produce more counter arguments to other members. In the present study, six grade students' argumentativeness measured after implementation of argumentation based instruction on the topic of physical and chemical change.

1.1. Definition of Important Terms

1.1.1. Argumentation

The definition of argumentation stated by Venville and Dawson (2010) is that students make claims about scientific and socio- scientific issues, provide their claims with evidence, and exhibit alternative explanations of science when they are participated in argumentation in the process of learning science. Students who participated in the activities in the present study made their own claims about scientific issues on physical and chemical change topic, supported their claims with the evidences they constructed in groups, made alternative explanations like rebuttals and backings.

1.1.2. Argumentation based Instruction

Argumentation based instruction in the present study can be defined as a classroom environment interpreted with dialogical arguments, that is different ideas are being inspected, and the aim of it to reach meaningful claims or courses of action. There are four main objectives in argumentation based instruction in science classrooms. These are:

- Developing students' conceptual understandings
- Developing students' skills of inquiry
- Developing scientific epistemology
- Describing science as a social process (Driver et al., 2000)

1.1.3. Argumentativeness

Infante and Rancer (1982) defined argumentativeness as "a generally stable trait which predisposes the individual in communication situations to advocate positions on controversial issues, and to attack verbally the positions which other people take on these issues" (p. 72).

1.1.4. Conceptual Understanding

Conceptual understanding in its most basic form as defined by the NAEP (2005) means understanding the principles of science used to explain and predict observations of the natural world and knowing how to apply this understanding efficiently in the design and execution of scientific investigations and in practical reasoning.

1.1.5. Attitude toward Science

The term ‘attitudes towards science’ in the present study means that keeping feelings, beliefs and values to evaluate conditions, events, people and subjects related with scientific learning (Wallace, 1997).

1.2. Significance of the Study

The present study explored the effect of argumentation based instruction on sixth grade students’ attitudes toward science, argumentativeness and development of conceptual understanding about physical and chemical change topic. When students do science, they have to argue to construct scientific knowledge (Jimenez-Aleixandre & Erduran, 2007). Moreover, instructors use different educational methods implying argumentative strategies for the peers who are needed to be scientifically literate persons. Therefore, recent studies in science education mainly focused on argumentation in science classes (Driver et al., 2000; Jimenez-Aleixandre et al., 2000; Kelly & Takao, 2002; Zohar & Nemet, 2002). This study is significant to extend the previous studies' findings with respect to argumentative strategies in science classes in the literature.

Argumentation being a critically important discourse process in science, it should be promoted in the science classroom (Duschl & Osborne, 2002; Jimenez-Aleixandre et al., 2000; Kelly, Druker & Chen, 1998; Zohar & Nemet, 2002). This requirement of the promotion of argumentation in the science classroom produces significant questions of what the rationale can be used for introducing argumentation in science learning. Therefore, comparison of argumentation based instruction with traditional learning with different dimensions is an important concern for the research area in science education as done with this study. Moreover, science education should promote argumentation as one of the dimensions of learning science (Driver et al., 2000; Duschl & Osborne, 2002; Kuhn, 1993). Students learn science and improve their scientific concepts while learning how to develop valid argument (Von Aufschnaiter et al., 2008). Therefore, the comparison of the conceptual understandings of students in argumentation based instruction with traditional instruction is another concern of the present study.

Argumentation has been integrated in curriculum in many countries (Jimenez-Aleixandre & Erduran, 2007) because of its positive effects of developing scientific literacy. On the other hand, students as being citizens have to possess positive attitudes toward science. Previous studies have shown that there is an important declaration of students' positive attitudes toward science (O' Leary, 2001; Roberts, 2002). Besides other variables (e.g. gender, teacher) effecting students attitudes toward science, instructional strategies have an influence on students attitudes toward science. Osborne (2003) emphasized that there is a greater need for searching the aspect influencing students' attitudes toward science besides gender and quality of teaching. Therefore, investigating the influence of argumentation on sixth grade students' attitudes toward science helps to meet this requirement.

The effect of argumentation based instruction on sixth grade students' argumentativeness was another concern of the present study. Argumentativeness is defined as tendency to argue. It is definitely named and defined with its characteristics as argumentativeness trait by Infante and Rancer (1982). The Argumentativeness Scale developed by these researchers was used in the present study to measure students' approach or avoidance to argument. Findings of the present study not only gave idea about students' willingness to argue when instructed with argumentation based strategy and traditional strategy but also showed the change on students' argumentativeness trait after instructed with these strategies. Moreover, the researchers of argumentativeness trait will find information about the influence of argumentation based instruction on sixth grade students' argumentativeness. Also, they have chance to compare traditional instruction and argumentation based instruction with respect to students' argumentativeness. Furthermore, the findings will be useful for science teachers who want to use argumentation based instruction in their classrooms.

Recent studies on argumentation which explore students' development of conceptual understandings, argumentativeness mainly studied with eight graders or greater levels (e.g. pre-service teachers) (Jimenez Alexander et al.,2000; Venville & Dawson, 2010, İşbilir, 2010; Sadler & Fowler, 2006) However, there are fewer studies about argumentation on elementary graders'(particularly sixth graders) conceptual understandings, argumentativeness and attitudes toward science. In this aspect, this study provides valuable information to researchers who want to study on argumentation with elementary level students.

1.3. Purpose of the Study

The aim of the present study was to investigate the influence of argumentation based instruction on sixth grade students' development of conceptual understanding about physical and chemical change topic, attitudes toward science, and argumentativeness.

1.4. Research Questions

RQ1. Is there a significant mean difference between the groups exposed to argumentation based instruction, and traditional instruction with respect to Science Attitude Scale (SAS) scores?

RQ2a. Is there a significant mean difference between pre-SAS and post-SAS scores of the group instructed traditionally?

RQ2b. Is there a significant mean difference between pre-SAS and post-SAS scores of the group instructed with argumentation based instruction?

RQ3. Is there a significant mean difference between the groups exposed to argumentation based instruction and traditional instruction with respect to physical and chemical change concept test (PCCCT) scores?

RQ4a. Is there a significant mean difference between pre-PCCCT and post-PCCCT scores of the group instructed traditionally?

RQ4b. Is there a significant mean difference between pre-PCCCT and post-PCCCT scores of the group instructed with argumentation based instruction?

RQ5. Is there a significant mean difference between the groups exposed to argumentation based instruction, and traditional instruction with respect to argumentativeness scores?

RQ6a. Is there a significant mean difference between pre-argumentativeness scores and post- argumentativeness scores of the group instructed traditionally?

RQ6b. Is there a significant mean difference between pre-argumentativeness scores and post-argumentativeness scores of the group instructed with argumentation based instruction?

1.5. Research Hypotheses

RH1. There is no statistically significant mean difference between the groups exposed to argumentation based instruction, and traditional instruction with respect to SAS scores.

RH2a. There is no statistically significant mean difference between pre-SAS and post-SAS scores of the group instructed traditionally.

RH2b. There is no statistically significant mean difference between pre-SAS and post-SAS scores of the group instructed with argumentation based instruction.

RH3. There is no statistically significant mean difference between the groups exposed to argumentation based instruction, and traditional instruction with respect to PCCCT scores.

RH4a. There is no statistically significant mean difference between pre-PCCCT and post-PCCCT scores of the group instructed traditionally.

RH4b. There is no statistically significant mean difference between pre-PCCCT and post-PCCCT scores of the group instructed with argumentation based instruction.

RH5. There is no statistically significant mean difference between the groups exposed to argumentation based instruction and traditional instruction with respect to argumentativeness scores.

RH6a. There is no statistically significant mean difference between pre-argumentativeness scores and post-argumentativeness scores of the group instructed traditionally.

RH6b. There is no statistically significant mean difference between pre-argumentativeness scores and post-argumentativeness scores of the group instructed with argumentation based instruction.

CHAPTER 2

LITERATURE REVIEW

The review of the literature related with argumentation and science education, Toulmin's Argumentation Theory, and research on argumentation in Turkey is included in this chapter.

2.1. Argumentation and Science Education

Argument is an activity based on old times (Billig, 1989). It has many different meanings. It may be expressed as "reaching to conclusion by judging" (Kaya, 2009, p.29). The function of argument in social life is inevitable. People can argue on everything to solve their daily problems. However, children rather than adults are lack in argumentation skills such as organizing an argument, establishing relationship between evidence and theory in their social life (Kuhn, 1991). Argument in science education is discussing ideas besides negotiating. In this perspective, scientific argumentation gets its importance to emerge the rationality of science and the justifications of scientific views.

When argument becomes a systematic form, that is, a scientist try to resolve a scientific problem, the position of argumentation in science can be mentioned.

Argument has its position in science to help scientist to form an explanation to a situation, to construct a theory or pattern. Scientific argumentation is defined as proposing ideas about scientific topic, supporting it, evaluating, examining and the procedure of purification (Driver et al., 2000). It requires to students to exercising their thoughts, and gives chance to judge on the events, conditions, and situations (Erduran et al., 2004). Moreover, science education improves with conflicting, supporting the claims or rebuttals rather than coming to an agreement (Kuhn, 1962). This provides to students learning scientific argumentation (Clark & Sampson, 2007).

Argumentation mainly mentioned in three main types in education: rhetorical (Kuhn, 1992) or didactic (Boulter & Gilbert, 1995), analytical, and the dialogical. Rhetorical argument is described as telling and persuading people about the case (Driver et al., 2000). Rhetorical argumentation is used in traditional classes in general. However, analytical argument is based on the theory of logic, reaching a set of conclusion from premises inductively or deductively (Jimenez Alexander et al., 2000). On the other hand, dialogical argument requires a group of people arguing on a case mutually.

Rhetorical argument can be explained with teacher-student discussion, that is, a teacher trying to convince students to a reasonable topic is making a rhetorical argumentation. This type of argument especially stresses knowledge and persuasion. That is, teacher has to persuade students by presenting reasons with scientific knowledge. At this position, two parts of this type of argument is mentioned: rational and traditional arguments- Rational argument is that teacher provides reasons and evidences to scientific knowledge. Traditional argument is that teacher presents scientific knowledge from direct source (Newton et al., 1999).

Rhetorical argument has some limitations in point of that it causes students' perception of the scientific knowledge with their beliefs and limiting students' comprehension of the nature of scientific authority. Therefore, the need of student interaction in argumentation emerges. However, not only rhetorical argument but also analytical argument doesn't provide this requirement. Analytical argument is also teacher centered because teacher prepares activities for children and evaluates after they do the activity (Lemke, 1990). The book and the teacher are the real authority of arguments. Students don't ask questions to find evidence, criticize, judge, interrogate the scientific knowledge. Teacher generally asks the question, and then, students give answer to that questions. Teacher evaluates their answer to control whether student get scientific knowledge or not (Boulter & Gilbert, 1995). That is, students do not have enough opportunity to take part in argumentations that provide to gather scientific knowledge by cross-examining.

Dialogical argument, on the other hand, having more important position in education, can be explained with student-student discussion. Teacher is not a leader, but he or she guides their students to improve the argument. Dialogical arguments apart from other arguments provide students interaction with other friends, and deciding, critiquing, and concluding altogether. This interactive argumentative environment provides students to comprehend extensively and get the scientific knowledge meaningfully (Boulter & Gilbert, 1995). Additionally, students gain high metacognitive levels and realize themselves epistemological knowledge (Kaya, 2009). In the present study, the teacher provided students to join dialogical argumentations.

Students have to be a scientifically literate person to adapt the developing world. Being a scientifically literate person requires taking some insight into the epistemology, practices and methods of science, and being aware of nature of science by learning it. At this point, argumentation takes its position in science education. Students argue about a scientific topic to get these requirements. Regarding the position of argumentation in science education, Driver et al. (2000, p.297) stated as:

> ... we would wish to argue that the claim “to know” science is a statement that one knows not only *what* a phenomenon is, but also *how* it relates to other events, *why* it is important, and *how* this particular view of the world came to be…

Kuhn (1986) defined science education as an argumentation centered social activity. Science education has some discursive components from students’ social life to solve their problem in their life. Students construct scientific knowledge with discussing about it. Actually, to gain scientific knowledge, students have to argue with their friends and teachers. Students have to make reasoning to bear the scientific knowledge in their minds, to comprehend it, and to use it in their experiments or problem solving activities (Duschl &Osborne, 2002). Then, argumentation had its important position in science education (Driver et al., 2000; Duschl, Ellenbogen & Erduran, 1999; Jimenez-Aleixandre et al., 2000; Kelly & Takao, 2002).

Osborne et al. (2004) suggested argumentative techniques used in science education. These are:

1. **Competing theories (cartoons)**: Students argue on two or more theories given in the cartoons. They choose one of these theories and decide on its rightness. They explain their decision (Keogh & Taylor, 1999).

2. **Competing theories (tale):** Two or more theories are made into a story or their real stories. Students select the story they believe and try to prove it by data.

3. **Competing theories (ideas and evidences):** Two or more physical phenomenon but preferably two explanations are given to students. They choose one of them and are provided to discuss on it.

4. **Concept Maps**: A concept map about the topic is given to students. Students argue on the topic by means of the given concept map. They discuss about the reason of the connection between concepts. This technique resembles the usage of concept map in science lessons (Osborne, 1997).

5. **Construction of an argument**: Some data are given about an expression that explains an event to the students. Students choose one of these data that explains the event, and they have to discuss on it (Garrat, Overtone, & Threlfall, 1999).

6. Table of Statements: Some expressions about a science topic are given in a table. Students discuss the expression that s/he selected from the given expressions (Gilbert & Watts, 1983, Osborne et al., 2004).

7. Report of an experiment: A report which has already written about an experiment previously done is given to the students. They argue on the results of that experiment. It also may be a deficient or mistaken report (Goldsworthy, Watson & Wood-Robinson, 2000).

8. Prediction, Observation and Explanation: An event is assigned to predict what the conclusion of this event is. Students decide on the result and write it. Then, the real conclusion is given to them. They compare their predictions and the result. They explain what the difference is between their predictions and the real one.

9. Design of an experiment: A hypothesis is asked students to plan an experiment. Students prepare a plan by groups and argue on it. (Osborne et al., 2004)

2.1.1 Argumentation and Conceptual Understanding

Developing students' concepts about scientific topics is one of the main goals of science education. To do this, argumentation in science classrooms is an effective way. Constructivist approach is pointed out the importance of argumentation based classroom environment to construct scientific literacy. Therefore, the curriculum in many countries put into concern the argumentation in science classrooms.

The effect of argumentation on conceptual understanding of students was studied by many researchers (Cross et al., 2008; Hogan, 2002; Zohar & Nemet, 2002). Some studies concentrated on conceptual understanding of students how argumentative strategies help to improve students' conceptual understandings. (Barnes & Todd, 1977; Nussbaum & Sinatra, 2003; Sağır, 2008;). For example; Niaz, Aquilera, Maza and Liendo (2002), in their studies, gave chance to 160 freshmen students who enrolled in general chemistry courses to discuss about new topics, asked and got answer to discursive questions, reflected their counter ideas. They gave some data about the experiments of Thomson, Rutherford and Bohr, and provided them to examine their answers to the questions. By means of this way, they investigated the development of conceptual understanding of students. They concluded that students do not pay attention to the scientific data and showed progressive development of conceptual understanding with the consistent improvement. In another study by Cross, Taasoobshirazi, Hendricks, and Hickey (2008), the impact of argumentation on twenty 10^{th} grade students' conceptual understanding. They used 17 multiple choice test to find students' conceptual development and they concluded that involvement in argumentation has greater impact on the development of more secure conceptual understanding. Similarly, Yesiloğlu (2007) in her study investigated the effectiveness of argumentation on 10th grade students' understanding of concepts about gases, their achievement in solving algorithmic problems about concepts and principles and their attitudes towards chemistry. The sample of the study was a total of 54 students from two 10th grade classes at public high school. A quasi-experimental pretest-posttest control group design was used in this study. To reach the data about their conceptual understanding on gases, achievement tests were used. The results of the study showed that the achievement and conceptual understanding scores of the students which were instructed with argumentation are higher than of the students which are instructed with traditional instruction. Consequently, he results of these studies that investigate the effect of argumentative strategies on the development of conceptual understanding indicated that under the effect of argumentation instruction, the conceptual understandings of students improve.

Some of the studies in literature focused on the relationship between argumentation and conceptual understanding (Sadler & Zeidler, 2005; Means & Voss, 1996, Acar, 2008). In one of the studies, McNeil, Lizotte and Krajcik (2006) found high correlation between conceptual understanding and argumentation. They studied with seventh grade students to examine their scientific reasoning in their explanations and used a multiple choice test about substance and chemical change topics to identify conceptual understanding. They analyzed the arguments of students according to Toulmin’s Argumentation Pattern.

In a similar way, the present study explored the conceptual understanding of 6th grade elementary level students by using argumentative strategies designed according to TAP.

2.1.2. Argumentation and Attitudes toward Science

Attitude with its resistant characteristic to change has very important position in learning process. Actually, it is defined as positive or negative tendency to response person's oneself or any other thing such as a topic, subject, event, etc. This reaction is based on person's experience, motivation, and knowledge about this event, subject or topic (Sağır, 2008). Attitudes affect achievement, or vice versa. This important position of attitudes in learning requires evaluating students' attitudes.

Wallace (1997) defined attitudes toward science as situations, events and feelings for evaluating objects related with learning science. There are many researches examining the relationship between attitudes toward science and another variable such as achievement, gender, classroom environment, etc. (e.g. Freedman, 1997; Francis & Greer, 1999; Osborne, 2003). For example, Berberoğlu (1990) concluded that academic achievement is positively related with attitudes toward science. On the other hand, there are some studies about factors that affect the attitudes of students toward science lessons. As an example, the materials used in learning process and students' active participation to lesson enhances students' attitudes toward science (Mitchell, 1997).

Another important factor that affects students' attitudes is science teacher. The negative attitude of teacher, limited knowledge about the topic, using didactic method except from constructivist approaches reflect to student in the class (Palmer, 2004, Jarvis & Pell, 2002). Teachers, who support students' interests to science and their needs about learning scientific knowledge, apply new strategies in science education enhances their attitudes toward science (Sağır, 2009).

It was mentioned in the literature that educational method changes students' attitudes toward science. Most of the studies supported that the strategies such as constructivist based laboratory activities, problem solving approach, inquiry based learning have positive effect on students' attitudes toward science (Geban, Aşkar & Özkan, 1992; Sabap, 2005; Tattar, 2006, Siegel & Ranney,2002). On the contrary, some studies found no effect of educational strategies to attitudes toward science. (Tümay, 2001; Süzen, 2004; Ünal & Ergin, 2006). Furthermore, the effect of argumentation based classroom environment as an educational strategy on students' attitude toward science is another concern of studies in the literature in recent years (Sağır, 2008; Altun, 2010). For example, Altun (2010) investigated the effectiveness of argumentation on 7^{th} grade students' (N=63) attitudes toward science applying argumentative strategies in "the light unit". There were an experimental and a control group in the study. An attitude toward Science Scale was used to measure students' attitudes before and after the implementation. She found no significant difference in students' attitudes toward science between two groups. As another example, Siegel and Ranney (2002) implemented computer-based activities designed to enhance students' arguments and they investigated the effect of the treatment on the science attitudes of students. The results of their studies showed that the computer-based argumentative activities enhance students' attitudes about the relevance of science. Eventually, these studies about the effect of argumentation on students' attitude toward science indicated that there is positive effect of argumentation on students' attitude toward science.

The present study explored the effect of argumentation based instruction on 6th grade elementary level students' attitudes toward science.

2.1.3 Argumentation and Argumentativeness

Argumentativeness is defined as "a generally stable trait which predisposes a person to advocate positions on controversial issues and to attack verbally the positions" (Infante & Rancer, 1982, p.72). The difference between tendency to approach argument (ARGap) and tendency to avoid argument (ARGav) is described as argumentativeness trait. Argumentativeness trait (ARGgt) is calculated by extracting ARGav from ARGap because of the debilitation function of ARGav related with dislike and the anxiety function of ARGap associated with arguing. Infante (1981) mentioned that argumentativeness trait predicts the perceptions, expectations and the motivation to argue for an individual and a variety of educational variables. By this way, the argumentativeness trait has three main levels of an argumentative individual defined by Infante and Rancer (1982):

1. High Argumentative: This is high on ARGap score and low on ARGav score. They show "more flexible, interested, verbose, dynamic, expert, willing and displaying more argumentation skills" (Terlip, 1989, p.56). They have little anxiety for argumentation and like conflicting issues.

2. Low Argumentative: This is high on ARGav score and low on ARGap score. They dislike talking about controversial issues because they feel uncomfortable.

3. Moderate Argumentative: These are individuals that have moderate feelings to approach to argue on a topic and moderate motivation to avoid arguing on a topic. They argue when they feel safe on a topic. Their motivation for arguing is success, but they don't actually enjoy this situation.

Argumentativeness trait based on these levels developed by Infant and Rancer (1982). Most of the studies focused on the relationship between a trait (aggressiveness, leadership, etc.) and argumentativeness (Levine & Boster, 1996; Kazoleas & Kay, 1994) Levine and Boster (1996) found a positive relationship between levels of argument and argument construction of peers in their studies. Another study by Myers (1998) focused on instructor socio-communicative style, argumentativeness and verbal aggressiveness in college classrooms. As another example, studying with pre-service science teachers, İşbilir (2010) focused on their quality of written argumentations about socio-scientific issues in an online discussion environment in relation to their epistemic beliefs and argumentativeness. Argumentativeness Scale is applied to the 30 pre-service science teachers. He found no correlation between argumentativeness and argumentation quality levels. However, there was a correlation between argumentativeness and epistemic beliefs of participants. On the other hand, there are some researches about the effect of teaching methods on the participants' argumentativeness (Tekeli, 2009, Sağır ,2008, Kaya & Kılıç, 2008). For example in Tekeli's (2009) study argumentation centered classroom environment was implemented to 64 elementary level students for the acids and bases topic. The argumentativeness scale was used to determine the change in argumentativeness level before and after implementation. Author concluded that argumentation centered classroom environment affects students' argumentativeness positively. In another study, Sağır (2008) studied with 7^{th} and 8^{th} grade level students, whom argumentativeness were measured by argumentativeness scale. Result of this study indicated that students' argumentativeness is improved by an argumentation centered classroom environment. Similarly, Kaya and Kılıç (2008) investigated the effects of science courses founded on argumentative discourse activities on elementary school students' tendencies to approach argumentative situations. 7^{th} and 8^{th} grade students were participated in a semester-long argumentative discourse integrated science courses students. The Argumentativeness Scale (AS) developed by Infante and Rancer (1982) was administered to all the students as pretest and posttest, and 37 randomly selected students were individually interviewed at the end of the study. They concluded that both 7th and 8th Grade students' argumentativeness significantly increased from prior to the end of this study. Consequently, the results of the studies investigating the effect of argumentation on students' argumentativeness showed that there is a significant impact of argumentative strategies on students' argumentativeness.

The present study investigated the effect of argumentation based instruction on sixth grade students' argumentativeness by using the argumentativeness scale developed by Infant and Rancer (1982).

2.2. Toulmin's Argumentation Theory

Toulmin is the constructer of a theory about argumentation, which is mentioned in the literature by many researchers (Druker, Chen & Kelly, 1996, Jime´nez-Aleixandre et al., 1997; Zohar & Nemet, 2002; Osborne et al., 2004; Erduran et al., 2004), He defined argumentation as a pattern which has related components (Toulmin, 1958). In his book, *the Uses of Argument*, he defined these components as *Data, Claim, Warrant and Backings*, and for more complex arguments as *Qualifiers and Rebuttals.*

- Data: These are the facts, or evidences, or observations that support the claim.
- Claim: The conclusion drawn from the merits to be established.
- Warrants: These are the causes such as principles that justify the link between data and claim.
- Backings: This defined as generalizations that support particular warrants.
- Qualifiers: The limitations on the claim when the claim accepted as true.
- Rebuttals: These are the conditions when the claim doesn't accept as true. They may be in contradiction with any other basic component of the argument

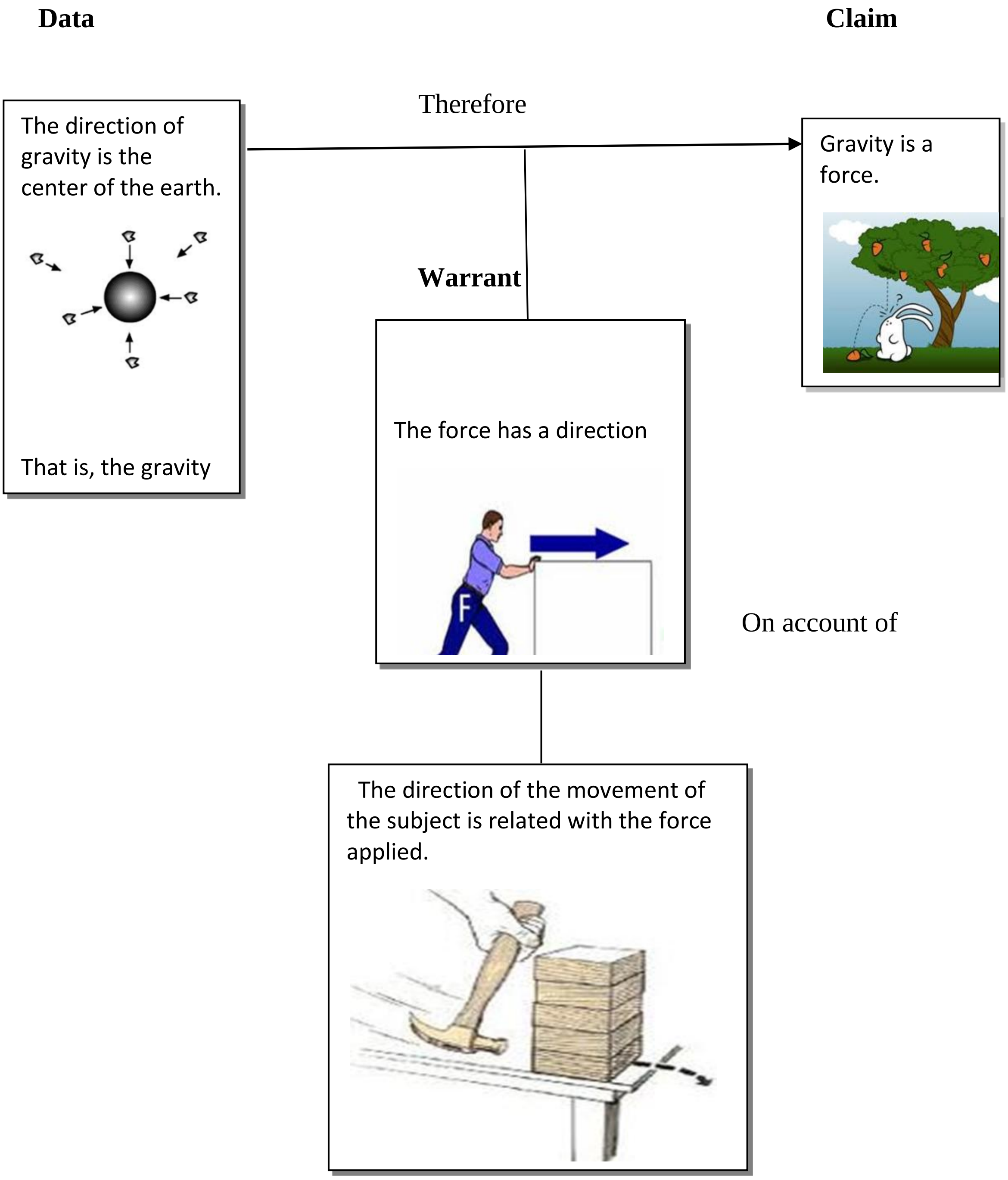

Figure2.1. An example of Toulmin's Argumentation Pattern. Adapted from Resources for Introducing Argumentation and the Use of Evidence in Science lassrooms, p.6, by Jimenez Alexander et al., 2009, Danu', University of Santiago

The usage of the components of TAP in science education can be explained using "gravity and force" topic. The example prepared by the researcher adapted from an activity given in the book "Resources for Introducing Argumentation and Evidence in Science Classrooms" by Jimenez Alexander, Ramon, Otero, Santa Maria and Mauriz (2009) is shown in Figure2.1.

According to Driver et al. (2000) the argument given in the example above can be concluded as because "direction of gravity is the center of the earth"….since "the force has a direction"…. on account of "direction of the movement of the subject is related with the force applied"… therefore "Gravity is a force".

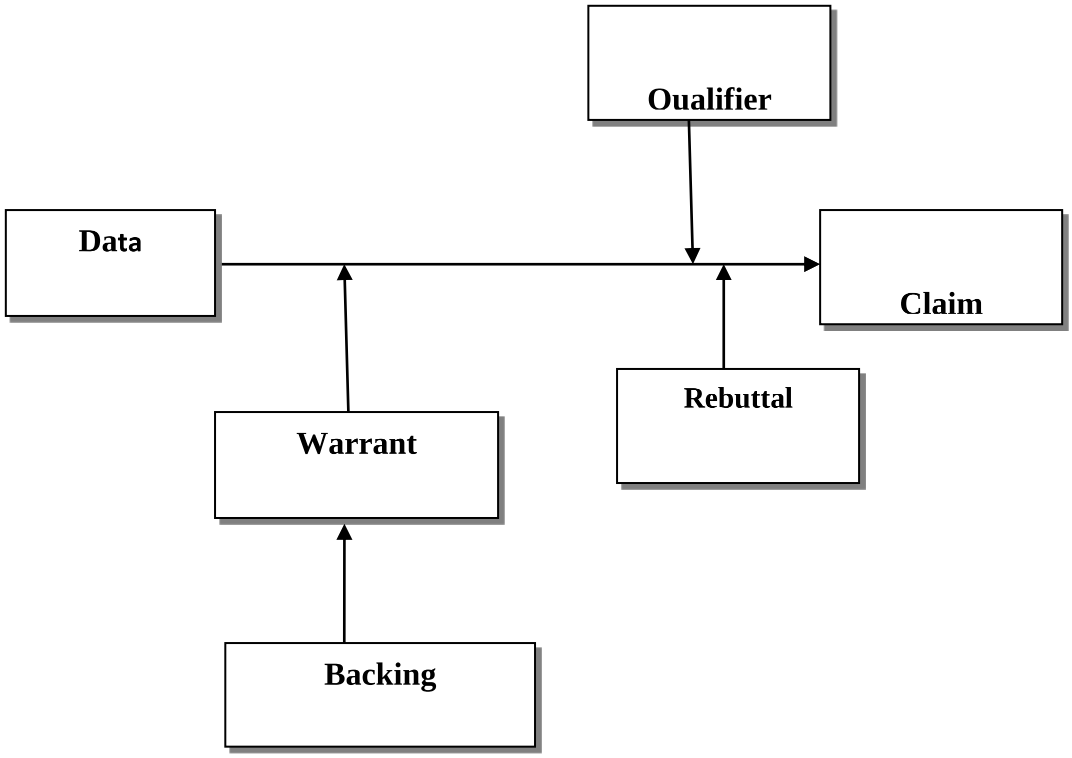

Figure 2.2 Toulmin's Argument Pattern. Adapted from Argumentation in Science Education: Perspectives from classroom-based research p. 57, by Erduran, 2008, Dordrecht, London: Springer.

Table 2.1. Toulmin's Analytical framework used for assessing the quality of argumentation

Level of argumentation	Description
Level 1	Argumentation consists of arguments that are a simple claim versus a counter-claim or a claim versus claim.
Level 2	Argumentation has arguments consisting of claims with data, warrants, or backings, but do not contain any rebuttals.
Level 3	Argumentation has arguments with a series of claims or counter-claims with data, warrants, or backings with the occasional weak rebuttal.
Level 4	Argumentation shows arguments with a claim with a clearly identifiable rebuttal. Such an argument may have several claims and counter-claims as well, but this is not necessary.
Level 5	Argumentation displays an extended argument with more than one rebuttal.

Source: Erduran et al. (2004). TAPping into argumentation: Developments in the application of Toulmin's argument pattern for studying science discourse. *Science Education, 88,* 915-933

The functional relationship of these components is shown in the figure 2.2. Driver et al. (2000) formulate an argument according to TAP as "because (data)….since (warrant)…. on account of (backing)… therefore (claim)".

Osborne et al. (2004) analyzed arguments with its components. They designated levels from weak to qualitative arguments. According to them, a weak argument only contains claim, data, and warrant, and a strong argument contains claim, data, warrant, rebuttal, and qualifier. Presenting rebuttals that individual confirms his or her idea with the evidences shows construction of a good quality argument by the individual (Kuhn, 1991). The five levels predicted by Osborne et al. (2004) are presented in the Table 2.1.

Together with its superiority, Toulmin's analysis has some limitations. These limitations are (Driver et al., 2000):

1. The structure of the arguments is given in this pattern, but the correctness of these components is not discussed.

2. The interactional parts of argument are not mentioned in the structure of argumentation.

3. There is a discursive event influenced by linguistic and situational contexts in which the specific argument is embedded

After emerging classroom discourse in teaching and learning, the concept of argumentation in science education has been investigated by many researchers (Von Aufschnaiter et al., 2008; Sadler, 2006, Osborne et al., 2004; Newton et al., 1998; Kuhn, 1993). Video recordings, audio tapings, writing the dialogues were the main instruments in these studies. (e.g.Jimenez-Aleixandre et al.,1997). These researchers investigated the nature of argumentation of students by using Toulmin's Theory. For example, a study conducted by Erduran, Osborne and Simon (2005), aimed to investigate what type of pedagogical strategies needed to promote argumentation skills in students, and examine whether implementation of these strategies extent students argumentation skills. Data were gathered about scientific and socio scientific issues from 8 year schools in London. As a result, authors reported that teachers found in training workshops generated statistically different argumentation skills in their classrooms.

2.3. Research on Argumentation in Turkey

There is an inclination to study argumentation in recent years in Turkey after an efficacious change to constructivism in educational programs in science education. The studies are mainly concentrated on the effect of argumentation based classroom environments by constructing argumentative activities based on TAP on various variables such as students' reasoning. The analyses of some studies are especially done by Toulmin's pattern for qualitative measurements (Kılıç & Kaya, 2008; Eşkin, 2008; Kaya, 2005). For example, Eşkin (2008) examined the effect of argumentation on the students' reasoning and argumentation levels. A total of 52 tenth grade students participated in the study. The analysis of Toulmin was used in this study to make qualitative measurement. The findings of the study showed that the application of argumentation in the classrooms develops more correct and detailed reasoning, and improve argumentation skills of students. In another study, Özdem (2009) studied with pre-service science teachers to find out their nature of argumentation in inquiry- oriented laboratory tasks. Using Walton's (1996) analysis to measure the effect of argumentation, the author concluded that designing inquiry-oriented laboratory environment which is enriched with critical discussion can support argumentation.

Some studies used only quantitative measurements to examine the effect of argumentation in science lessons (Siegel & Ranney, 2002; Sağır, 2008; Yeşiloğlu, 2007). For example, Sağır (2008) investigated the effectiveness of argumentation theory based teaching in science courses. To examine the effectiveness, students' argumentativeness, attitudes toward science, academic success, and nature of science conceptions were the variables of this study. Data were collected through Argumentativeness Scale, Attitudes toward Science Scale, Achievement Tests and interviews. The results showed that academic success and attitudes toward science do not change differently between argumentation and traditional classrooms, but argumentativeness, and concepts related with nature of science differ significantly in two groups. However, Tekeli (2009) studied with 8th grade elementary level students. She reported that the conceptual understanding about acid-base, the understanding of the nature of science, the development of scientific reasoning abilities and the attitudes towards science and technology are improved in argumentation based classes. In another study, Gültepe (2011) reported that although there is no any statistically significant difference between experimental and control groups, the quality of answers of students can show the difference in critical thinking. Kaya (2009) pointed out a gap in the literature about the argumentation and comparison of traditional, inquiry-oriented and argumentation based classroom on primary school students' learning about the acids and bases subject and their science process skills. She found a significant difference in conceptual understanding and achievement in three groups, but there isn't any significant difference in the teaching variant to show which teaching method provides more effective learning. This present study, also, aimed to find the effect of argumentation based classroom environment on 6th grade students' conceptual understanding about physical and chemical change topic, argumentativeness, and attitudes toward science by using quantitative data.

2.4. Summary

To summarize, the effect of argumentation based instruction on various variables was investigated by many researchers (Sadler & Zeidler, 2005; Means & Voss, 1996, Acar, 2008). There are many researches on the effect of argumentation based instruction on the development of conceptual understanding (Cross et al., 2008; Hogan, 2002; Zohar & Nemet, 2002). Moreover, some researches concentrated on the effect of argumentation based instruction on students' tendencies to argument

(Tekeli, 2009, Sağır ,2008, Kaya & Kılıç, 2008) and students' attitudes toward science (Geban, Aşkar & Özkan, 1992; Sabap, 2005; Tattar, 2006, Siegel & Ranney,2002). Additionally, there is a great tendency to study argumentation in recent years in Turkey (Kılıç & Kaya, 2008; Eşkin, 2008; İşbilir, 2010; Yeşiloğlu, 2008, Özdem, 2009). On the other hand, overview of the studies indicate that there is an ongoing need to examine the impact of argumentation based instruction on attitudes toward science, argumentativeness and conceptual understanding of students, especially with low grade students, and with different science topics. Therefore, the present study attempts to investigate the impact of argumentation based instruction sixth grade students' attitudes toward science, conceptual understanding of physical and chemical change topic and argumentativeness.

CHAPTER 3

METHOD

This chapter gives definite information about the design of the study, population and sample, data collection, treatment, analysis of data, trustworthiness of the study, assumptions and limitations of the study.

3.1. The Design of the Study

The purpose of this study is to investigate the effect of an argumentation based instruction on sixth grade elementary level students' conceptual understanding about physical and chemical change topic, argumentativeness, and attitudes toward science. Quantitative data are obtained to prove this purpose.

In this study, the non-equivalent control group design as a type of quasi-experimental design was used. The already formed classes were assigned randomly as experimental and control groups without disrupting the curriculum. Students were not chosen randomly. They didn't leave their classes for treatment because the administration didn't give permission to change their classes for the treatment. Design of the study is presented in Table 2.

As seen in the Table 3.1., Argumentativeness Scale was administered to students before and after implementation to determine the tendency of students to argument. Science Attitude Scale (SAS) was used to determine students' attitudes to science before and after implementation. Students' understanding about the physical and chemical change concepts was assessed by pretest and posttest with Physical and Chemical Change Concept Test (PCCCT).

Table 3.1. The Design of the Study

Groups	Pre-Tests	Treatment	Post-Tests
Experimental	SAS,PCCCT, Argumentativeness Scale	Argumentation Based Instruction	SAS,PCCCT, Argumentative ness Scale
Control	SAS,PCCCT, Argumentativeness Scale	Traditional Instruction	SAS,PCCCT, Argumentative ness Scale

3.2. The Participants

The target population is all 6^{th} grade elementary level students in Ankara. The accessible population is sixth grade elementary level students in one of the elementary public school in Ankara, Turkey. The participants of the study were sixth grade students in this school. From the three sixth grade classes, two of them were selected according to proximity of their average scores in their science lessons in the first semester. The data about the average scores of students in their science lesson gathered from administration of the school. The control group (n=33) and experimental group (n=32) were selected randomly from these two classes. Of the participants in the control group 17 were male, and 16 were female. Also, of the participants in the experimental group 15 were male, and 17 were female. Students had completed topics including change of matter during fifth and fourth grade science courses.

Table3.2. Distribution of students in control and experimental group

	N (Number of students)	Average scores in science lesson
Experimental Group	32	88
Control Group	33	84

The students in the study selected from the school that the researcher works as a teacher. Teacher who implemented the treatment was the researcher herself. Convenience sampling was chosen because the school was close to the researcher by providing easy access.

3.3. Instruments

The instruments used in the present study were Science Attitude Scale (SAS), Physical and Chemical Change Concept Test (PCCCT), Argumentativeness Scale.

For quantitative measurements, Science Attitude Scale (SAS), Physical and Chemical Concept Test (PCCCT), Argumentativeness Scale were used to explore students' attitude toward science, students' conceptual understanding, and argumentativeness after implementation. These tests and scales are administered before implementation process as pre-test and after implementation process as post-test. The data were analyzed by SPSS (Statistical Package for the Social Sciences) program.

3.3.1. Science Attitude Scale (SAS)

Students' attitude toward science was measured by SAS developed by Geban et.al (1994). This Likert type instrument contains 15 items (see Appendix B). There are choices in each item as "strongly agree", "agree", "undecided", "Disagree" "Strongly disagree". The total point of each student was calculated by adding each point. The scale was implemented as pre-test and post- test. The total points of each student were calculated both before and after the implementation. The results were analyzed by using SPPS program and mixed between-within subjects ANOVA. The reliability coefficient of the instrument in the present study was calculated as .848.

3.3.2. Physical and Chemical Change Concept Test (PCCCT)

This test was developed by the researcher for assessing the students' conceptual understanding about physical and chemical change topic before and after treatment (sees Appendix B). It was developed by taking consideration into science and technology curriculum (table 3.3) and related literature. It consists of 16 multiple choice questions related with all concepts of physical and chemical change such as physical and chemical change, pure and mixture substances. The results were analyzed by using SPPS program and mixed between-within subjects ANOVA. Furthermore, in the table 3.3, the main themes of the objectives related with physical and chemical change topic in the curriculum with questions number of the PCCCT are given in the table 3.3.

A panel of two science educators and one science teacher examined content validity and clarity and format of each item on the test.

A pilot study was conducted to test the reliability of the instrument. The test applied to 70 participants in an elementary public school. The alpha coefficient of the instrument in the pilot study was calculated as .781. It was founded as .786 for the main study.

Table3.3.The objectives in the curriculum including the concept test with item numbers.

Main theme of objective in the curriculum	Question number
The events that exemplifies the change of matter's appearance	1,3, 4, 11, 12
The events that exemplifies the change of matter's structure	2,3, 4, 11, 12
The identity of matter remains the same in physical changes	10, 16
The identity of matter changes in chemical changes	10, 16
Representing physical and chemical changes with atomic and molecular models	6, 14, 16
Representing pure and mixed substances with atomic and molecular models	5,7, 8, 9, 13, 15

3.3.3. Argumentativeness Scale

The Argumentativeness Scale was applied to students to determine their tendency to argument and how they construct argumentative environment. It was originally developed by Infante and Rancer (1982) and translated into Turkish by Kaya (2005) (see Appendix B). It contains 20 Likert type items about argumentativeness. Items numbered as 2, 4, 7, 9, 11, 13, 15, 17, 18, and 20 express the tendency to argument.

Items numbered as 1, 3, 5, 6, 8, 10, 12, 14, 16, and 19 express the avoidance to argument. There are choices in each item as “always”, “frequently”, “sometimes”, “rarely” “never”. The items express tendency to argument pointed as 1,2,3,4, and 5 and the items express avoidance to argument pointed as 5,4,3,2, and 1. The total point of each student was formed by adding each point (Kaya, 2005).

Argumentativeness Scale was implemented as pre-test and post- test. The total points of each student were calculated both before and after the implementation. The results were analyzed by using SPPS program and mixed between-within subjects ANOVA. Infante and Rancer (1982) reported that Cronbach’s Alpha reliability for the items regarding tendency to argument was .86 and items avoidance to argument was .91. The reliability of the instrument for the present study was for tendency to argument, .87, and .81 for avoidance to argument.

3.4. Treatment

This study was implemented in the second semester of 2010-2011 Academic Year in one of elementary schools in Ankara. The instruction for each group spanned seven weeks and addressed a topic about physical and chemical change. Students in the experimental group were instructed by argumentation based instruction and students in the control group were instructed by traditional instruction.

3.4.1. The Control Group

The regular science instruction based on science and technology curriculum was implemented in control group. Teacher's book, students' book and workbook, which were prepared for the public schools, were the sources for students and teacher. The learning strategies were mainly appropriate with constructivist approach. Students in the control group made experiments, argued on some questions, made inquiries, and did homework from their workbooks.

3.4.2. The Experimental Group

The activities for argumentation based class were prepared by the researcher. Toulmin's Argumentation Pattern (TAP) was used to prepare these activities. According to this theory, *claims* are defined as conclusions, the merits of which to be confirmed. Claims are supported by the *Data.* The justification of the connection between claims and data is provided by the *Warrants. Backing* is defined as assumptions that provide justification for warrants. *Qualifiers* show limitations on the claim under the situation that claims taken as true. When claims are not true, the *rebuttals* explain the situation (Toulmin, 1958).

Activities used in the experimental group were prepared to lead students to argue on the topic. The handouts were prepared to deduce students' misconceptions on the topic and, they reflect argumentative patterns such as constructing an argument. While preparing handouts for argumentation of the students, the researcher used TAP and use argumentation techniques from the related literature. In these activities students generally worked in small groups (4 or 5 in each group). They argued on the topics in small groups first and they shared their arguments with whole class after discussing in each group.

The role of the researcher was being a facilitator. Teacher guided each group, when they required going further or didn't sure what to do next, by questions and/ or counter-arguments to promote argumentation among group members.

There were six activities about the topic and one introductory activity to become familiar with argumentation implemented in the class that instructed with argumentation based instruction. All of these activities are given in Appendix A.

Introductory Activity:

This activity named as "Learning Argumentation" is mainly aimed to help students comprehend TAP and how to use these patterns in their arguments. Students learned organizing their daily arguments with this activity. There are two parts in the activity. One of them gives information about TAP and exemplifies a daily argumentation between a father and his son, classifies it according to TAP. In the second part, students actively classify a daily argumentation among three students according to TAP. A blanked schema is given to students as hand out; they fill that to make classifications. In this activity students were expected to fill in the blanks in the schema to make classifications.

Activity 1: *"What is the Difference in these Events?"*

In this activity, students were expected to exemplify changing only the appearance of substance or structure of matter by arguing it with their friends in the group. They needed to write their thought as claim, their data for that claim, and at the end, they had to justify their claim. An example is given below.

Example:

Oğuz*: My tea contains too much sugar after adding new sugar.*

Our thought*: The appearance of matter changes*

Our evidence*: The taste of sugar and tea stays the same.*

Our Justification*: When the taste remains the same, this justifies that their appearance only changes.*

Activity 2: "Did the Identity of Matter Change"

This activity was adapted from the book "*Resources for Introducing Argumentation and the Use of Evidence in Science Classrooms"* by Jimenez Alexander et al. (2009). It contained two parts. One of them required students argue on the results and observations of an experiment, decided on what materials used in the experiment. They were expected to write their justifications about their decision. The second part named as "Let's Do the Experiments Ourselves!" provide students to not only make their experiments themselves but also they construct the experiment. This part was adapted from Goldsworthy et al. (2000)

Activity 3: "Matter Changes"

This activity was adapted from IDEAS PACK (Osborne et al, 2004). After reading brief information about physical and chemical change, students were expected to choose right claim about an experiment given as an example. Then, they needed to provide a data by selecting one choice from three choices given to them. On this activity, students needed to write a qualifier and a rebuttal to their arguments.

Activity 4: "What about my Guess?"

This study was adapted from the study of White and Gunstone (1992). There are four different events given to the students. The preceding situation of each event was given. Students needed to guess the subsequent position of each. They made their guess one by one and compared with their friends in the same group. All students in each group reach an agreement, and they drew it an extra paper given by the teacher. Teacher distributed the right drawings to each group to argu on their last decision. At the end, groups explained why their guess is wrong.

Activity 5: **"Pure and Mixture"**

This activity was prepared to promote discussion on the situation of the subjects while constructing new mixtures with the given materials. They needed to write their observations and conclusions about their mixtures. Then, they were expected to prepare heterogeneous and homogenous mixtures. They needed to decide about whether their mixture is true or not. They supported their decision with an explanation.

Activity 5a: "Pure or Mixture?"

Students were expected to argue on the six subjects chosen from their daily life about whether they are mixture or pure substance. They had to write their justification to their selection for each substance. If they choose mixture, they had to discuss on whether it is homogenous or heterogonous.

Activity 6: "The Particles are mixing"

The teacher leaded students in each group to argue on eight cards that contain pictures of particular dimensions of subjects. They selected a card and tried to decide on the pure substance (compound), the pure substance (element), the mixture (homogenous) the mixture (heterogonous). Then, they were expected to write the data, the justification, and the rebuttal for each decision.

3.5. Trustworthiness of the Study

By making non-equivalent control group design, threats to internal validity for this study are history, maturation, testing, instrumentation, and regression are controlled (Fraenkel & Wallen, 2006).However, location, data collector characteristics and bias, attitude of subjects and implementation were required to control for this study. Location was the laboratory of the school and it was kept constant by the researcher.

The threat of data collector characteristics was controlled by using the same data collector for the two groups. Data collector bias was another threat for this study, and it was controlled by selecting a data collector that doesn't aware of the hypotheses of this study and couldn't determine the characteristics of students in two groups. Because the researcher was science teacher of the participants in the school, the Hawthorne Effect may occur. To control this threat, the students knew the treatment as the real part of their science lesson. Implementation was another threat of this study because the researcher implemented the treatment may have personal bias in favor of one method over the other. This threat was controlled by taking reports after every class to look at the implementation occurs as intended. Furthermore, this was required for verification of independent variable. Verification of independent variable was required to confirm whether teaching methods are implemented as intended. There was a method that taking reports of behavior after implementation to control the independent variable (Shaver, 1983). This was a type of making systematic observation. The researcher as being teacher of two groups, she takes reports of her behavior to verify the independent variable. Then, she checks her reports with a checklist of each teaching method.

3.6. Analyses of Data

As descriptive statistics, means and standard deviations were used to investigate the general characteristics of the sample.

Statistical analyses of the data were made by SPSS. Descriptive Statistics were presented about the collective variables of the present study. Mixed between-within subjects ANOVA was used to investigate the effect of argumentation based instruction, and traditional instruction on students' conceptual understanding about physical and chemical change topic, attitude toward science, and argumentativeness. Assumptions of mixed between ANOVA were checked.

3.7. Assumptions

1. All of the students give answers with their sincerity in all instruments.
2. The researcher bias controlled by the researcher taking notes after every lesson.
3. After the conceptual understanding of students is taken under control, the performance of students in dependent variable is not affected from anything except from teaching method.
4. There is no interaction between the control and experimental group.
5. Students have background knowledge about the topic.

3.8. Limitations

1. The number of students is limited with 65.
2. The study is limited with in a public elementary school in Ankara.
3. The period of the treatment is limited with 5 weeks and 4 hours in a week.

4. The findings of the study are only related with physical and chemical change topic.

5. Students' retention related with physical and chemical change topic wasn't examined in this study.

CHAPTER 4

RESULTS AND CONCLUSION

This chapter is divided into two sections. The first one gives descriptive information about the data. The second one gives inferential statistics by which the null hypotheses are tested.

4.1. Descriptive Statistics

Table 4.1 shows the descriptive information related to science attitude scale (SAS), and physical and chemical change concept test (PCCCT), and argumentativeness scores for both the experimental and the control groups. The number of participants, mean, range, minimum and maximum values, standard deviation, and skewness and kurtosis values are presented in the table 4.1.

4.1.2. Descriptive Statistics for SAS scores

Since the present study concerned with the effect of traditional and argumentation based instruction on the students' attitude toward science, the descriptive statistics of SAS scores were investigated. Descriptive statistics related to the SAS were calculated for both control and experimental groups regarding pre- and postapplications as presented in the table 4.1. The mean values for experimental group were 68.87 and 69.65 for the pre- and posttest results respectively. The mean values for control group were 66.45 for pre-test and 66.24 for post-test. Although the related mean values were very close to each other, students in experimental group developed more positive attitude toward science than students in control group according to mean values. Actually there was a decrease in mean scores of control group after the treatment.

4.1.2. Descriptive Statistics for PCCCT Scores

PCCCT was applied to students to measure their conceptual understanding about physical and chemical change before and after the treatment. The descriptive statistics of SAS scores were investigated to determine the effect of traditional and argumentation based instruction on students' PCCCT scores. The mean values for experimental group were 6.09 and 8.65 for the pre- and posttest results respectively as presented in the table 4.1. The mean values for control group were 6.36 for pre-test and 7.70 for post-test. As seen from the results that both of the groups' pre-test scores were very close to each other. However, students in experimental group have higher mean scores than students in control group according to their post-test scores. This means that students in experimental group developed more conceptual understanding than students in control group.

Table 4.1.Descriptive statistics related to science attitude scale (SAS) and physical and chemical change concept test (PCCCT) and argumentativeness scores for both the experimental and the control groups.

	Experimental Group								Control Group							
Variables	N	Mean	SD	Range	Min.	Max.	Skew.	Kurt.	N	Mean	SD	Range	Min.	Max.	Skew.	Kurt.
Pre-arg.	32	71.34	8.88	47	45	82	-1,63	3.04	33	60.96	13.19	47	40	87	0,21	-0.81
Pre-SAS	32	68.87	4.98	15	60	75	-0.37	-1.45	33	66.45	7.41	27	48	75	-0.72	-1.84
Pre-PCCCT	32	6.09	3.60	14	1	15	0.77	0.01	33	6.36	2.78	10	2	12	0.13	-0.93
Post-arg.	32	81.21	11.68	52	47	99	-1.04	1.31	33	67.48	13.29	59	32	91	-.33	.32
Post-SAS	32	69.65	6.02	21	54	75	-0.98	-0.03	33	66.24	9.37	41	34	75	-1.60	3.18
Post-PCCCT	32	8.65	3.75	15	1	16	0.34	-0.43	33	7.70	2.83	10	3	13	0.23	-1.01

4.1.3. Descriptive Statistics for Argumentativeness Scores

Students' tendencies to argumentation were measured by Argumentativeness Scale developed by Infante and Rancer (1982). The scale was applied as pre-post test to two groups instructed with traditionally and argumentation based instruction. The results of the scale for Argumentativeness Scale were presented in the table 4.1. The mean scores for experimental group were 71.34 and 81.21 for the pre- and posttest results respectively. The mean values for control group were 60.97 for pre-test and 67.48 for post-test. The mean value of experimental group's pre-test score was higher than control group. Both of the groups developed their argumentativeness scores after the treatment according to their mean values.

4.2. Inferential Statistics

Mixed between within subjects analysis of variance test was used to test whether there was a significant mean difference between students' SAS, PCCCT, and argumentativeness scores who were participated in two groups that received argumentation based and traditional instruction.

Statistical analysis for three mixed between-within subjects ANOVA were presented in the next part of this section. At first, assumptions of mixed between within subjects ANOVA for SAS, PCCCT and argumentativeness scores were presented. Secondly, the results of mixed between-within subjects ANOVA for SAS, PCCCT and argumentativeness scores were presented.

4.2.1. Assumptions of Mixed Between- Within Subjects ANOVA

Mixed between within subjects analysis of variance test was used to test whether there was a significant mean difference between students' SAS, PCCCT, and argumentativeness scores who were participated in two groups that received argumentation based and traditional instruction. Assumptions of mixed between-within subjects ANOVA were checked before conducting the analysis.

1. Sample Size

When the sample is large enough (e.g. 30+), the violation of this assumption should not cause any major problems (Pallant, 2007). The sample size was 65 for the present study. Therefore, conducting mixed between-within subjects ANOVA was appropriate for the three variables.

2. Normality and Outliers

Histograms for all groups indicated that the scores appeared to be normally distributed except from post argumentativeness score of experimental group and post SAS scores of control group. Skewness and kurtosis values provided in Table 4.1 are in acceptable range being between -2 and +2 for all the dependent variables indicating normality except from post argumentativeness score of experimental group and post SAS scores of control group. Because the sample size large enough (e.g. 30+), violation of this assumption didn't cause any problem. (Pallant, 2007)

3. Homogeneity of Intercorrelations

The first mixed between-within subjects ANOVA results of Box's M test were F(3,7377)=5.314, *p*=0.002 (*p*>0.001). The values for the second mixed between-within subjects ANOVA were *F*(3,7377)=2.083, *p*=0.1 (*p*>0.001). The result of Box's M test for the third mixed between-within subjects ANOVA as like the second one, *F*(3,7377)=3.48, *p*=0.02 (*p*>0.001), indicated that homogeneity of intercorrelations assumption was not violated for all the tests.

4. Sphericity

To evaluate the results if sphericity assumption was violated for the three tests, the Mauchly's Test values were interpreted. The result of Mauchly's Test of Sphericity for all tests were *p*=0.00 (*p*>0.05), indicated that sphericity assumption was violated. This assumption was commonly violated assumption that required the equivalence of the variance of the population difference scores for any two conditions as the variance of the population difference scores for any other two conditions (Pallant, 2007). The multivariate analyses didn't require sphericity. Also, meeting other assumptions should provide to be safe for the test.

5. Homogeneity of Variances

Levene's Test of Equality of Error Variances for all groups presented in Table 4.2. The results indicated for the third test that error variance of the dependent variable were equal for the groups. Then, it was safe to proceed.

After meeting assumptions, mixed between- within subjects ANOVA was run to determine whether there was a significant mean difference between students' SAS, PCCCT and argumentativeness scores who participated two groups that received traditional instruction and argumentation based instruction.

Table 4.2.Levene's Test of Equality of Error Variances

	F	df1	df2	Sig.(p)
Pre-SAS	3.66	1	63	.06
Post-SAS	2.64	1	63	.11
Pre-PCCCT	4.30	1	63	.06
Post- PCCCT	1.54	1	63	.22
Pre-Argumentativeness	7.32	1	63	.09
Post-Argumentativeness	.53	1	63	.48

4.2.2. Mixed Between-Within Subjects ANOVA Results for SAS Scores

Mixed between- within subjects ANOVA was used to determine whether there was a significant mean difference between groups with respect to SAS scores. The null hypotheses for the test results were:

H1. There is no statistically significant mean difference between the groups exposed to argumentation based instruction, and traditional instruction with respect to SAS scores.

H2a. There is no statistically significant mean difference between pre-SAS and post-SAS scores of the group instructed traditionally.

H2b. There is no statistically significant mean difference between pre-SAS and post-SAS scores of the group instructed with argumentation based instruction.

After meeting assumptions for SAS scores of students, it was needed to assess the interaction effect. The table 4.3 shows the results of Multivariate tests (time*group). The value in the second raw of table shows that there was no interaction effect between time and treatment, that is, it was not statistically significant F (1, 63) = .99, p=.65.

Table 4.3 Mixed between-within subjects ANOVA results for SAS scores

Effect	Value	F	df1	df2	Sig.	eta squared
Time	.99	0.67	1	63	.80	.001
Time*Groups	.99	.20	1	63	.65	.003

The value for Wilk's Lamda for the time was .99 with a significant value of .80 (p<0.05). There was not a statistically significant effect for time. That means that there was not a change in SAS scores of students across two different time periods before and after the treatment (eta squared =.001). The value eta squared meant that there was a small effect size according to guidelines proposed by Cohen (1988).

According to table of Tests of Between-Subjects Effects for SAS scores (table 4.4), there was a significant difference in the SAS scores between two groups F (1, 63) =4, 36 *p*=.04 (*p*<.05), partial eta squared=.07. This was a moderate effect size according to Cohen (1988).

Table 4.4. Tests of Between-Subjects Effects for SAS scores

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	597572.10	1	597572.1	9.43	.00	.99
Groups	276.5	1	276.5	4.36	.04	.07

4.2.3. Mixed Between-Within Subjects ANOVA Results for PCCCT Scores

Mixed between- within subjects ANOVA was used to determine whether there was a significant mean difference between groups with respect to PCCCT scores. The research hypotheses were:

H3. There is no statistically significant mean difference between the groups exposed to argumentation based instruction, and traditional instruction with respect to PCCCT scores.

H4a. There is no statistically significant mean difference between pre-PCCCT and post-PCCCT scores of the group instructed traditionally.

H4b. There is no statistically significant mean difference between pre-PCCCT and post-PCCCT scores of the group instructed with argumentation based instruction.

Mixed between within subject ANOVA results are presented in the table 4.5. There was an interaction effect between time and treatment. F (1, 63) =.90, *p*=.01.

Table 4.5 Mixed between-within subjects ANOVA results for PCCCT scores

Effect	Value	F	df1	df2	Sig.	eta squared
Time	.75	20.95	1	63	.00	.25
Time*Groups	.90	.20	1	63	.01	.09

Although there was a significant interaction effect between time and groups, the information about the results of the test was presented in the following tables. The value for Wilk's Lamda for the time was .75 with a significant value of *p*= .00 (*p*<0.05). This meant that there was a statistically significant effect for time, that is, there was a change in PCCCT scores of students across two different time periods before and after the treatment (eta squared =.25). Eta squared value meant that there was a large effect size according to guidelines proposed by Cohen (1988).

The results presented in Tests of Between-Subjects Effects for PCCCT scores table (table 4.6), there was not a significant difference in the PCCCT scores between two groups F (1, 63) =.001 *p*=.97, partial eta squared=.00. The effect size was small according to Cohen (1988).

Table 4.6. Tests of Between-Subjects Effects for PCCCT scores

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	7043.71	1	7043.71	426.8	.00	.87
Groups	.02	1	276.5	.001	.97	.00

The mean values for experimental group were 6.09 and 8.65 for the pre- and posttest results, and for the control group were 6.36 for pre-test and 7.70 for post-test respectively as presented in the table 4.1 above. The means of pre-PCCCT scores for the two groups were near to each other at the beginning, that is, there was no difference in their beginning score. However, the mean of students' post-PCCCT scores in experimental group was higher than the mean of students' post-PCCCT scores.

4.2.4. Mixed Between-Within Subjects ANOVA Results for Argumentativeness Scores

Argumentativeness Scores were analyzed by Mixed between- within subjects ANOVA to determine whether there was a significant mean difference between groups instructed with argumentation based and traditional instruction. The null hypotheses tested were:

H5. There is no statistically significant mean difference between the groups exposed to argumentation based instruction and traditional instruction with respect to argumentativeness scores.

H6a. There is no statistically significant mean difference between pre-argumentativeness scores and post-argumentativeness scores of the group instructed traditionally.

H6b. There is no statistically significant mean difference between pre-argumentativeness scores and post-argumentativeness scores of the group instructed with argumentation based instruction.

The table 4.7 shows the results of Multivariate tests (time*group). The value in the second raw of table shows that there was no interaction effect, that is, it was not statistically significant Wilk's Lamda= .97, F (1, 63) = 2.11, *p*= .15.

The value for Wilk's Lamda for the time was .56 with a significant value of .000 (<0.05) meaning that there was a statistically significant effect for time, that is, there was a change in the argumentativeness scores across two different time periods (eta squared =.44). This value means a large effect according to guidelines proposed by Cohen (1988).

Table 4.7 Mixed between-within subjects ANOVA results for argumentativeness scores

Effect	Value	F	df1	df2	Sig.	eta squared
Time	.56	50.21	1	63	.000	.44
Time*Groups	.97	2.11	1	63	.15	.03

According to Tests of Between-Subjects Effects for argumentativeness scores table (table 4.8.), there was a significant difference in the argumentativeness scores between two groups in argumentativeness scores F (1, 63) =19.61, *p*=.00, partial eta squared=.24. There was a large effect size according to Cohen (1988).

Table 4.8. Tests of Between-Subjects Effects for argumentativeness scores

Source	Type III Sum of Squares	df1	df2	F	Sig.	Partial Eta Squared
Intercept	641484.09	1	63	2.67	.00	.98
Groups	4721.08	1	63	19.61	.00	.24

4.3. Conclusions

The results of the present study could be summarized as follows,

1. There was not a statistically significant improvement in SAS scores of both experimental and control group after implementation of the treatment.

2. There was a significant mean difference in SAS scores of students between experimental group instructed by argumentation based instruction and control group instructed by traditional instruction.

3. Both in traditional and argumentation based classrooms, students developed statistically significant conceptual understandings in physical and chemical change topic.

4. Although there was an interaction between time and treatment in mixed between within subjects ANOVA results for PCCCT scores of students, the results were presented for information about the difference of the two groups. The test results showed that there was not statistically significant mean difference between experimental and control group in development of PCCCT scores. However, experimental group had higher mean score than control group in their Post-PCCCT scores.

5. The time had a significant effect on treatment, that is, there was a significant change in argumentativeness scores of both experimental and control group across the time.
6. There was a significant mean difference in argumentativeness scores of students for the two groups (those who received traditional instruction and those who received argumentation based instruction).

CHAPTER 5

DISCUSSION

This chapter presents a discussion of the findings of the present study based on the research questions and suggests implications for an improvement of science education along with recommendations for future research.

5.1. Discussions

Argumentation has been an important part of science education and by this way; it has a significant role in science classrooms. Many studies are shown this important position of argumentation in science classrooms (Driver et al., 2000; Jiménez-Aleixandre et al., 2000; Osborne et al., 2004). Furthermore, students' attitude toward science is related with the type of instructional method that makes science meaningful to them (Aikenhead, 2006; Fensham, 2006). Argumentation based instruction having characteristics for students to make science meaningful for them, and, also, has some impact on students' tendency to argue on a science topic and their conceptual understandings. In a similar manner, the present study aimed to investigate the impact of argumentation based instruction on students' attitudes toward science, conceptual understanding, and argumentativeness. For this purpose, participants performed 6 different argumentative activities for seven weeks period.

These activities were about physical and chemical change topic and one of them was about orientation of how to use argumentative patterns (e.g. claim, warrant). On these activities, students generated their claim about the topic, supported their claims, and considered the counter arguments of their ideas.

Before the treatment Science Attitude Scale, Physical and Chemical Change Concept Test, and Argumentativeness Scale were administered to students. Pre-test results were used to examine the improvement of experimental and control groups after the treatment with respect to collective variables. Students in the experimental group were instructed with argumentation based instruction and students in the control group were instructed with traditional instruction. After the treatment, SAS, PCCCT, and Argumentativeness Scale were re-administered to participants in both of the groups to show the impact of argumentation based instruction on students' attitudes toward science, conceptual understanding and argumentativeness.

One of the remarkable findings of the study was the endurance of students' attitude toward science to change in the both instruction types, that is, it didn't change significantly after the treatment in both groups. Furthermore, there is a small decline in mean scores of students' attitude toward science in control group. This finding was explained by having similar results with some studies showing that the attitudes of students have resistance to change (Blosser, 1984; Shrigley, Koballa & Simpson, 1988). Also, the decrease in attitude scores of students in control group may be explained by the negative effect of traditional instruction on students' attitude toward science (Osborne and Dillon, 2008). This finding is similar with the findings of Sağır (2008) and Yeşiloğlu (2007) that there is not a significant change in attitudes scores of students after argumentation based instruction. Additionally, attitude of students to science is constituted in long years, and it may take time to change more than seven weeks period as done with the present study.

Another finding of the present study related with attitude toward science scores showed that there is a small change in experimental groups' attitude scores which is not statistically important, and this change is statistically important when compared with control group. To clarify this finding, students in the experimental group engaged in discussion and conducted activities in which they were expected to argue and comment on their findings. This might promote positive attitudes toward science among students. Similarly, Osborne and Dillon (2008) stated that any collaborative writing or work that involves construction of an argument results in improvement of science attitudes. This result is parallel with the study of Osborne and Collins (2001), in which they concluded that pupils desired more opportunities in science for practical work, extended investigations and opportunities for discussion – all of which provide an enhanced role for personal autonomy and indirectly with positive attitude toward science. Similarly, using computer-based activities containing argumentative patterns Siegel and Ranney (2002) suggested these types of activities in order to enhance students' attitudes toward science.

The findings about conceptual understanding of students showed that the conceptual understanding about the physical and chemical change topic changed after implementation of argumentation based instruction, and when compared with control group instructed with traditional instruction the mean of students' score in experimental group were higher. This means, argumentation based instruction enhances students' science learning. In parallel with the present study, Zohar and Nemet (2002) found that there is a significantly greater difference in the development of conceptual knowledge between the experimental group which received argumentation intervention and the control group. In the same way, in the study of Venville and Dawson (2010), both experimental and control groups improved significantly in their genetics conceptual understanding, but the improvement of the argumentation group was significantly better than the comparison group. They concluded that argumentation intervention is an advantage for students of learning genetics. Similarly, the results about conceptual understanding in the present study showed that it is more advantageous of learning with argumentation based instruction than traditional instruction because it gave some opportunities students to discuss on the topic and present their arguments and counter arguments about the events during the instruction. On the other side, according to the study of Clark and Sampson (2007), there is a significant relationship argumentation and conceptual quality, and it could be substantially enhanced the argumentation that takes place within science classrooms. Although this study showed the relationship between argumentation and conceptual quality, it can be inferred from that the improvement of conceptual understanding of students in the experimental group can be concerned as due to the argumentation based instruction.

In the present study, the impact of argumentation based instruction on students' trait to be argumentative (i.e. argumentativeness) was investigated. The results were shown that students in both in control group instructed with traditional instruction and experimental group in the class integrated with argumentation based instruction were improved significantly in argumentativeness scores. However, another finding related with argumentativeness scores was illustrated that students in experimental group had higher tendency to argue on science topics than students in control groups. Because argumentativeness trait is one of the important component of any education improves scientific literacy (Driver et al., 2000, Simon & Johnson, 2008), this result indicating tendency to argument improved by argumentation based instruction was worthy to notice. Also, this result indicated that argumentativeness trait, in one aspect, that provides students to present different points of view on the same issue, developed more successfully in argumentation integrated classes than traditional ones. These findings about argumentativeness were in line with the studies of Sağır (2008) and Kaya and Kılıç (2008) in which they demonstrated that argumentation based instruction had more positive effect on students' argumentativeness than traditional instruction.

5.2 Implications of the Study

The findings of the present study had some implications for science teachers, researchers, and curriculum developers. Presents study revealed that argumentation based instruction was more effective in developing students' attitudes toward science, conceptual understanding and argumentativeness than traditional instruction. Therefore, the suggestion according to this finding can be that instructional strategies that provide students to comment on the topic, encourages students to be active in discussing on their findings during the classroom activities (such as experiments) and consequently promote positive attitudes toward science, develop conceptual understanding and argumentativeness of students should be integrated into curriculum. Additionally, students should given opportunities to discuss their own hypothesis and exhibit the counter ideas.

Teachers should be trained about the integration of argumentation based instructions in their lessons. Moreover, they should develop new strategies to enhance discussion on the ideas of the students about science topics. Curriculum developers should also consider this strategy rather than traditional one in order to increase students' conceptual understanding in science learning.

The findings related with conceptual understanding showed that argumentative activities developed conceptual understanding of students in physical and chemical change topic. Therefore, teachers may prepare argumentative activities for their students to enhance students' science learning. Researchers should think of inquiring whether there is an impact of argumentation based instruction on conceptual understanding of students about other science topics.

Furthermore the results related with attitudes toward science have two implications. One of them is that the need for improving students attitude toward science can be met by integrating argumentation based instruction to science lessons, because the results of the present study showed that if students have opportunity to discuss on anything about the topic (e.g. the ideas , hypothesis), their attitudes toward science may improve. Another implication is that the integration of traditional instruction to science lessons should be limited because this type of instruction has negative effect on students' attitude toward science.

5.3. Recommendations for Further Research

1. The impact of argumentation based instruction on conceptual understanding in science topics other than physical and chemical change topic can be investigated.
2. The impact of argumentation based instruction on different grade levels and different schools can be investigated.
3. Some other instructional methods can be implemented in the topic of Physical and Chemical Change and compared with the effectiveness of argumentation based instruction.
4. The impact of argumentation based instruction can be examined by considering different variables including achievement, reasoning ability. Because higher

science achievements are related to the learner's active engagement in learning tasks, to his/her positive attitude towards science (Rennie, 1990), the effect of argumentation based instruction on achievement may be studied by looking at the relationship among attitude toward science, argumentation based instruction and achievement.

5. Qualitative analysis may be done to investigate the effect of argumentation based instruction on the variables of the present study thoroughly rather than quantitative one.

6. This study can be replicated with large sample size.

7. The duration of the study can be extended to one semester and several topics in science education.

8. Students' retention related with physical and chemical change topic can be examined with a delayed post-test.

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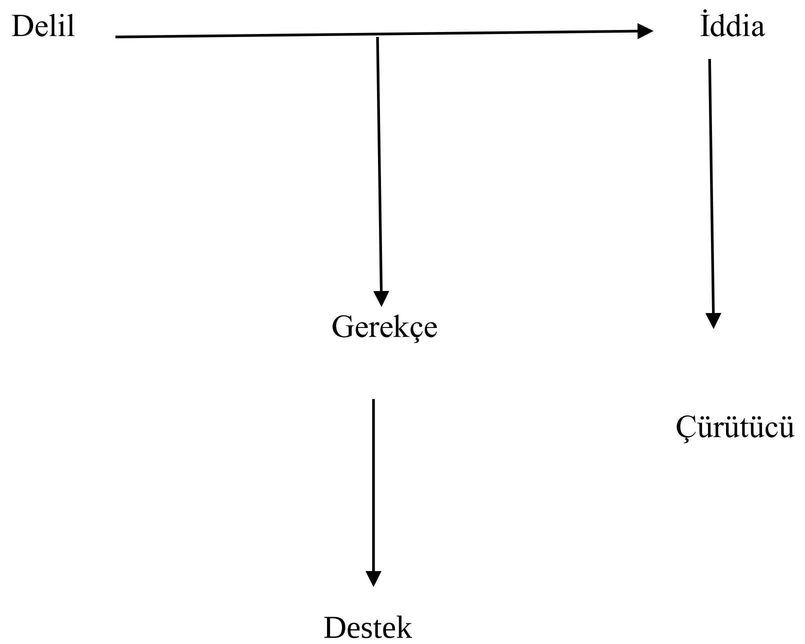
APPENDICES

APPENDIX A

CLASSROOM ACTIVITIES

INTRODUCTORY ACTIVITY. “TARTIŞMAYI ÖĞRENİYORUM”

Tartışma iddia, delil, gerekçe, destek, çürütücü kavramlarını içerir.



Bu kavramları tanımlarsak,

İddia: Tartışmada savunulan şeydir. Örnek olarak babası ile başarısı hakkında tartışma yapan bir öğrencinin iddiası başarılı olduğunu savunmasıdır.

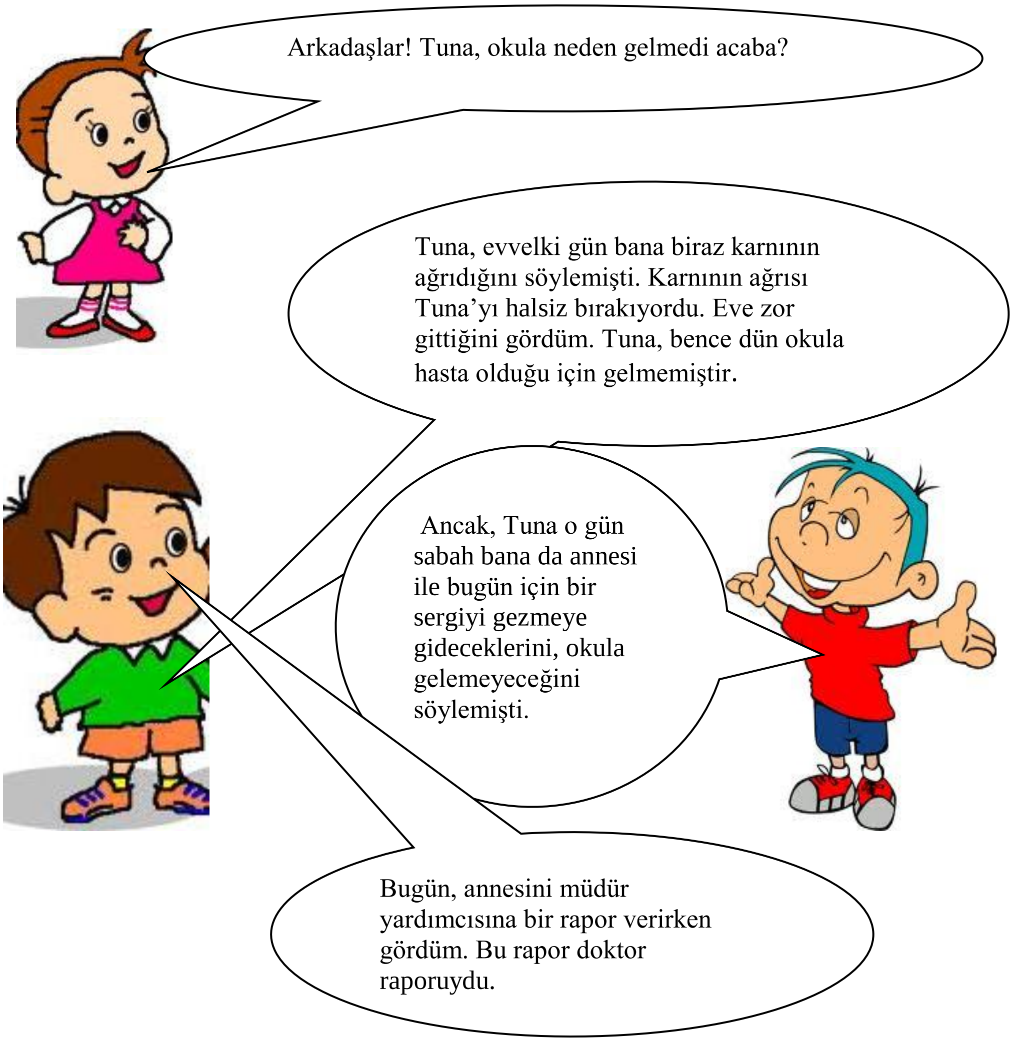
Delil: İddiayı destekleyen gerçeklere denir. Bir önceki örnekteki öğrencinin fen ve teknoloji dersinden 85 aldığını söylemesi delile bir örnek olabilir.

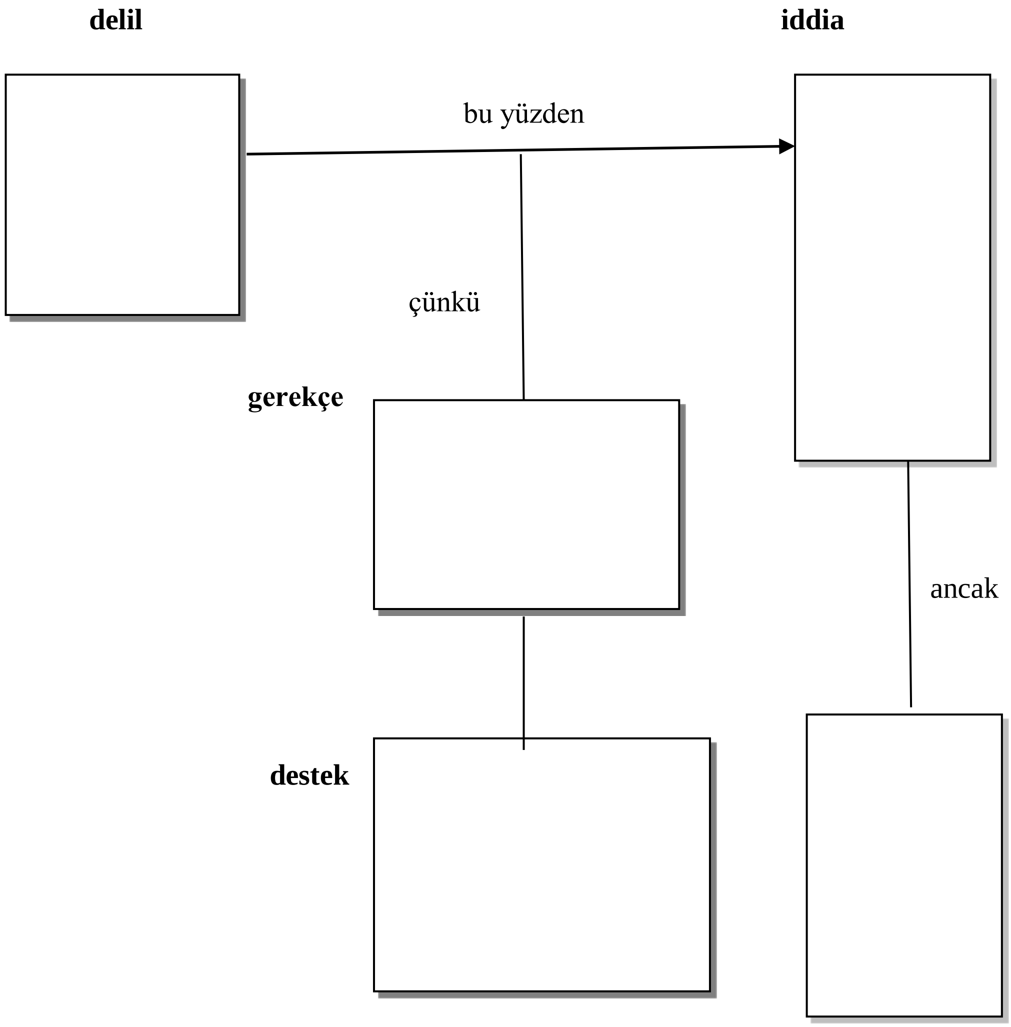
Gerekçe: Delil ile iddia arasındaki bağlantıyı kuran açıklamadır. Yani delilin iddiayı nasıl desteklediğinin ortaya konmasıdır. Yukarıdaki örnek için" 85 notu çok iyi anlamına gelen bir nottur." açıklaması öğrencinin babasına sunabileceği bir gerekçe olabilir.

Destek: Gerekçeyi destekleyen açıklamalardır. Bu açıklamalar gerekçenin daha güçlü bir anlam kazanmasını sağlar. Öğrenci babasına çok iyi anlamına gelen notları alan öğrencilerin başarılı olduğunu söyleyerek gerekçesinin destekleyebilir.

Çürütücü: İddianın karşıtı ifadelerdir. Örneğin, öğrencinin babasının öğrenciye "fen ve teknoloji dersinden 85 almış olabilirsin ama Türkçe dersinden aldığın 40 notu başarı olmadığını gösteriyor" demesi öğrencinin iddiasını çürütücü bir ifadedir.

Aşağıda üç arkadaş arasında geçen bir tartışma verilmiştir. Bu tartışma ile ilgili verilen şekilde boş bırakılan yerleri doldurun.


Arkadaşlar! Tuna, okula neden gelmedi acaba?
Tuna, evvelki gün bana biraz karnının ağrıdığını söylemişti. Karnının ağrısı Tuna'yı halsiz bırakıyordu. Eve zor gittiğini gördüm. Tuna, bence dün okula hasta olduğu için gelmemiştir.
Ancak, Tuna o gün sabah bana da annesi ile bugün için bir sergiyi gezmeye gideceklerini, okula gelemeyeceğini söylemişti.
Bugün, annesini müdür yardımcısına bir rapor verirken gördüm. Bu rapor doktor raporuydu.


delil
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ACTIVITY 1. BU OLAYLARDA DEĞİŞEN NEDİR?

Aşağıda bazı olaylar verilmiştir. Verilen bu olaylarda değişen maddenin sadece görünümü müdür? Yoksa içyapısı mıdır? Her bir durum için ne düşünüyorsunuz? Deliliniz ve gerekçeniz nedir?

Örnek:

Oğuz: *Çayıma yanlışlıkla yeniden şeker atınca çok şekerli oldu.*

Düşüncemiz: *Maddenin sadece görünümü değişmiştir.*

Delilimiz: *Şeker ve çay başka bir maddeye dönüşmemiştir. Tatları aynı kalmıştır.*

Gerekçemiz: *Şeker ve çayın tatlarının aynı kalması onların başka bir maddeye dönüşmediğini, sadece görünümünün değiştiğini gösterir.*

Ayşe: Tokam kırıldı. Artık onu kullanamayacağım. Tamir etmekte çok zor.

Düşüncemiz:

Delilimiz:

Gerekçemiz:

Filiz: Bu yemek bozulmuş. Bunu yememiz imkânsız. Başka bir yemek pişirmeliyim.

Düşüncemiz:

Delilimiz:

Gerekçemiz:

Meral: Ocağı açık unuttum. Kaynattığım suyun hepsi buharlaşıp havaya karıştı.

Düşüncemiz:

Delilimiz:

Gerekçemiz:

Yavuz: Öğretmenimin söylediği gibi zeytinyağı ve kül karıştırdım ve sabun oldu.

Düşüncemiz:

Delilimiz:

Gerekçemiz:

Seda: Aa! Bu çok güzel! Ufuk kırmızıya dönmüş.

Düşüncemiz:

Delilimiz:

Gerekçemiz:

Metehan: Bugün aldığımız bir habere göre doğaya duyarsız insanlar, yine orman yangınlarına neden oldu.

Düşüncemiz:

Delilimiz:

ACTIVITY 2. MADDENİN KİMLİĞİ DEĞİŞTİ Mİ?

Değişiyorum İ.Ö.O.'nda bir grup öğrenci öğretmenlerinin verdiği bir ödev üzerine bazı değişimler sonucunda "maddenin kimliği" nin değişip değişmediğini anlamaya çalışmışlardır.

Dizayn edilen bu deney hakkında sizde grup arkadaşlarınızla tartışarak aşağıdaki soruların yanıtlarını verilen uygun boşluklara yazın.

Öğrenciler aşağıda verilen araç-gereçlerden hangilerini kullanmışlardır? Neden?

Verilen araç-gereçler :

- Kağıt
- Makas
- Kibrit
- Ataş
- Su
- İspirto ocağı
- Yumurta
- Sirke
- Mıknatıs

Öğrencilerin bu deneyi yapmaktaki amaçları nedir?

……

……

Öğrencilerin hipotezi aşağıdakilerden hangisi olabilir?

a) Maddenin kimliği asla değişmez.

b) Bazı durumlarda madde kimlik değiştirir.

c) Değişen maddenin dış görünüşüdür. Kimliği değildir.

Neden bu hipotezi seçtiniz?Gerekçenizi yazınız :

……………………………………………………..…………………………………………

……………………………………………….…………………………………………...

Bir önceki etkinlikte verilen bir grup öğrencinin deneylerini yaptıktan sonra elde ettikleri sonuçlar aşağıda verilmiştir.

Sonuçlar:

Değişim olayı	**Gözlem**
Kesilen Kağıt	Kağıt küçük parçalara ayrıldı
Yakılan kağıt	Siyah renkli oldu. Çabuk dağılıyor.
Sirke damlatılmış yumurta kabuğu	Kötü kokuyor. Kabuk yumuşadı.

Öğrenc.Öğrencilerin elde ettiği bu üç sonucu grup arkadaşlarımızla birlikte tartışalım.

1.Kesilen Kağıt

Maddenin kimliği değişti mi?

Evet Hayır

Gerekçenizi yazın.

……

2.Yakılan kağıt

Maddenin kimliği değişti mi?

Evet Hayır

Gerekçenizi yazın.

……

3. Sirke damlatılmış yumurta kabuğu

Maddenin kimliği değişti mi?

Evet Hayır

Gerekçenizi yazın.

……

Bir önceki etkinlikte verilen üç hipotezden hangisini seçmiştiniz? Hatırlayın. Elde edilen bu sonuçlara bakarak seçtiğiniz bu hipotezin doğru olup olmadığını açıklayın.

………

KENDİ DENEYİMİZİ YAPALIM

Bu öğrencilerin yaptığı bu deneyi tekrar etmek için kendiniz yeniden bir deney tasarlayın.

Bu deneyi tasarlarken aşağıdaki boşlukları doldurun.

Araç- gereçler

………………

………………

………………

………………

Amacınız

……

Hipoteziniz

……

Deneyinizin aşamaları

………

………

………

………

Tasarladığınız bu deneyi öğretmeninizden yardım alarak yapın. Sonuçları ve gözlemlerinizi aşağıdaki çizelgeye kaydedin.

Sonuçlar ve gözlemleriniz

Değişim olayı	**Gözlem**

Elde ettiğiniz sonuçları arkadaşlarınızla birlikte tartışın.

1. **Değişim olayı**

Maddenin kimliği değişti mi?

Evet Hayır

Gerekçenizi yazın.

……

2. **Değişim olayı**

Maddenin kimliği değişti mi?

Evet Hayır

Gerekçenizi yazın.

……

3. **Değişim olayı**

Maddenin kimliği değişti mi?

Evet Hayır

Gerekçenizi yazın.

……

ACTIVITY 3 . “MADDE DEĞİŞİYOR”

Fiziksel Değişim: Buzun erimesi, altından bilezik yapılması, küp şekerin ezilerek toz şeker haline getirilmesi bazı fiziksel değişimlerdir. Maddenin yapısı değişmeden sadece dış görünüşünde meydana gelen değişmelerdir. Fiziksel değişimler sonucunda yeni maddeler oluşmaz. Sadece maddenin renk, şekil, büyüklük gibi özellikleri değişir. Fiziksel değişimler sonucunda maddenin kimliği değişmez.

Kimyasal Değişim: Sütten yoğurt ve peynir yapılması, demirin paslanması, meyvelerin çürümesi bazı kimyasal değişimlerdir. Maddenin iç yapısında meydana gelen değişmelere kimyasal değişim denir. Kimyasal değişmeler sonucunda maddenin kimliği değişir ve yeni maddeler oluşur.

Yukarıda verilen bilgiler ışığında Değişiyorum İ.Ö.O. öğrencilerin yaptığı deneyi düşünerek , aşağıda verilen iki iddiadan birisini seçiniz.

a.Değişiyorım İ.Ö.O.’ndaki öğrencilerin deneyinde gerçekleşen her üç olayda fiziksel değişimdir

b.Bu deneyde gerçekleşen üç olayı da fiziksel değişim olarak adlandırmak yanlış olur.

Aşağıdaki argümanlardan hangisi seçtiğiniz bu iddiaya iyi bir delil sağlar? Niçin?

- **Sirke damlatılmış yumurta kabuğu başka bir maddeye dönüşür.**
- **Kağıdı kestiğimizde küçük kağıt parçalarına dönüşür.**
- **Kağıdı yaktığımızda küle dönüşür.**

Benim fikrim

…………………………………………………………………………..…………………………………………………………………

………

Bu kanıt fikrimi destekler çünkü

……………………………………………………...………………………………………………………………………………

……

Benim fikrime karşı olan argümanlar…………………………………….....…..………………………

……………………………………………………………………………….…………………………………………………………

……………………………………………………………………………………………olabilir.

Bana inanmayan birisini………………………………………..…………………………………………………

………

……………………………………………ile ikna edebilirim.

ACTIVITY 4. TAHMİNİM DOĞRU MU?

Aşağıda dört ayrı değişim olayı verilmiştir. Her bir olay için maddelerin değişmeden önceki hali kutucuklarda verilmiştir. Maddelerin değişimden sonraki hali nasıl olur?

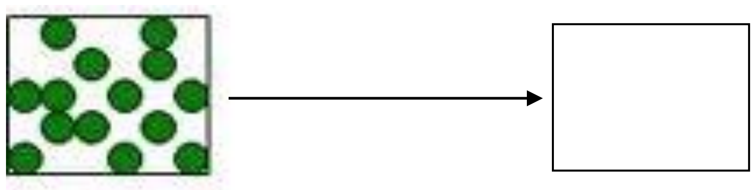
a.Sıvı bir maddenin gaz haline dönüşmesi.

b. Hidrojen ve oksijen moleküllerinden su oluşumu.

c.Kağıdın kesilmesi.

d.Zehirli karbon monoksit gazının oksijenle yanması sonucu karbondioksit oluşumu

a.Sıvı bir maddenin gaz haline dönüşmesi.



SIVI GAZ

1) Maddelerin değişimden sonraki hali tanecik boyutunda nasıl olur? Kendi

tahmininiz nedir? Boş kutucuğa çizerek gösteriniz.

2)Kendi tahmininizi yanınızdaki grup arkadaşlarınızın tahmini ile karşılaştırınız

3)Neden sizin tahmininizin doğru olduğunu arkadaşlarınıza açıklayınız.

4)Arkadaşlarınızla bir karar birliğine ulaşıp son tahmininizi size verilen ekstra çalışma kâğıdına çizin. Şimdi öğretmeninizin size vereceği doğru çizimle karşılaştırın.

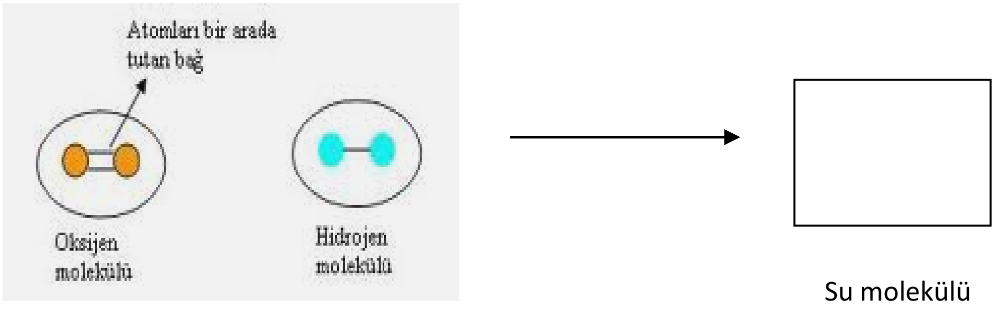
5) Tahmininiz doğru mu? Evet ☐ Hayır ☐

6) Eğer tahmininiz yanlışsa bunu nasıl açıklarsınız?

....

....

b. Hidrojen ve oksijen moleküllerinden su oluşumu.



1) Maddelerin değişimden sonraki hali tanecik boyutunda nasıl olur? Kendi tahmininiz nedir? Boş kutucuğa çizerek gösteriniz.

2)Kendi tahmininizi yanınızdaki grup arkadaşlarınızın tahmini ile karşılaştırınız

3)Neden sizin tahmininizin doğru olduğunu arkadaşlarınıza açıklayınız.

4)Arkadaşlarınızla bir karar birliğine ulaşıp son tahmininizi size verilen ekstra çalışma kâğıdına çizin. Şimdi öğretmeninizin size vereceği doğru çizimle karşılaştırın.

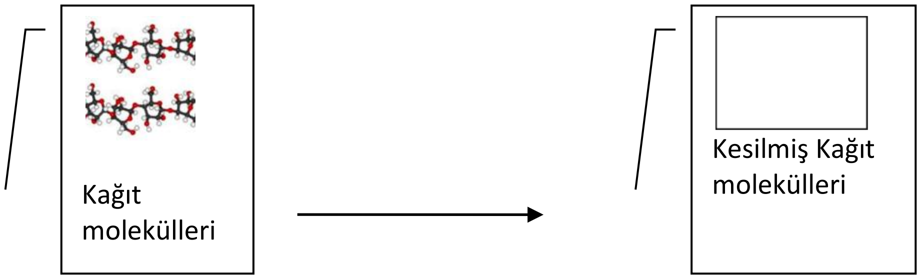
5)Tahmininiz doğru mu? Evet ☐ Hayır ☐

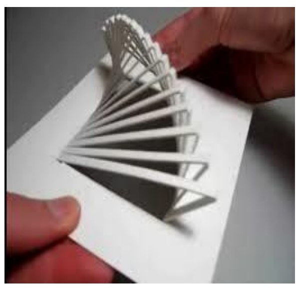
6) Eğer tahmininiz yanlışsa bunu nasıl açıklarsınız?

....

....

c.Kağıdın kesilmesi.





Kağıt

Kesilmiş kağıt

1) Maddelerin değişimden sonraki hali tanecik boyutunda nasıl olur? Kendi

tahmininiz nedir? Boş kutucuğa çizerek gösteriniz.

2)Kendi tahmininizi yanınızdaki grup arkadaşlarınızın tahmini ile karşılaştırınız

3)Neden sizin tahmininizin doğru olduğunu arkadaşlarınıza açıklayınız.

4)Arkadaşlarınızla bir karar birliğine ulaşıp son tahmininizi size verilen ekstra çalışma kâğıdına çizin. Şimdi öğretmeninizin size vereceği doğru çizimle karşılaştırın.

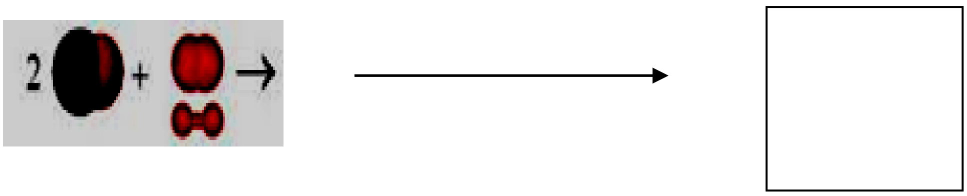
5)Tahmininiz doğru m u? Evet ☐   Hayır ☐

6) Eğer tahmininiz yanlışsa bunu nasıl açıklarsınız ?

....

....

d.Zehirli karbon monoksit gazının oksijenle yanması sonucu karbondioksit oluşumu



Karbonmonoksit+Oksijen   Karbondioksit

1) Maddelerin değişimden sonraki hali tanecik boyutunda nasıl olur? Kendi

tahmininiz nedir? Boş kutucuğa çizerek gösteriniz.

2)Kendi tahmininizi yanınızdaki grup arkadaşlarınızın tahmini ile karşılaştırınız

3)Neden sizin tahmininizin doğru olduğunu arkadaşlarınıza açıklayınız.

4)Arkadaşlarınızla bir karar birliğine ulaşıp son tahmininizi size verilen ekstra çalışma kâğıdına çizin. Şimdi öğretmeninizin size vereceği doğru çizimle karşılaştırın.

5)Tahmininiz doğru mu? Evet ☐ Hayır ☐

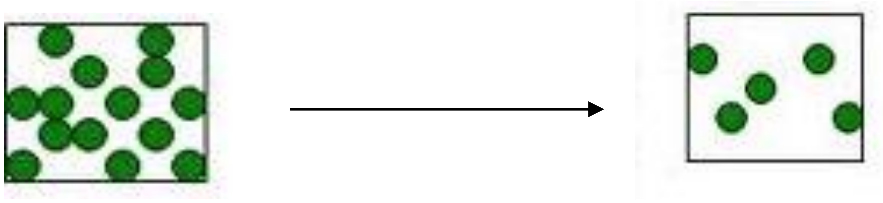
6) Eğer tahmininiz yanlışsa bunu nasıl açıklarsınız ?

....

....

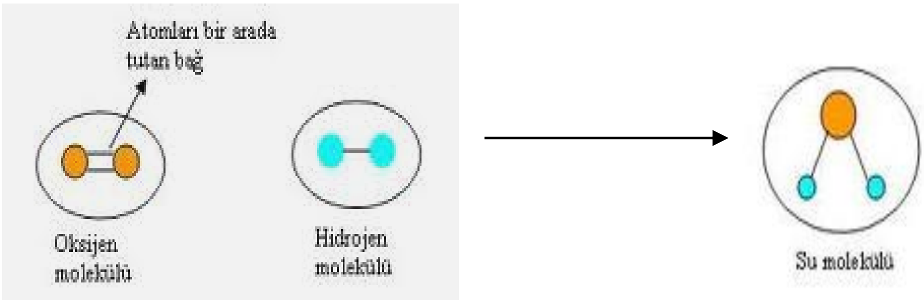
ACTIVITY4.1. DEĞİŞİMLER SONRASI MADDELERİN TANECİK BOYUTUNDA GÖRÜNÜMÜ

a.Sıvı bir maddenin gaz haline dönüşmesi.

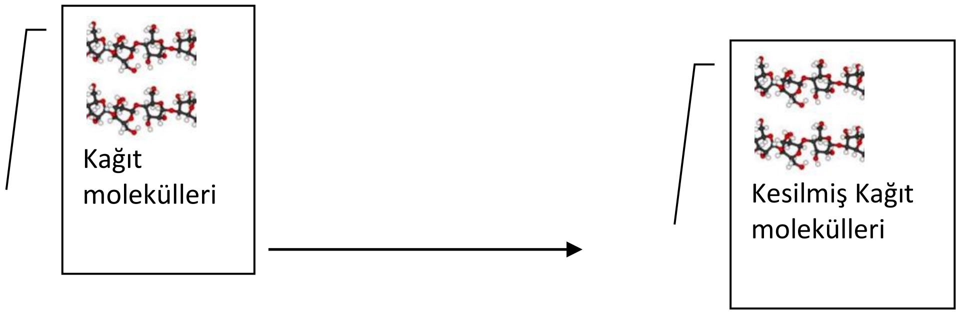


SIVI GAZ

b. Hidrojen ve oksijen moleküllerinden su oluşumu.

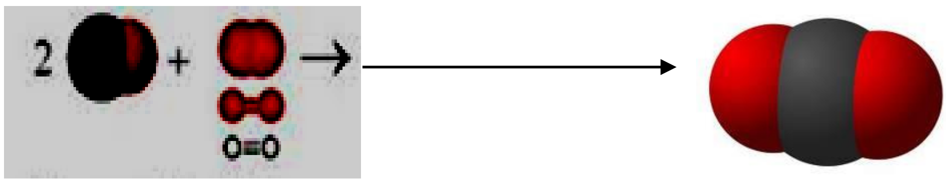


c.Kağıdın kesilmesi.



Kağıt Kesilmiş kağıt

d.Zehirli karbon monoksit gazının oksijenle yanması sonucu karbondioksit oluşumu



Karbonmonoksit+Oksijen Karbondioksit

ACTIVITY 5. SAF MADDE ve KARIŞIM

Saf madde: İçerisinde başka bir madde bulundurmayan maddelerdir. Daha önceden de bildiğiniz gibi elementler ve bileşikler saf maddelerdir. Örnek olarak, su, şeker, demir birer saf maddedir.

Karışım: İki ve ikiden fazla maddenin başka bir maddeye dönüşmeden ya da kendi özelliklerini kaybetmeden bir araya gelmesidir. Çevremizde pek çok karışım vardır. Limonata, salata, tuzlu su birer karışım örnekleridir. Bu örneklerde dikkat ederseniz limonata; şeker ve limon suyundan oluşan, salata; çeşitli sebzelerden oluşan, tuzlu su; tuz ve sudan oluşan karışımlardır. Örnek olarak verilen bu karışımlar en az iki maddenin özelliğini kaybetmeden karışmasıyla oluşmuştur. Bazı karışımlar her yerinde aynı özelliği gösterirken (şeker ve su karışımı gibi), bazıları her yerinde eşit dağılmaz (zeytinyağı ve su karışımı gibi).

Şimdi kendi karışımlarınızı hazırlama zamanı!

A. Öğretmeninizin size vereceği aşağıdaki maddelerden seçim yaparak kendi karışımınızı hazırlayın.

Maddeler:

Demir tozu, kükürt, su, alkol, iyot, tuz.

Araç –gereçler:

Beherglas, cam çubuk, yukarıda verilen maddeler

Hazırlayacağınız karışım için seçtiğiniz maddeleri yazın:

Karışımınızı hazırlayın:

1. **Seçtiğiniz maddeleri beherglasa boşaltın.**
2. **Cam çubuk yardımıyla karıştırın.**

Neler gözlemlediniz?

……

……

………

Çıkardığınız sonuçlar nelerdir?

……

……

………

B. Bu maddelerden yeniden seçim yaparak her yerinde aynı özelliği gösterip, göstermeyeceğini tahmin ettiğiniz yeni karışımlar hazırlayın. Tahmininizi, aşağıdaki tahminimiz cümlelerindeki boşlukları doldurarak yazın.

Tahminimiz :

Öğretmenimizin verdiği maddelerden seçtiğimiz …………………………………….karıştırırsak, bu karışım her yerinde aynı özelliği **göstermeyen** bir karışım olacaktı**r:**

Karışımınızı hazırlayın:

1. Seçtiğiniz maddeleri beherglasa boşaltın.
2. Cam çubuk yardımıyla karıştırın.

Neler gözlemlediniz?

………

………

……

Çıkardığınız sonuçlar nelerdir?

………

………

……

Tahmininiz doğru mu? Evet ☐ **Hayır** ☐

Eğer tahmininiz yanlışsa bunu nasıl açıklarsınız?

………

………

……

Tahminimiz :

Öğretmenimizin verdiği maddelerden seçtiğimiz …………………………………….karıştırırsak, bu karışım her yerinde aynı özelliği **<u>gösteren</u>** bir karışım olacaktır:

Karışımınızı hazırlayın:

1. **Seçtiğiniz maddeleri beherglasa boşaltın.**
2. **Cam çubuk yardımıyla karıştırın.**

Neler gözlemlediniz?

……

……

………

Çıkardığınız sonuçlar nelerdir?

……

……

………

Tahmininiz doğru mu? Evet ☐ **Hayır** ☐

Eğer tahmininiz yanlışsa bunu nasıl açıklarsınız?

……

……

………

ACTIVITY5a. SAF MADDE Mİ KARIŞIM MI?

Aşağıda yazılan maddeler hakkında tartışarak bu maddeler hakkında karışım mı saf madde mi, eğer karışımsa her yerinde aynı özelliği gösteren karışım mı yoksa her yerinde aynı özelliği göstermeyen karışım mı karar verin.

1. Çeşme suyu

Karışımdır çünkü

………

- Her yerinde aynı özelliği gösteren karışımdır çünkü………………………………………………………………
- Her yerinde aynı özelliği göstermeyen karışım çünkü………………………………………………………………

Saf maddedir çünkü……….

2. Hava

Karışımdır çünkü

………

- Her yerinde aynı özelliği gösteren karışımdır çünkü………………………………………………………………
- Her yerinde aynı özelliği göstermeyen karışım çünkü………………………………………………………………

Saf maddedir çünkü……….

3. Karbondioksit gazı

Karışımdır çünkü

………

- Her yerinde aynı özelliği gösteren karışımdır çünkü………………………………………………………………

- Her yerinde aynı özelliği göstermeyen karışım
  çünkü……………………………………………………………

Saf maddedir çünkü…….

4. Şekerli çay
Karışımdır çünkü

………

- Her yerinde aynı özelliği gösteren karışımdır
  çünkü……………………………………………………………
- Her yerinde aynı özelliği göstermeyen karışım
  çünkü……………………………………………………………

Saf maddedir çünkü…….

5. Bakır tel
Karışımdır çünkü

………

- Her yerinde aynı özelliği gösteren karışımdır
  çünkü……………………………………………………………
- Her yerinde aynı özelliği göstermeyen karışım
  çünkü……………………………………………………………

Saf maddedir çünkü…….

6. Ayran
Karışımdır çünkü

………

- Her yerinde aynı özelliği gösteren karışımdır
  çünkü……………………………………………………………

- Her yerinde aynı özelliği göstermeyen karışım
  çünkü……………………………………………………………

Saf maddedir çünkü…….

ACTIVITY 6. "TANECİKLER KARIŞIYOR"

Öğretmeninizin size verdiği kartlardan rastgele seçim yaparak, grup arkadaşlarınızla birlikte aşağıdaki cümlelerdeki boşlukları doldurun.

- ✓ Seçtiğimiz madde **saf madde (bileşik)**t ir.

Delilimiz………

………

Bu delil iddiamı destekler çünkü

………

………

Başka birisi benim iddiamı

………

……………………………………………………………………………………………argümanı ile çürütebilir.

- ✓ Seçtiğimiz madde **saf madde(element)** tir.

Delilimiz………

………

Bu delil iddiamı destekler çünkü

……

……

Başka birisi benim iddiamı

……

……………………………………………………………………………………………argümanı ile çürütebilir.

- ✓ Seçtiğimiz madde **karışımdır**.

Delilimiz………

………

Bu delil iddiamı destekler çünkü

……

……

Başka birisi benim iddiamı

……

…………………………………………………………………………………………………argümanı ile çürütebilir.

- ✓ Seçtiğimiz madde **her yerinde aynı özelliği gösteren karışımdır.**

Delilimiz………

………

Bu delil iddiamı destekler çünkü

……

……..

Başka birisi benim iddiamı

……

……………………………………………………………………………………………argümanı ile çürütebilir.

✓ Seçtiğimiz madde **her yerinde aynı özelliği göstermeyen karışımdır.**

Delilimiz……

....

Bu delil iddiamı destekler çünkü

……

……….

Başka birisi benim iddiamı ………………………………………………………………………………………………

………………………………………………………………………………………………argümanı ile çürütebilir.

APPENDIX B

ARGUMENTTIVENESS SCALE

	Anket Maddeleri	Her zaman	Sık sık	Bazen	Nadiren	Hiçbir zaman
1	Bir tartışmada, tartıştığım kişinin benim hakkımda olumsuz bir izlenime kapılmasından endişe duyarım					
2	Çekişmeli konularda tartışmak zekamı geliştirir.					
3	Tartışmalardan uzak durmayı severim.					
4	Bir konuyla ilgili tartışırken çok istekli olurum ve kendimi enerji dolu hissederim.					
5	Bir tartışmayı bitirdiğim zaman, bir daha başka bir tartışmaya girmeyeceğime kendi kendime söz veririm					
6	Bir kişiyle tartışmak, benim için çözümden çok problemler yaratır.					
7	Bir tartışmayı kazandığım zaman, güzel duygular hissederim.					
8	Biriyle tartışmayı bitirdiğim zaman, kendimi sinirli ve üzgün hissederim.					
9	Çekişmeli bir konu hakkında iyi bir tartışma yapmaktan hoşlanırım					
10	Bir tartışma içerisine gireceğimi anladığım zaman, hoş olmayan duygular hissederim					
11	Bir konu hakkında fikrimi savunmaktan zevk alırım					
12	Tartışma meydana getirecek bir olayı engellediğim zaman mutlu olurum					
13	Çekişmeli bir konuda tartışma fırsatını kaçırmak istemem.					
14	Benimle aynı düşüncede olmayan insanlarla bir arada olmayı çok istemem.					
15	Tartışmayı heyecan verici, karşı koyma ve zihinsel bir olay olarak algılarım.					
16	Bir tartışma sırasında etkili fikirleri kendi kendime üretemem.					
17	Çekişmeli bir konuda tartıştıktan sonra kendimi yeniden canlanmış ve mutlu hissederim.					
18	Bir tartışmayı iyi bir şekilde yapacak yeteneğe sahibim.					
19	Bir tartışma içerisine çekilmekten uzak durmaya çalışırım.					
20	Bir konuşmamın tartışmaya dönüşeceğini hissettiğim zaman çok heyecanlanırım.					

Sevgili öğrenciler,

Bu anket, sizlerin tartışmaya ne kadar istekli (yakın) ve uzak olduğunuzu belirlemek amacıyla oluşturulmuştur. Ankette 20 madde verilmiştir. Maddeleri dikkatlice okuduktan sonra, verilen seçeneklerden size en uygun gelen seçeneği **X** işareti kullanarak işaretleyin. Bu anketteki soruların doğru veya yanlış cevapları yoktur. Ayrıca, anket sonuçlarınız okul idaresine, öğretmenlerinize veya ailenize verilmeyecektir. Cevaplarınızda dürüst ve içten olmanız, çalışmanın amacı için çok önemlidir. Bilimsel bir çalışmaya katkıda bulunduğunuz için teşekkür ederim.

APPENDIX C

SCIENCE ATTITUDE SCALE

Adı: Soyadı:

Sınıfı:

Sevgili öğrenciler,

		Tamamen katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç katılmıyorum
1	Fen bilgisi çok sevdiğim bir alandır.					
2	Fen bilgisi ile ilgili kitapları okumaktan hoşlanırım.					
3	Fen bilgisinin günlük yaşantıda çok önemli yeri vardır.					
4	Fen bilgisi ile ilgili ders problemleri çözmekten hoşlanırım.					
5	Fen bilgisi konuları ile ilgili daha çok şey öğrenmek isterim.					
6	Fen bilgisi dersine girerken sıkıntı duyarım.					
7	Fen bilgisi çevremizdeki doğal olayların daha iyi anlaşılmasında önemlidir.					
8	Fen bilgisi dersine ayrılan ders saatlerinin daha fazla olmasını isterim.					
9	Fen bilgisi dersine çalışırken canım sıkılır.					
10	Fen bilgisi konularını ilgilendiren günlük olaylar hakkında daha fazla bilgi edinmek isterim.					
11	Düşünce sistemimizi geliştirmede fen bilgisi dersi önemlidir.					
12	Fen bilgisi dersine zevkle girerim.					
13	Dersler içinde fen bilgisi dersi sevimsiz gelir.					
14	Fen bilgisi konuları ile ilgili tartışmaya katılmak bana cazip gelmez.					
15	Çalışma zamanımın önemli bir kısmını fen bilgisi dersine ayırmak isterim.					

Bu anket, sizlerin fen bilgisi dersi ile ilgili tutumunuzu ölçmek amacıyla yapılmaktadır. Ankette 15 madde verilmiştir. Maddeleri dikkatlice okuduktan sonra, verilen seçeneklerden size en uygun gelen seçeneği **X** işareti kullanarak işaretleyin. Bu anketteki soruların doğru veya yanlış cevapları yoktur. Ayrıca, anket sonuçlarınız okul idaresine, öğretmenlerinize veya ailenize verilmeyecektir. Cevaplarınızda dürüst ve içten olmanız, çalışmanın amacı için çok önemlidir. Bilimsel bir çalışmaya katkıda bulunduğunuz için teşekkür ederim.

APPENDIX D

PHYSICAL AND CHEMICAL CHANGE CONCEPT TEST

1. Aşağıda bazı değişimler gösterilmiştir. Bunlardan hangisi fiziksel değişmeye örnektir?

a.Küp Şeker ⟶ Meyve suyuna batırılmış küp şeker

b. Kek hamuru ⟶ Pişmiş Kek

c. Mum ⟶ Yanan mum

d. Portakal ⟶ Küflenmiş portakal

2. Aşağıdaki değişimlerden hangisi kimyasal değişmeye örnektir?

a. Buz ⟶ Su

b. Portakal ⟶ Kesilmiş Portakal

c. Çiğ Yumurta ⟶ Pişmiş yumurta

d. Su ⟶ Mürekkep karıştırılmış su

3. Bir öğretmen tebeşiri ezerek toz haline getiriyor. Daha sonra yanında getirdiği kibriti yakıyor. Öğrencilerden maddedeki değişim ile ilgili örnek gösterdiği bu iki ayrı olayı tartışmalarını istiyor.

Ali: Tebeşirin toz haline gelmesi sırasında maddenin yalnızca dış görünüşü değişmiştir. Bu değişim bir fiziksel değişimdir. Kibritin yanmasında da maddenin dış görünüşü değiştiği için bu değişimde bir fiziksel değişimdir.

Ayşe: Hayır! Tebeşirin toz haline gelmesi sırasında tanecikler bundan etkilenir. Bu değişim kimyasal bir değişimdir. Ancak kibritin yanmasında tanecikler etkilenmediği için bu değişim bir fiziksel değişimdir.

Ahmet: Ayşe'ye katılmıyorum çünkü tanecikler değişseydi kibritin yanması olayında olduğu gibi madde başka bir maddeye dönüşürdü. Bu fiziksel bir değişimdir. Kibritin yanmasında maddenin içyapısı değişmiştir. Bu yüzden bu değişim de bir kimyasal değişimdir

Öğrencilerden hangisi ya da hangilerinin söylediği doğrudur?

a. Ali b.Ahmet c. Ayşe d. Ali ve Ahmet

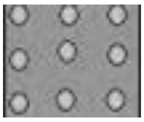
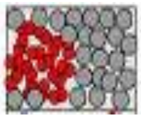
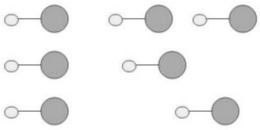
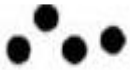
4.Mevsimler değiştiğinde yeşil yaprakların solması ve çürümesi kimyasal bir değişimdir.

Aşağıdaki ifadelerden hangisi yukarıdaki olayın kimyasal değişim olduğunu doğru açıklar.

a. Değişim yaprakların dış görünüşündedir.
b. Değişim sonucu yapraklar değişerek başka bir maddeye dönüşmüştür.
c. Değişim sonucu yaprakların rengi değişmiştir.
d. Değişim sonucu yapraklar daha dayanıksız hale gelmiştir.

5. Aşağıda bazı maddelerin tanecik modelleri verilmiştir. Bir öğrenci bu maddelerin tanecik modellerine bakarak maddelerin saf madde mi karışım mı olduğuna karar veriyor. Öğrencinin hangi seçimi sizce <u>yanlıştır</u>.

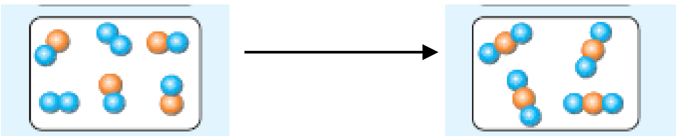
a. b. c. d.

			
Saf madde	**Karışım**	**Karışım**	**Saf madde**

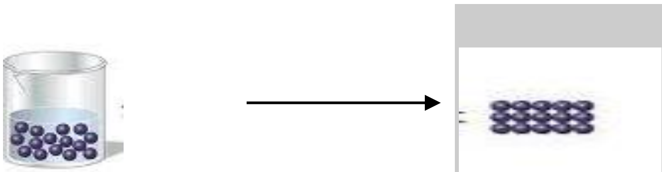
6.Aşağıda maddelerin tanecik modelleri kullanılarak bazı değişim örnekleri veriliyor.

Hangisi fiziksel değişime bir örnek olabilir?

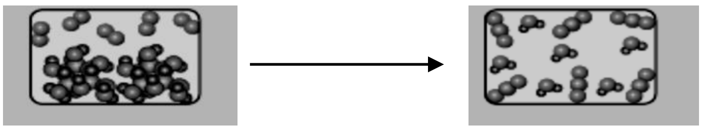
a.

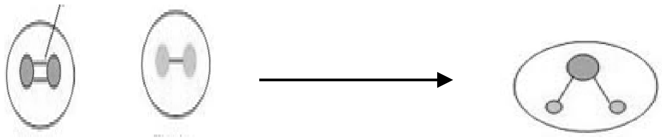


b.



c.



d. 

7. Filiz, iki ayrı saf madde olan saf etil alkol ve saf iyodu kullanarak bir karışım hazırlıyor.

Pınar, şekerli su ile demir tozunu karıştırarak bir karışım hazırlıyor.

Filiz ve Pınar'ın hazırladığı bu karışımlarla ilgili olarak hangisi söylenebilir?

a. Karışımı oluşturan maddeler yeni bir maddeye dönüşür.

b. Saf maddeler karışım oluşturduğunda oluşan bu yeni karışımda bir saf maddedir.

c.Saf olmayan maddeler karışımı oluşturamaz.

d. Saf maddeler bir araya gelerek karışımı oluşturabilir.

8. Aşağıda saf maddeler ile ilgili bazı yorumlar verilmiştir. Hangisi yanlıştır.

a. Hava bir saf madde değildir çünkü içerisinde solunumu sağlayan oksijen, yada çevreyi kirleten karbon monoksit gibi farklı gazlar bulunur.

b.Oksijen gazı bir saf maddedir çünkü yapısında sadece oksijen atomları bulunur.

c. Meyve suyu saf maddedir çünkü her yerinde aynı özelliği gösteren bir sıvıdır.

d. Salata saf madde değildir çünkü farklı sebzelerin karıştırılmasıyla oluşur.

9. Aşağıdakilerden hangisi bir karışımdır?

a. Oksijen gazı

b. Şeker molekülü

c. Hidrojen gazı ve oksijen gazından oluşan su molekülü

d.Çeşitli gazlardan oluşan hava.

10. Aşağıdakilerden hangisi doğrudur?

a. Fiziksel değişim olayı sonucu değişen madde eski haline geri dönemez.

b. Kimyasal değişim olayı sonucu değişen maddenin eski haline geri dönmesi zordur.

c. Hem fiziksel değişim hem de kimyasal değişim sonucu değişen madde eski haline geri kesinlikle dönemez.

d. Hem fiziksel değişim hem de kimyasal değişim sonucu değişen madde eski haline kesinlikle geri dönebilir.

11. Eğer bir kimyasal maddenin sadece dış görünüşü değişiyorsa, bu değişim bir

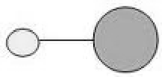
a. Kimyasal değişimdir b. Fiziksel değişimdir c.Hal değişimidir. d.Hiçbiri.

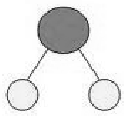
12.Eğer bir kimyasal madde değişerek başka bir maddeye/maddelere dönüşüyorsa, bu değişim bir

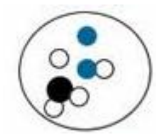
a.Fiziksel değişimdir. b.Hal değişimidir.

c.Karışımdır. d.Kimyasal değişimdir.

13. **Aynı cins atomlardan oluşmuş saf maddelere aşağıdakilerden hangisi model olabilir?**

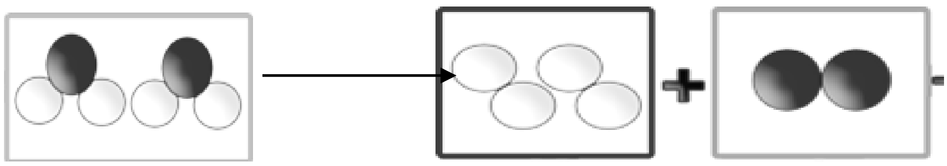
a. 

b. 

c. 

d. 

14.



Su molekülü Hidrojen elementi Oksijen elementi

Şekilde su molekülün elementlerine ayrılması gösterilmiştir.

Buna göre aşağıdakilerden hangisi <u>söylenemez</u>?

a. Bu bir fiziksel değişimdir.

b. Her üç madde de saf maddedir.

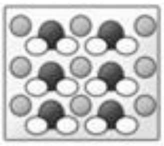
c.Hidrojen ve Oksijen elementi molekül yapılı elementtir.

d. Su bir bileşiktir.

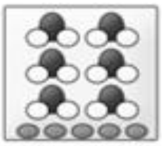
15. Öğretmenlerinin verdiği karışımlardan, Selin her yerinde aynı özelliği gösteren bir tür karışım hazırlıyor. Meltem ise; her yerinde aynı özelliği göstermeyen bir tür karışım hazırlıyor.

Selin ve Meltem'in hazırladığı karışımların model gösterimi eşleştirildiğinde hangisi <u>yanlış olur?</u>

a.Selin

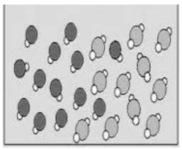


b. Meltem

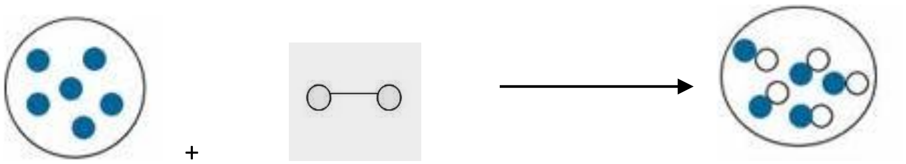


c. Selin

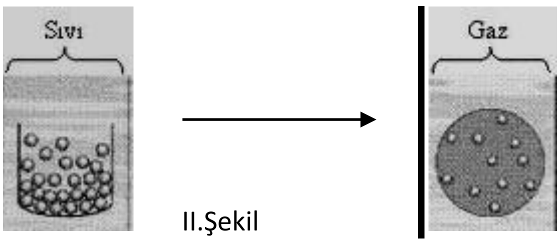
d.Meltem



16.



I.Şekil



II.Şekil

I. ve II. şekillerdeki maddelerin durumları modellerle gösterilmiştir.

Şekillerdeki modeller ile ilgili olarak aşağıdaki ifadelerden hangisi <u>yanlıştır</u>?

a. I. şekildeki maddeler kimyasal değişime uğramıştır.

b. II. şekildeki maddenin kimliği değişmiştir.

c. II. şekildeki maddenin sadece görüntüsü değişmiştir.

d. I. şekilde bileşik oluşumu gösterilmiştir