EFFECTIVENESS OF CONTEXT BASED INSTRUCTION ON 10TH GRADE STUDENTS' UNDERSTANDING OF FOSSIL FUELS AND CLEAN ENERGY RESOURCES TOPICS AND THEIR ATTITUDES TOWARD ENVIRONMENT

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ABSTRACT

EFFECTIVENESS OF CONTEXT BASED INSTRUCTION ON 10TH GRADE STUDENTS' UNDERSTANDING OF FOSSIL FUELS AND CLEAN ENERGY RESOURCES TOPICS AND THEIR ATTITUDES TOWARD ENVIRONMENT

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The purpose of the this study was to investigate the effectiveness of context-based instruction as compared to the traditional instruction on 10th grade high school students' understanding of fossil fuels and clean energy resources topics and their attitudes toward environment. The effect of school type was also investigated. A quasi-experimental pre-test-post-test control group research design was used for that purpose. A total number of 113 10th grade students of two different types of high schools were the participants of the study. Experimental group students were instructed with context-based instruction whereas control group students were instructed with traditional instruction through six weeks. Fossil Fuels and Clean Energy Resources Achievement Test and Attitude toward Environment Scale were used as pre-tests and post-tests in the experimental and control groups. Student Questionnaire about Context Based Instruction was used as a post-test in the

experimental group. Furthermore, Science Process Skills Test was used as a pre-test in both groups. In statistical analysis MANCOVA was conducted and the main effects of treatments, school types, and their interaction effects were investigated. The results showed that in comparison to the traditional instruction, the context-based instruction was superior on students' achievement and attitudes toward environment. The interaction effects between treatment and school type were significant for attitudes toward environment but not significant for achievement. A significant school type difference was not found.

Keywords: Context-Based Instruction, Chemistry Education, Fossil Fuels and Clean Energy Resources, Attitudes toward Environment, School Type

ÖZ

BAĞLAM TEMELLİ ÖĞRETİMİN 10. SINIF ÖĞRENCİLERİNİN FOSİL YAKITLAR VE TEMİZ ENERJİ KAYNAKLARI KONUSUNU ANLAMALARINA VE ÇEVREYE YÖNELİK TUTUMLARINA ETKİSİNİN ARAŞTIRILMASI

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Bu çalışmanın amacı bağlam temelli öğretimin geleneksel öğretime göre 10. sınıf öğrencilerinin fosil yakıtlar ve temiz enerji kaynakları konusundaki başarısına ve çevreye karşı tutumlarına olan etkisini araştırmaktır. Okul türünün etkisinin de araştırıldığı bu araştırmada yarı deneysel ön-test son-test kontrol gruplu araştırma deseni kullanılmıştır. Araştırmaya iki farklı liseden toplam 113 10. sınıf öğrencisi katılmıştır. Altı hafta süre ile deney grubunda bağlam temelli öğretim, kontrol grubunda ise geleneksel öğretim uygulanmıştır. Fosil Yakıtlar ve Temiz Enerji Kaynakları Başarı Testi ve Çevre Tutum Anketi deney ve kontrol gruplarında ön-test ve son-test olarak uygulanmıştır. Bağlam Temelli Öğrenme Hakkındaki Öğrenci Görüş Anketi sadece deney grubunda son-test olarak uygulanmıştır; ayrıca Bilimsel İşlem Becerileri Testi her iki grupta da ön-test olarak uygulanmıştır. Ortak Dağılımın Çok Değişkenli Analizi (MANCOVA) istatistiksel yöntemi kullanılarak veriler

analiz edilmiştir. Öğretim metotlarının ve okul türünün ana etkileri, bununla birlikte bu bağımsız değişkenlerin etkileşimleri de araştırılmıştır. Elde edilen sonuçlar bağlam temelli öğretimin geleneksel öğretime göre öğrencilerin başarısında ve çevreye yönelik tutumlarında daha üstün olduğunu göstermiştir. Öğretim metodu ve okul türünün etkileşimleri öğrencilerin çevreye yönelik tutumları üzerinde istatistiksel olarak anlamlıdır; ancak öğrencilerin başarısı üzerinde istatistiksel olarak anlamlı değildir. Okul türü arasında istatistiksel olarak anlamlı bir farkı bulunamamıştır.

Anahtar Kelimeler: Bağlam Temelli Öğretim, Kimya Eğitimi, Fosil Yakıtlar ve Temiz Enerji Kaynakları, Çevreye Karşı Tutum, Okul Türü

To my lovely wife, Naz

&

To my lovely son, İbrahim

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LIST OF ABBREVIATIONS

ANCOVA	: Analyses of Covariance
ATES	: Attitude Toward Environment Scale
CBI	: Context-Based Instruction
CHEAKS	: Children's Environmental Attitude and Knowledge Scale
ChemCom	: Chemistry in the Community
CiC	: Chemistry in Context
ChiK	: Chemie in Kontext
ChiP	: Chemistry in Practice
df.	: Degree of Freedom
F	: Fisher's F distribution
FCEAT	: Fossil Fuels and Clean Energy Resources Achievement Test
MANCOVA	: Multivariate Analysis of Covariance
N	: Number of Subjects
PASW	: Predictive Analytics Software
REACT	: Relating, Experiencing, Applying, Cooperating, Transferring
Sig.	: Significance
SPST	: Science Process Skills Test
SQCBI	: Student Questionnaire about Context Based Instruction
TI	: Traditional Instruction
USA	: United States of America
UK	: United Kingdom

CHAPTER 1

INTRODUCTION

Science education is very important for almost every moment of our daily lives and has crucial effects on people's quality of lives, health, life styles and environment. In solving the problems about political, social and economic issues as individuals and societies, we need the guidance of science and we can only make informed decisions about those problems through understanding science. However, there have been a lot of problems about science education in the world. To illustrate, over-load of curricula, insufficient and poor teacher training programs, assessment problems, lack of resources and technological devices and ineffective way of instructions are some of the problems about science education. Among those problems mentioned above, the present study mainly focused on the method of instruction since it seems likely that the method of instruction affects the whole education process and constitutes the fundamental of teaching and learning.

Even though the world changes rapidly, the changes in the pedagogical approaches that are used in chemistry education have been few in the recent decades (King, 2012). In general, the traditional chemistry instructions have been in practice in chemistry classes in the world. However, in the last decades a new instructional approach to chemistry education has been put into practice in some countries which is called as 'context-based approach'. According to King (2012), it is the context-based approach when there is 'an application of the chemistry to real world situation' in the center of chemistry teaching. In this way, the instruction will be grounded on a 'need-to-know' basis, which means that students need to learn the concepts of chemistry in order to gain the perception of real world situations.

The students often questions how to use the concepts of chemistry they learned in their daily lives and the need to learn the subjects of chemistry. If they cannot find the answers to these questions, their motivations and attitudes toward chemistry decrease, which gives rise to some problems in the educational process. Therefore, the method of instruction as well as the curricula should satisfy these questions of students.

Gutwill-Wise (1991) states that there are a lot of weaknesses of traditional science education, especially when students try to establish a connection between science and real life problems. Similarly, according to Whitelegg and Parry (1999), science is taught in school as if it is something abstracted from the real world and it is something out of our lives. Including active student engagement via student-centered activities, context-based instruction is an effective way of instruction, and meaningful learning can be obtained in this way. In context-based instruction, the main point is concentrating on current issues and permitting students to apply the skills that they learn at schools to their daily lives as well as fostering them deeper understandings about concepts of scientific principles (Winther & Volk, 1994; Yager, 2007; Lee, 2010). The curriculum for context-based instruction was defined by Kortland (2007) as "practical applications and/or socio-scientific issues act as a starter for the teaching-learning of science in an attempt to bridge the gap between the often abstract and difficult science concepts and the world the students live in" (p.1). Therefore, since real-life contexts are used in context-based instruction, the replies to students' questions about where they will use and why they should learn the chemistry topics can be given. Through context-based instruction, it is expected that students are aided to understand the usefulness and close relevance of what they are taught (Bennett, Lubben &Hogarth, 2006). Furthermore, if students understand the usefulness and relevance of what they are taught, this will probably affect the students' affective variables such as attitudes and motivations toward chemistry in a positive manner in that it results in improving deeper understanding in chemistry and higher engagement in activities (Bennett, Lubben &Hogarth, 2006). According to King (2012), context-based chemistry instruction aims "to improve student interest

and motivation in chemistry by connecting canonical chemistry concepts with real-world contexts". There are five high scale programmes that used context-based chemistry instruction in the last two decades all across the world. The main and the common point of those programs concerning the units in curricula is to begin with a context. Five programmes were applied in five different countries whose education systems were completely different from one another. These programs are Chemistry in Context in the USA, Salters in the UK, Chemie im Kontext in Germany, Chemistry in Practice in the Netherlands and Industrial Science in Israel (King, 2012).

In the research area, we confront with two main problems. The first one is the lack of systematic researches about the implementations of context-based instruction (Taasoobshirazi & Carr, 2008) whereas the second one is the ambiguity in research results about the effectiveness of context-based instruction on both students' understandings of science and their affective reactions to science (Bennett et al., 2006; Taasoobshirazi & Carr, 2008). The previous research studies do not agree on the idea that the context-based instruction is an effective way of teaching and improves students' affective variables positively; instead they present completely different results that oppose to one another. Medrich, Calderon and Hoachlander (2003) explains this situation by establishing two reasons which are failing to implement carefully designed context-based studies due to the need of great efforts as well as great budget, and failing to include control groups or pre-tests. This ambiguity in the literature makes the present study important in that it not only involves a control group and pre-tests and also grounds its conclusions on statistical procedures.

In the recent decades, researchers are highly interested in context-based instruction and there are a lot of research studies on this research area. Due to the increasing interest of the researchers and the ambiguity in previous studies, the findings of the present study are important for determining the effectiveness of context-based instruction on students' understandings of chemistry topics. However, there have not

been many studies conducted in Turkish context enlightening the effectiveness of context-based instruction. Therefore, the main purpose of the present study was to investigate the effectiveness of context-based instruction on tenth grade high school students' understanding of fossil fuels and clean energy resources topics and their attitudes toward environment.

The present study is significant in regards to several aspects such as its design, its variables, the topics it includes, evidence obtained for the effectiveness of instructional method used and for chemistry teachers, curriculum designers and policy makers. In the next paragraphs the explanations and the justification for the significance of the study was briefly discussed.

First of all the present research study includes a design for context-based instruction, experimental and control groups, comparison of two instructional methods which are traditional instruction and context-based instruction, pre-tests that assess students' knowledge about chemistry topics and their attitudes toward environment and findings supported by statistical analyses. Considering the ambiguous findings of the previous research studies in the literature as Taasoobshirazi and Carr (2008) indicated, due to the fact that they do not include pre-tests and control groups as well as carelessly designs for context-based instruction (Medrich, Calderon & Hoachlander, 2003), the importance of this study can be appraised. Furthermore, this study is a well-designed experimental research since students' prior knowledge on the subject matters and prior attitudes toward environment and their science process skills were controlled statistically to equalize the groups. Moreover, this study is significant in that it focuses on two dependent variables which are chemistry achievement and attitudes toward environment. By the help of the instruction method applied, students are expected to improve their chemistry achievement because they will understand that chemistry concepts are closely related to their daily lives.

The topics taught in this study were fossil fuels and clean energy resources. In Turkey, it is the first time that these topics have been taught in high school chemistry

lessons and included in the new curriculum. These topics are very important for our daily and social lives as well as the environment because students will be aware of how energy is obtained and consumed, how they affect our life, what the alternative energy resources are and how these resources affect the environment. Besides, students will gain a deep understanding about the advantages and disadvantages of fossil fuels and they will have an opportunity to compare different energy resources and also understand how energy is important for daily life for both individuals and societies. Moreover, there have not any researches conducted including these topics in the literature. Therefore, the fossil fuels and clean energy resources topics make this study significant.

Furthermore, this study is significant because research studies about context-based approach are not widely conducted in Turkey and the materials developed in the study can be considered as an example for the context-based instruction which is an effective instructional method. Besides, the evidence for the effectiveness of this instructional method is provided by this study in Turkish context.

The present study is also significant for chemistry teachers, curriculum designers and national education policy makers as well. The study offers a set of materials for chemistry teachers to use in the chemistry classrooms besides presenting a detailed information for curriculum designers and national education policy makers about context-based instruction and the implementation of it in high school chemistry education. Moreover, this study will also set a basis to discuss the advantages and disadvantages of context-based instruction.

1.1. Definition of Important Terms

The important terms used in the present study are traditional instruction, context-based instruction, attitude and achievement. These terms are briefly explained as follows.

- *Traditional instruction*

Traditional instruction is a teacher-centered instruction in which teacher uses direct-lecturing method with few or no demonstrations and discussions resulting in factual memorization rather than an improvement of higher order thinking skills. It was defined by Taasoobshirazi and Carr (2008) as "business as usual" in the classroom.

- *Context-based instruction*

Context-based instruction is a student-centered instruction in which teacher uses real-life contexts as a starting point and encourages students to learn via establishing connections between real life and scientific principles and applications resulting in an improvement of higher order thinking skills rather than factual memorization.

- *Attitude*

"An attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 1993).
"Attitudes are the feelings, beliefs and values held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves" (Osborne, Simon & Collins, 2003, p.1053).
"Attitudes are internal beliefs that influence personal actions and that reflect characteristics such as generosity, honesty, and commitment to healthy living" (Schunk, 2008, p.287).

- *Achievement*

Achievement is the measurement of accomplishing the aims of the course by endeavors.

1.2. Problems and Hypotheses

In this section, the main problems, sub-problems and hypotheses of the research study will be presented.

1.2.1. The Main Problems and Sub-problems

Three main problems and six sub-problems of the present study are as follows.

1.2.1.1. The Main Problems

Main Problem (1)

Do methods of instruction (context-based instruction versus traditional instruction) make difference on the collective dependent variables (Fossil Fuels and Clean Energy Resources Achievement post-test scores and Attitudes toward Environment post-test scores) of tenth grade high school students when the effects of Science Process Skills test scores, Fossil Fuels and Clean Energy Resources Achievement pre-test scores and Attitudes toward Environment pre-test scores are controlled?

Main Problem (2)

Do Anatolian and vocational tenth grade high school students differ on the collective dependent variables (Fossil Fuels and Clean Energy Resources Achievement post-test scores and Attitudes toward Environment post-test scores) when the effects of Science Process Skills test scores, Fossil Fuels and Clean Energy Resources Achievement pre-test scores and Attitudes toward Environment pre-test scores are controlled?

Main Problem (3)

Is there any interaction between method of instruction and school type on the collective dependent variables (Fossil Fuels and Clean Energy Resources Achievement post-test scores and Attitudes toward Environment post-test scores) of tenth grade high school students when the effects of Science Process Skills test scores, Fossil Fuels and Clean Energy Resources Achievement pre-test scores and Attitudes toward Environment pre-test scores are controlled?

1.2.1.2. The Sub-problems

Sub-problem (1)

Do methods of instruction (context-based instruction versus traditional instruction) make difference on tenth grade high school students' conceptual understanding of fossil fuels and clean energy resources topics when the effects of Science Process Skills test scores, Fossil Fuels and Clean Energy Resources Achievement pre-test scores and Attitudes toward Environment pre-test scores are controlled?

Sub-problem (2)

Do methods of instruction (context-based instruction versus traditional instruction) make difference on tenth grade high school students' attitudes toward environment when the effects of Science Process Skills test scores, Fossil Fuels and Clean Energy Resources Achievement pre-test scores and Attitudes toward Environment pre-test scores are controlled?

Sub-problem (3)

Do Anatolian and vocational tenth grade high school students differ on their conceptual understanding of fossil fuels and clean energy resources topics when the effects of Science Process Skills test scores, Fossil Fuels and Clean Energy Resources Achievement pre-test scores and Attitudes toward Environment pre-test scores are controlled?

Sub-problem (4)

Do Anatolian and vocational tenth grade high school students differ on their attitudes toward environment when the effects of Science Process Skills test scores, Fossil Fuels and Clean Energy Resources Achievement pre-test scores and Attitudes toward Environment pre-test scores are controlled?

Sub-problem (5)

Is there any interaction between method of instruction and school type on tenth grade high school students' conceptual understanding of fossil fuels and clean energy resources topics when the effects of Science Process Skills test scores, Fossil Fuels and Clean Energy Resources Achievement pre-test scores and Attitudes toward Environment pre-test scores are controlled?

Sub-problem (6)

Is there any interaction between method of instruction and school type on tenth grade high school students' attitudes toward environment when the effects of Science Process Skills test scores, Fossil Fuels and Clean Energy Resources Achievement pre-test scores and Attitudes toward Environment pre-test scores are controlled?

1.2.2. Hypotheses

$H_0$1: There is no statistically significant overall effect of the instruction methods taking into account context-based instruction and traditional instruction on the population mean of the collective dependent variables of tenth grade high school students' post-test scores of fossil fuels and clean energy resources topics and attitudes toward environment when the effects of Science Process Skills test scores, Fossil Fuels and Clean Energy Resources Achievement pre-test scores and Attitudes toward Environment pre-test scores are controlled.

$H_0$2: There is no statistically significant mean difference between Anatolian and vocational high school students on the population means of the collective dependent variables of tenth grade students' post-test scores of Fossil Fuels and Clean Energy Resources Achievement test and attitudes toward environment when the pre-test scores of science process skills test scores, Fossil Fuels and Clean Energy Resources Achievement test scores and Attitudes toward Environment test scores are controlled.

$H_0$3: There is no statistically significant interaction between method of instruction and school type on the population means of collective dependent variables of tenth grade students' Fossil Fuels and Clean Energy Resources Achievement post-test scores and Attitudes toward Environment post-test scores when the pre-test scores of science process skills test scores, Fossil Fuels and Clean Energy Resources Achievement test scores and Attitudes toward Environment test scores are controlled.

$H_0$4: There is no statistically significant difference between the post-test mean scores of tenth grade high school students taught via context-based instruction and who taught via traditional instruction on the population means of Fossil Fuels and Clean Energy Resources Achievement post-test scores when the pre-test scores of science process skills test scores, Fossil Fuels and Clean Energy Resources Achievement test scores and Attitudes toward Environment test scores are controlled.

$H_0$5: There is no statistically significant difference on the post-test mean scores between Anatolian and vocational tenth grade high school students' understanding of fossil fuels and clean energy resources topics when the pre-test scores of science process skills test scores, Fossil Fuels and Clean Energy Resources Achievement test scores and Attitudes toward Environment test scores are controlled.

$H_0$6: There is no statistically significant interaction between method of instruction and school type on tenth grade high school students' conceptual understanding of fossil fuels and clean energy resources topics when the effects of Science Process Skills test scores, Fossil Fuels and Clean Energy Resources Achievement pre-test scores and Attitudes toward Environment pre-test scores are controlled?

$H_0$7: There is no statistically significant difference between the post-test mean scores of tenth grade high school students taught via context-based instruction and who taught via traditional instruction on the population means of Attitudes toward Environment post-test scores when the pre-test scores of science process skills test scores, Fossil Fuels and Clean Energy Resources Achievement test scores and Attitudes toward Environment test scores are controlled.

$H_0$8: There is no statistically significant difference on the post-test mean scores between Anatolian and vocational tenth grade high school students' attitudes toward environment when the pre-test scores of science process skills test scores, Fossil Fuels and Clean Energy Resources Achievement test scores and Attitudes toward Environment test scores are controlled.

$H_0$9: There is no statistically significant interaction between method of instruction and school type on tenth grade high school students' attitudes toward environment when the pre-test scores of Science Process Skills test scores, Fossil Fuels and Clean Energy Resources Achievement test scores and Attitudes toward Environment test scores are controlled?

CHAPTER 2

REVIEW OF RELATED LITERATURE

This chapter includes five sections. In the first section the meaning of context-based instruction tried to be enlightened. Afterwards, the theories lying behind of context-based instruction are presented. In the third section, the curriculum projects that adopted context-based instruction are briefly summarized. In the following section, international and national research studies about context-based instruction are presented. The last section of the chapter reviews the affective variable of the study which is attitude toward environment.

2.1. The Meaning of Context-Based Approach

As a starting point, the meaning of the term 'context' will be clarified. Collins Essential English Dictionary (1990) gives a definition for the term as "the context of an idea or event is the general information about the time, place, and the situation in which it occurred, which you need to know in order to understand it fully". Pearsall (1999) states the everyday meaning of the word as "the parts that immediately precede or follow a word or passage and clarify its meaning". The origin of the word comes from Latin language in the verb "contexere" which means to weave together and in the noun form "contextus" means coherence, connection, and relationship (Gilbert, 2006). Therefore, a context should provide a 'coherent structural meaning' for a new thing which is established at a comprehensive framework (Gilbert, 2006). Besides, Bennett et al. (2005) stated that a context means a social and cultural environment where students, teachers and institutions take part. In the chemistry education field, the use of contexts is parallel to the aforementioned descriptions,

where the chemistry learning is a meaningful thing for students and a connection is established between chemistry and students' daily lives (Gilbert, 2006). Duranti and Goodwin (1992) mentions four characteristics of an educational context;

> a. a setting, a social, spatial, and temporal framework within which mental encounters with focal events are situated;
> b. a behavioural environment of the encounters, the way that the task(s), related to the focal event, have been addressed, is used to frame the talk that then takes place;
> c. the use of specific language, as the talk associated with the focal event that takes place;
> d. a relationship to extra-situational background knowledge (Duranti & Goodwin, 1992, pp. 6-8)

In the literature, there are several similar terms used, which are "contextual approach", "context-led approach", "context-based approach", "contextualized approach", "context-based teaching", "context-based learning" (Bennett & Lubben, 2006; Holman & Pilling, 2004; Gilbert, 2006), contextual teaching, contextual learning and context-based education. Researchers made several definitions about these related terms and in this section, appropriate ones will be briefly explained. In a broader context, context-based approach is evaluated as an instructional method which tries to establish a connection between the subject matter and students' daily lives. Medrich, Calderon & Hoachlander (2002, defines contextual teaching and learning as;

> "a conception of teaching and learning that helps teachers relate subject matter to real world situations; and motivates students to make connections between knowledge and its applications to their lives as family members, citizens, and workers" (p.51).

According to Berns and Erikson (2001);

> "Contextual teaching and learning helps students connect the content they are learning to the life contexts in which that content could be used. Students then find meaning in the learning process. As they strive to attain learning goals, they draw upon their previous experiences and build upon existing knowledge." (p.2).

Furthermore, about context-based chemistry education Bennett and Lubben (2006) states;

> "... units of the course should start with aspects of the students' lives, which they have experienced either personally or via the media, and should introduce ideas and concepts only as they are needed" (Campbell et al., 1994, pp.418-419 as cited in Bennett & Lubben, 2006).

According to Bennett and Holman (2002), context-based teaching in chemistry should focus on the pertinence of chemical concepts and students' daily lives by encompassing the social-environmental issues, and industrial-technological applications. By this way students will gain an understanding about chemical concepts and ideas via establishing and comprehending the relevance of the topics and the real life, which will result in meaningful learning of chemistry. In addition, if students need to learn the chemistry concepts, the learning will also be meaningful. Therefore, chemistry topics should be introduced on a need-to-know basis. Via the contexts, students will be able to see the reasons for a need of broader chemistry knowledge and this situation will result in meaningful learning (Bulte et al., 2006).

The meaning of the term 'context' and 'context-based approach' was briefly clarified in this section as a beginning. The next sections which include the theory underlying context-based approach and the summaries of the studies conducted in the field should be evaluated within this concern.

2.2. Theoretical Background of Context-Based Approach

Theories are important for the researchers as they connect research and educational practice (Schunk, 2012, p.10). Besides, for researchers, theories are tools for establishing recommendations for applications in education depending on the research findings (Schunk, 2012, p.27). Therefore, in this section, first of all the theories underlying the context-based approach are briefly mentioned. Afterwards, the characteristics of context-based instruction based on the theoretical background are presented briefly.

Context-based approach was not grounded on a single theory by the researchers. Gilbert (2006) pointed out three approaches important for the use of context-based approach, which are constructivism, situated learning, and activity theory.

Constructivism is a philosophical prospect asserting that learners create their own learning (Schunk, 2012, p.230) and this learning is situated in contexts (Bredo, 2006). According to constructivism, individuals construct knowledge via experience and previous knowledge, and conducting knowledge to new circumstances by establishing a relationship between the new ones and previous ones (Berns & Erickson, 2001). Constructivism addresses brand new activities which wants students to use higher-order thinking skills and critical thinking (Briner 1999 as cited in Berns & Erickson, 2001). In context-based approach, the contexts are about real-life issues, which is a parallel application according to constructivist approach.

From the point of view of constructivism, it is important to use previous knowledge in the process of learning chemistry topics through chemical talk in order to construct knowledge actively (Gilbert, 2006). One important attribute of learning in constructivism, stated by Mandl and Kopp (2005), was that gaining knowledge is related to a definite and particular context and circumstance. In context-based approach, specific contexts are used in order to provide learning, which is compatible with the philosophy of constructivism.

Four points are important for constructivists in education, which are students' attendance in thinking actively, appreciating students' own opinions and views, the reality that scientific ideas are formed by people, and an instructional design that facilitates students making sense and using their previous knowledge (Ogborn, 1997). Moreover, Savery and Duffy (1995) presented several attributes of constructivist instruction, some of which are developing complex and authentic tasks and contexts regarding students' level of development, and organizing activities that are new to students. These attributes are also parallel to the context-based approach in instructional design.

The second theoretical approach for context-based instruction is situated learning (or situated cognition). According to situated learning, learning does not only related to a person's mind, situated learning includes interaction of a situation and a person's mind (Schunk, 2012, p.233). In order to achieve and develop meaningful learning, it is necessary to establish a link between learning and context (Brown, Collins & Duguid, 1989). Besides, from the point of view of situated learning, social and physical environments are very important because knowledge depend on situation and context (Mandl & Kopp, 2005). Students can learn better via appreciating the interactions and the frame of the learning environment is very important because learning is situated that is what teachers and students must comprehend (Gilbert, 2006).

One of the propositions of situated learning is that it is difficult to conduct knowledge from one task to another (Mandl & Kopp, 2005). Therefore, the ways for transferring knowledge from one situation to another must be sought due to the fact that transferring knowledge can be evaluated as one of the most important outcome of learning (Gilbert, 2006). The propositions of situated learning are compatible with context-based approach.

The third theoretical approach important for the use of context-based approach is activity theory. Vygotsky proposed human consciousness is influenced by socially

meaningful activities (Bredo, 1997 as cited in Schunk, 2012, p.242). In his theory, Vygotsky emphasized the interaction of social, environmental and personal influence evaluating as a fundamental point in the process of human development, which supports cognitive processes (Tudge & Scrimsher, 2003 as cited in Schunk, 2012, p.242).

Since the learner and the object are not independent from each other according to Vygotsky, the meaning of an object was formed by the learner via defining a special situation that the learner faces in daily life (Gilbert, 2006). The object can be named as the focal event, in other words the setting, in which the student enters to a cognitive process with the teacher who interprets and explains the focal event in order to provide students' socially accepted understanding about the focal event (Gilbert, 2006). The zone of proximal development is the difference between the things that a student can do on himself or herself and can do with the help of other people. At this point, the important thing and the major task is to determine framework of the zone of proximal development, the difference between the things that a student can do on his own and can do with the help of other people, according to the focal event as well as identifying learning outcomes of resembling goals to be succeeded via various focal events (Gilbert, 2006).

In consideration of the aforementioned theoretical framework of context-based instruction, the attributes of context-based chemistry instruction can be summarized in four aspects (Gilbert, 2006).

(a) Students must acknowledge and evaluate the context (the setting or the focal event) as a social framework relating to time and space. Besides, students must value the context within the chemistry domain, and must value their attendance in a community of practice. In this way, students will interact with other productively and improve personal identities from the point of view of that community. Moreover, the context must be in the zone of proximal development of the student, and must be related to students' daily lives or must include social issues which are important for the community.

(b) A behavioral environment which is especially arranged must be carried by the learning task because this will determine the types of activities such as laboratory experiments and chemical analyses that students will conduct as well as determining the chemical language.

(c) The behavioral environment that is arranged determines the chemical language. This specific chemical language must be understood and used by the students in the context. In this way, the students must gain understandings about the specific chemical concepts. Furthermore, teachers must know students' previous knowledge for an effective use of chemical language.

(d) The relation of one context and relevant concepts must be established by the students. Greeno (1998) used the term "resituate" and Van Oers (1998) used the term "recontextualise" (as cited in Gilbert, 2006) for that transfer of knowledge from one context to similar contexts. The main sources of contexts can be important social issues that are controversial such as climate change and products of genetically modified organism.

As well as the attributes of context-based chemistry instruction, the three theories underlying context-based approach which are constructivism, situated learning, and activity theory were briefly explained in this part of the study owing to the fact that without theories, researchers cannot establish a link between research and practice. Henceforth, it will be focused on the studies which were conducted about context-based approach.

2.3. Chemistry Programmes Adopting Context-Based Approach

There have been many studies conducted according to context-based education since 1980s. In this section of the study, the focus is on the curriculum projects in the chemistry domain. Six important context-based chemistry programmes adopting context-based approach have been conducted in different countries having various

educational settings. A lot of researchers conducted several research studies on these programs. These programs are Chemistry in the Community (ChemCom) (Sutman & Bruce, 1992) and Chemistry in Context (CiC) in the USA (American Chemical Society, 2001), Salters' Approach in the UK (Bennett et al., 2005), Industrial Chemistry in Israel (Hofstein & Kesner; 2006), Chemie im Kontext (ChiK) in Germany (Parchmann et al., 2006), and Chemistry in Practice (ChiP) in The Netherlands (Pilot & Bulte, 2006).

Chemistry in the Community (ChemCom) is one of the most famous context-based approach programs conducted in the USA. It is prepared as an introduction to chemistry course for high school students on the need-to-know basis adopting a context-based approach, and it is a student-centered program that introduces chemical topics through social issues (Schwartz, 2006). The program was granted by American Chemical Society (Chemcom, 1988). The need for a new chemistry curricula was aroused in the USA owing to the fact that the textbooks in use was prepared as an encyclopedia that includes chemistry knowledge, scientific facts and laboratory practices showing the steps in order to find predetermined results (Sutman & Bruce, 1992). The main purpose of the program was to develop students' chemical literacy, to train them as informed decision-makers, and to succeed more students to select chemistry course in tertiary level (Ware & Tinnesand, 2005). Several studies that showed the effectiveness of the program was conducted (Mason, 1998). Furthermore during the implementation of this program, the ratio of students taking chemistry courses increased significantly, which was considered as one of the points showing the success of the program (Schwartz, 2006). The program was translated into Russian, Japanese and Spanish because of its success in the USA (Ware & Tinnesand, 2005).

Chemistry in Context (CiC) was prepared for similar purposes that aimed in Chemistry in the Community (ChemCom) in the USA (King, 2012). These purposes are to improve students' chemical literacy and to attain more students to choose chemistry course in the next years of school (King, 2012). The program was prepared

especially for the students who will not probably choose chemistry lessons in the following years of school life and will not prefer science-related careers in the future (Schwartz, 2006). The CiC curriculum was prepared in a way that it mainly includes social issues with chemical concepts regarding scientific methodology on need-to-know basis and emphasizes the development of students' higher-order thinking skills such as problem solving and critical thinking skills (Schwartz, 2006). Moreover, the curriculum includes various activities harmonizing laboratory, library and class work (Schwartz, 2006). The study of Nakhleh, Bunce, and Schwartz (1995) showed that student' beliefs about chemistry as a component of daily life and as a component of contemporary society were more positive as grade level of students increase. Besides, Schwartz (2006) states that this program is effective for students who are not intending to have chemistry related professions in their future career.

Salters' Approach is another context-based program that was implemented in the UK. A number of teachers and researchers tried to find ways for making chemistry courses more appealing to the students, and prepared the program in 1983 (Bennett & Lubben, 2006). At the beginning researchers and educators developed only five units for 13 years old students adopting context-based approach in the chemistry domain, and now there are several Salters' Approach programs in the domains of chemistry, biology and physics in use for 11-18 years old students (King, 2012). The three courses developed for secondary school students among these courses in the chemistry domain are "Chemistry: The Salters approach" was developed for students aged 14–16 in the mid-1980s, "Science: The Salters approach" was developed for students aged 14–16, in the late-1980s and "Salters Advanced Chemistry" was developed for students aged 17–18 in the early1990s (King, 2012). In Salters' curricula, there are not sequenced lists of predetermined concepts (Bennett et al., 2005, p.143). In the process of developing scientific ideas, students' daily lives are considered as the main focus and a variety of student-centered activities are involved in the curricula (Bennett & Lubben, 2006).

The Industrial Chemistry programme was firstly developed in 1980s in Israel in order to adapt to the regulations of the new education system implemented in the

country (King, 2012). The Department of Science Teaching at the Weizmann Institute of Science was developed and implemented the program more than 15 years (Hofstein & Kesner, 2006). The main purpose of the study was providing a chemistry education through industrial chemistry contexts which were closely related to students' daily lives or related to the society and the main focus of the program was on the importance of applied chemistry and its social, environmental and economic effects (King, 2012). The students taking chemistry course in secondary school (year 12) had to study on at a minimum of one industrial case in detail, which comprised 20% of the chemistry course (Hofstein & Kesner, 2006). It is probable that chemistry instruction via industrial case studies rather than only regarding theories and main concepts of chemistry will increase students' attitudes and motivations toward chemistry (Hofstein & Kesner, 2006).

Chemie im Kontext (ChiK) program started in the late 1990s in Germany and in the development process of the program, educators and researchers benefited and inspired from Salters' Approach (King, 2012). The need for a context-based chemistry program was aroused when the German researchers revealed that students were academically not successful in chemistry lessons and they had low attitudes and motivations toward chemistry (Westbroek, 2005). The goals of this program are to provide a framework for the application of context-based approach (King, 2012), and to transfer of knowledge gained from one context to similar contexts (Newting at al., 2007). Westbrook (2005) states that ChiK is different from other context-based projects in that it focuses on and gives importance on the transfer of knowledge and the application of knowledge to various situations. The units of the program, which is developed for 10 and 11 years old students, include real-life situations, issues considered critical to the society, and topics related to technology and science (King, 2012). In the program, teachers are supported by guidelines, instructions, materials that can be used in the lessons, and recommendations (Newting at al., 2007). The concepts are discussed through various contexts and used for the clarification in a variety of topics is a different and a striking characteristic of the Chemie im Kontext program (Parchmann et al., 2006).

Chemistry in Practice (ChiP) is another context-based program that was implemented in the Netherlands. The purpose of the project was to establish a relationship between chemistry learning and students' daily lives and social issues (King, 2012) as stated in aforementioned projects. The program was prepared for secondary school students as a general chemistry course (Pilot & Bulte, 2006) and targeted to modernize the chemistry curriculum in the Netherlends in order to address for all students (King, 2012). The chapters of the program include comprehensive topics such as food, medicine, quality of water and making a swimming pool (King, 2012).

The six important context-based chemistry programmes which adopt context-based approach in different educational settings were briefly explained in this section of the study. All of them show the importance and the effectiveness of context-based instruction for students' achievement and affective variables such as attitudes and motivations toward chemistry lessons. Furthermore, all of the projects drew attention to similar points. Firstly, the programmes are aimed to establish a connection between daily life and chemistry. Secondly, the programmes were prepared on a need-to-know basis. Thirdly, contexts including societal, technological, and scientific issues related to daily life were used in the programs. Finally, all of the programs were student-centered including various meaningful activities such as laboratory experiments, discussions and chemical analyses, which focus on higher order thinking skills.

2.4. Research Studies on Context-Based Approach

In different countries various chemistry programmes are in use in the world. Educators and researchers are seeking new ways of chemistry teaching for a better chemistry instruction. Therefore, new approaches are being developed by the researchers such as science-technology-society approach, problem-based learning approach, project-based science approach and context-based approach. Especially, in the last two decades, these new approaches have been implemented in several countries in chemistry programmes some of which are briefly explained in Section

2.3 in the present study. Important international and national studies related to context-based approach will be briefly reviewed in this section of the study. In order to be informed about context-based approach and to grasp a point of view about different implementations of context-based approach, first of all international research studies conducted in the last two decades will be presented and then national research studies conducted in the last decade will be presented concisely.

Sutman and Bruce (1992) made a research study about the evaluation of the effectiveness of Chemistry in the Community (ChemCom) program which was briefly explained in Section 2.3. The study took 5 years and 3700 students were the sample. The results of the study showed that the materials prepared according to context-based approach and used in the ChemCom program were evaluated as positive by the students in general and the students following the program enjoyed studying chemistry.

Ramsden (1997) studied on the effectiveness of context-based instruction as compared to the traditional chemistry instruction on secondary school students' conceptual understandings of some important chemical topics. An instrument including eight diagnostic items was used in the data collection procedure. The questions were about important chemistry concepts which are classification of substances, the law conservation of mass, chemical change and the periodic table. The sample was 216 high school students aged over 16. 124 students were following the Salter's chemistry course whereas the rest were following the traditional chemistry course. The results of the study showed that the students taught via context-based instruction achieved a little more than the students taught via traditional instruction. Moreover, students instructed via context-based approach had more enjoyment and interest toward chemistry lessons. Yet, students could not comprehend some important chemical concepts in both groups. Besides, even high achiever students in the context-based instruction group stated that they would not choose science related career in the future.

Barber (2000) conducted a research study on context-based instruction focusing on not only cognitive but also affective outcomes of the students. There were two groups of students aged 17 and 18 in the study; the ones who had been instructed via Salters Advanced Chemistry and the other were instructed via traditional instruction. The instruments used for collecting data were questionnaires and interviews. The results of the study showed that context-based instruction increased the interest of the students in chemistry and the students enjoyed the activities that they do during the chemistry lessons throughout the context-based instruction. The results of the study also showed that in the two year course period students taught via context-based instruction were still interested in chemistry and their level of motivation were high; on the other hand students who taught via traditional instruction lost some of their interest and motivation towards chemistry lessons.

Parchmann et al. (2006) conducted a study about the effectiveness of Chemie im Kontext (ChiK) program which was explained in Section 2.3. concisely. The sample was 399 secondary school students. 216 students were taught via context-based instruction in two school year period of time, whereas 183 students were taught via traditional instruction. Data collected by utilizing several questionnaires and face-to-face interviews. The results of the study indicated that students following ChiK program had significantly higher motivation and interest toward chemistry lessons than the students in the traditional program. Furthermore, the number of students who followed ChiK program expressed to choose chemistry courses in future was more than the students who followed traditional chemistry program.

Demircioğlu (2008) conducted a research on context-based approach. She developed context-based instructional materials for pre-service teachers at the university level and the research design was case study. The subject matter was states of matter in general chemistry course and the sample of the study was 35 university students. Quantitative data were obtained via achievement test and attitude questionnaire and repeated measures of ANOVA used as statistical analyses, whereas qualitative data were obtained via semi-structured interviews and unstructured classroom

observations. The results of the study showed that context-based instructional materials were effective in terms of participants' achievement in chemistry, attitudes toward chemistry. The results also showed that using context-based instructional materials increased retention of knowledge and considered as enjoyable by the participants.

Demircioğlu et al. (2009) made an experimental study about context-based instruction. The purpose of the study was to investigate the effectiveness of context-based instruction on students' understandings on periodic table topic, retention of knowledge about the topic and students' attitudes toward chemistry lessons. Pre-test post-test control group design was utilized. The sample of the study was 80 9th grade high school students in two preexisting classes in the same school. The experimental group was instructed by context-based chemistry instruction including chemical storylines, whereas the control group was instructed by traditional chemistry instruction. In the experimental and the control groups different teachers were instructed in a three-week period of time. The quantitative data were collected through an achievement test and an attitude questionnaire. The findings of the study showed that students in experimental group had significantly higher level of achievement on periodic table topic and developed more positive attitudes toward chemistry lessons than students in control group. The findings also showed that context-based instruction was effective for retention of knowledge.

İlhan (2010) conducted a research study about context-based instruction using mixed method design. For the quantitative part of the study, the research design was a quasi-experimental pre-test post-test control group design. The subject matter was chemical equilibrium and the sample was 104 high school students in grade 11 in one school. Two classes were in experimental group and were taught via context-based instruction, whereas two classes were in control group and were taught via traditional instruction. Quantitative and qualitative data were obtained by using an achievement test on the subject matter, a motivation questionnaire, a survey about constructivist learning environment and a questionnaire about students' opinions about the 7 week

implementation. The results of the study indicated that chemistry achievement ant chemistry motivation of the students taught via context-based instruction were greater than the students who were taught via traditional instruction. The results also indicated that compared to traditional instruction, context-based instruction contributed more to constructivist learning environment.

Kutu and Sözbilir (2011) made a research study on context-based approach integrated with ARCS (Attention-Relevance-Confidence-Satisfaction) motivation model, an instructional strategy. The topic was Chemistry in Our Lives unit in 9th grade chemistry curriculum. The sample was 60 high school students in a school. The effect of implementation on chemistry achievement, retention of knowledge, chemistry motivation and attitudes toward chemistry were investigated. Qualitative data were collected by semi-structured interviews and classroom observations. Quantitative data were collected by an achievement test developed by the researchers, an attitude scale, Instructional Materials Motivation Survey and a survey about constructivist learning environment. The findings of the study presented that the implementation caused a better retention of knowledge and an increase in students' motivation toward chemistry. On the other hand, there was not a significant change in students' attitudes toward chemistry. The findings of the study also showed that students regarded the learning environment as constructivist learning environment.

Elmas (2012) compared the effectiveness of context-based instruction and traditional instruction on students' achievement and attitudes toward environment. The design of the study was nonequivalent groups pre-test post-test design. 222 secondary school students from two types of schools were the sample of the study. The topic was Cleaning Materials unit in the 9th grade chemistry curriculum. The implementation took 5 weeks and measuring tools were an achievement test, a questionnaire on attitudes toward environment and Science Process Skills test. The multivariate analysis of covariance technique was used in statistical analyses in which science process skills of the students were taken as covariate. The results of

the study indicated that chemistry achievement of students who were taught via context-based instruction were greater than the students taught via traditional instruction. However, there were not any significant difference between experimental and control groups in terms of attitudes toward environment and the type of school.

Çiğdemoğlu (2012) investigated the effectiveness of context-based instruction with 5E learning cycle model in comparison to traditional instruction. The study was in quasi-experimental design and the implementation took six weeks. Chemical reactions and energy was the topic of the study. Change in achievement, understanding, motivation and chemical literacy were examined through utilizing tests and questionnaires. The gender was also considered as a variable in the study. The sample was 187 11th grade students in six classes in two schools. The students in the experimental group taught via context-based instruction with 5E learning cycle model and the students in the control group taught via traditional instruction. To analyze the data, students' science process skill test scores were taken as covariate and multivariate analysis of covariance was conducted. The results of the study indicated that chemical literacy, achievement and understandings on the chemical reaction and energy topic of the students in the experimental group were significantly greater than the students in the control group. However, there were not any significant difference between students taught via context-based instruction with 5E learning cycle model and students taught via traditional instruction on the level of motivation. Besides there were not any significant gender difference between experimental and control group students.

Sunar (2013) investigated the effect of context-based instruction with learning cycle model compared to traditional instruction. In her quasi-experimental study the topic was states of matter. The sample was 150 10th grade students in two secondary schools. The design of the research study was pre-test post-test control group design. The experimental group taught via context-based instruction with learning cycle model and the control group taught via traditional instruction. The duration of the implementation was 6 weeks. Change in achievement, retention of knowledge and

attitudes toward chemistry were examined through using an achievement test on states of matter topic and Affective Characteristics Questionnaire. The data were analyzed by conducting multivariate analysis of covariance and the results showed that the achievement test scores and the attitude questionnaire scores of the students in the experimental group were significantly greater than the students in the control group.

Ültay (2015) conducted a research study on the effectiveness of concept cartoons embedded within context-based approach. The subject matter was Chemical Bonds at grade eight curricula. 45 students were the sample of the study whose design was nonequivalent pretest-posttest control group design. Two teachers in two classes were the implementers of the research study. In order to reveal students' conceptual understanding, a concept test about chemical bonding including 16 multiple choice items and interviews including five open-ended questions which are parallel to items in the concept test were utilized. The study took 8 lesson hours and 5E model was used in the instruction. The quantitative data were analyzed through independent samples T-test and paired samples T-test statistical procedures and the qualitative data were analyzed through classifying the responds into five categories. The results of the study presented that context-based instruction was an effective way of instruction on students' understanding about the chemical bonds topic. However, utilizing concept cartoons within the contexts were not statistically effective on students' conceptual understanding on the topic.

In literature, of course, there are a great number of research studies other than mentioned in this section of the present study in the field of context-based approach. However, the research studies which include a careful design and evidence based on statistical analyses were mainly selected and presented regarding their utmost importance in the field. The audiences are supposed to be obtained a perspective and informed about the previous studies about context-based approach.

2.5. Attitudes toward Environment

Attitudes are an individual's internal beliefs that affect his/her behaviors (Schunk, 2008, p.287). Osborne, Simon and Collins (2003) define attitudes as "the feelings, beliefs and values held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves" (p.1053). As citizens and as human beings living in the earth, we should be aware about the protection of the environment. The more people develop positive attitudes and awareness toward the protection of the environment, the better the world we the live in will be. Therefore, in science education especially in chemistry education, the curricula should be designed in a way that students will develop positive attitudes toward environment, a crucial affective variable, and will be respectful to the environment; because students' feelings, values and beliefs will have great impact on their behaviors over the course of their lives. Including various activities resulting in meaningful learning, context-based chemistry education can improve students' attitudes toward environment through carefully designed suitable contexts. In the present study, fossil fuels and clean energy resources topics are very suitable for that purpose. Through context-based instruction including different activities about environmental issues, students are able to develop more positive attitudes toward environment.

Leeming, Dwyer and Bracken (1995) constructed and validated Children's Environmental Attitude and Knowledge Scale (CHEAKS) in order to measure students' attitudes toward environment and their knowledge on environmental issues and to obtain a valid and reliable instrument that will be useful in different contexts. Alp et. al. (2006) translated and adopted CHEAKS into Turkish. One of the subscales of this version of the instrument was attitude subscale which was used in the present study with a name of Attitude toward Environment Scale (ATES).

As a reliable and valid instrument, CHEAKS was used in several international studies (Leeming & Porter, 1997; Makki, Abd-El-Khalick, & Boujaoude, 2003;

Walsh-Daneshmandi & MacLachlan, 2006; Bodzin, 2008). In the experimental study of Leeming and Porter (1997), eight activities were implemented in order to increase students' awareness about the protection of the environment. The study included more that fifteen control and experimental groups with a pre-test post-test control group design. The results of the study showed that students' attitudes toward environment and knowledge about environment in the experimental groups were significantly greater than control groups. Furthermore, in the study of Makki, Abd-El-Khalick and Boujaoude (2003), the purpose was to evaluate Lebanese high school students' attitudes toward environment and their knowledge about environment. In the survey, CHEAKS was used as instrument. The sample of the study was 660 10th and 11th grade high school students. The results of study showed that the instrument was reliable and the students had positive attitudes toward environment but had low knowledge about environment. Besides, in order to determine the psychometric facets of CHEAKS, Walsh-Daneshmandi and MacLachlan (2006) conducted a quantitative study with a sample of 338 Irish adolescents. The design of the study was repeated measures design. The results of the study showed that CHEAKS was a robust instrument with high reliability and validity, and it could be used effectively in various settings for people in different ages in the research area of education. Moreover, Bodzin (2008) conducted an experimental study in order to determine the effect of integrated instructional technologies in the improvement of 4th grade students' attitudes toward environment. Therefore, only attitude subscale of CHEAKS was used in the study. The implementation was conducted after the school through science club program. The results of the study displayed that CHEAKS was a reliable instrument and the implementation was effective in enhancing students' attitudes toward environment.

Alp et. al. (2006) translated and adopted CHEAKS into Turkish and named as Turkish version of Children's Environmental Attitude and Knowledge Scale (T-CHEAKS). One of the main aims of their study was to reveal the degree of secondary school students' attitudes toward environment and knowledge about environment. A total of 1977 students in 22 schools were the sample of the study.

The findings of the study showed that T-CHEAKS had high reliability and regarding grade level and gender students' attitudes toward environment were significantly different. Furthermore, Alp et. al. (2008) conducted a research study about elementary school students' attitudes toward environment and knowledge about environment using T-CHEAKS as a measurement tool. A total number of 1140 students from 18 elementary schools were the sample of the study. The instrument, T-CHEAKS, was evaluated as a reliable instrument. The findings of the study presented that fathers' level of education had a significant effect on students' knowledge about environment and gender difference was statistically significant favoring girls. The studies showed that as CHEAKS, T-CHEAKS can also be used in different grade levels of student as well as adolescents.

In addition, different instruments rather than CHEAKS and T-CHEAKS were utilized in different studies about students' attitudes toward environment. One of them was Attitude toward Environmental Issues Scale (ATEIS) which was used in the study of Yilmaz, Boone and Andersen (2004). In their study, the purpose was to reveal students' views about environment and to determine the effects of several variables such as socioeconomic status and gender. The sample was 458 students in grades from 4 to 8. The results of the study showed that girls had significantly greater attitudes toward environment than boys similar to the findings of the previous studies and students from higher socioeconomic status families had more positive attitudes toward environment. The findings also indicated that students' level of success in science courses were directly proportional to their attitudes toward environment.

Moreover, Tuncer, Ertepinar, Tekkaya, and Sungur (2005) studied the effects of school type and gender on students' attitudes toward environment. The sample consisted of 1497 students in grades 6th, 7th, 8th and 10th grades from private and public schools. The instrument which was utilized to determine students' attitudes toward environment was a Likert-type questionnaire including 45 items. The results of the study presented that students' level of awareness about environmental issues

and susceptibility for protecting the environment were very high. The results of the study also indicated that girls had more positive attitudes toward environment than boys similar to the findings of the previous research studies, and private schools students had more positive attitudes than public school students.

Attitudes are known to be resistant to changes in a short-term duration. In this study, attitudes are of great concern although the duration of implementation of context-based instruction is limited with six weeks. However, in the present study, the topics instructed were very suitable for developing students' positive attitudes toward environment. Furthermore, classroom discussions and several activities conducted throughout context-based instruction were considered as very effective for improving positive attitudes toward environment.

To sum up, in the literature review section, the meaning of context-based approach was clarified and theories underlying behind context-based approach were briefly explained at the beginning. Afterwards comprehensive programmes adopting context-based approach were summarized concisely because all these high-stake programmes adopting context-based approaches are very important for showing the effectiveness of the implementations as well as analyzing the deficiencies of the implementations. Then, important studies having good research designs on context-based approach were summarized, and as the only affective variable of the present study, students' attitudes toward environment were reviewed briefly. However, it has been widely accepted by the researchers that there is a need for conducting more and more research studies including effective designs in order to test the effectiveness of context-based instruction. Having a careful experimental design, this study aimed to make a contribution to fill this gap in the field.

CHAPTER 3

METHODOLOGY

3.1. Research Type and Experimental Design

Considering the purpose of the study and the appropriateness of the nature of research problem, the researcher decided to use an experimental research method in the present study due to the fact that experimental research can be used for testing hypotheses about cause-and-effect relationships and it allows the researcher for directly manipulating a particular variable (Fraenkel & Wallen, 2009). In the present study the pre-test post-test control group design was used in order to determine the effects of context-based instruction versus traditional instruction on tenth grade high school students' chemistry achievement in the fossil fuels and clean energy resources topics and attitudes toward environment.

Intact classes of students were used in the study since in Turkey it is not practical to form experimental and control groups whose students are randomly assigned. Therefore the study is a quasi-experimental research because students cannot be randomly assigned to experimental and control groups (Fraenkel & Wallen, 2009).

In order to reveal students' prior knowledge about fossil fuels and clean energy topics, the FCEAT was administered as pre-test to both experimental and control groups. The purpose was to determine whether there was a significant difference between experimental and control groups in their prior knowledge about the topics. The ATES was also administered as pre-test to all students participating to the study

for similar purpose to reveal whether there were significant differences between experimental and control groups. Students' FCEAT-pre and ATES-pre scores were potential covariates for the analyses. At the end of the treatments FCEAT and ATES were administered as post-test to both experimental and control groups. Besides, the SPST was administered to all groups only at the beginning of the treatment for the purpose of using it as a covariate if possible in the analyses. Research design of the study is given in the Table 3.1.

Table 3.1 Research design of the study

Groups	Pre-test	Treatment	Post-test
Experimental Group	FCEAT ATES SPST	Context-Based Instruction	FCEAT ATES
Control Group	FCEAT ATES SPST	Traditional Instruction	FCEAT ATES

3.2. Population and Sample

The target population of the present study was all tenth grade students in Anatolian and vocational high schools in Ankara, capital of Turkey. As it is difficult to reach the target population, accessible population was specified. The accessible population of the study was all tenth grade students in Anatolian and vocational high schools at Etimesgut and Sincan districts of Ankara. The results of the present study might be generalized to accessible population.

Two schools from two districts, two teachers and four intact classes were selected

from the accessible population by using convenience sampling. One teacher and two classrooms from each type of school were selected. Both of the teachers were volunteer for the implementation. For each school one class was in experimental group and one class was in control group. The experimental and control groups were randomly selected among the classrooms that the teachers lectures. The total number of the students participating to the study was 113. Table 3.2 presents the data related to the participants related to school type, group and gender in detail.

Table 3.2 Sample of the study in terms of school type, group and gender

		Group				
		Experimental		**Control**		
		Male	Female	Male	Female	Total
School Type	Anatolian	12	19	21	10	62
	Vocational	20	5	21	5	51
	Total	32	24	42	15	113

3.3. Variables

There are seven variables in the present study, two of them are dependent and the others are independent variables all of which were displayed in the Table 3.3. The two dependent variables are Fossil Fuels and Clean Energy Resources Achievement Test post-test scores (FCEAT-post) and Attitudes toward Environment Scale post-test scores (ATES-post). These two variables are continuous and interval scale dependent variables.

Independent variables are separated into two groups; group membership and covariate. Independent variables related to group membership are method of instruction and school type. Both of them are categorical and nominal scale independent variables. Independent variables which are considered as covariates

used for the purpose of controlling the differences between groups before the treatments are Fossil Fuels and Clean Energy Resources Achievement Test pre-test scores (FCEAT-pre), Attitudes toward Environment Scale pre-test scores (ATES-pre) and Science Process Skills Test scores (SPST). These three variables are continuous and interval scale.

Table 3.3 Variables of the study

Name	Type	Continuous/Categorical	Scale
FCEAT-post	Dependent	Continuous	Interval
ATES-post	Dependent	Continuous	Interval
FCEAT-pre	Independent	Continuous	Interval
ATES-pre	Independent	Continuous	Interval
SPST	Independent	Continuous	Interval
Teaching Method	Independent	Categorical	Nominal
School Type	Independent	Categorical	Nominal

3.4. Instruments

3.4.1. Fossil Fuels and Clean Energy Resources Achievement Test (FCEAT)

The researcher developed the FCEAT for the purpose of measuring 10^{th} grade high school students' achievement scores in the fossil fuels and clean energy resources topics in the chemistry course. These two topics include formation of the coal, types of coals, superiority and drawback of the coal as a fuel, the formation process of crude oil, common petroleum products, refining of petroleum, components of petroleum, types of hydrocarbons, producing fuels from herbal resources, and clean energy resources.

In the development process of the instrument, firstly the chemistry curriculum was analyzed in detail for the aim of identifying the objectives of the topics that will be

taught in the treatments. Afterwards, a lot of resources such as chemistry course books, test banks, and foreign course books were investigated in detail and the questions of FCEAT that are compatible with the objectives of the curriculum were prepared. Furthermore, a table of specification was prepared to show the relationship between the questions and concepts of the fossil fuels and clean energy resources topics. Finally, in order to collect content-related validity evidence, the instrument was reviewed by three chemistry teachers and two academicians one of which was a professor in the field. After making necessary changes on the items according to the suggestions and the comments of the reviewers, the final version of FCEAT were formed. The FCEAT instrument includes 18 multiple-choice question and each having one correct answer and four distracters (see Appendix A). The Cronbach's alpha reliability coefficient (Crocker & Algina, 1986) was calculated as 0.66.

In the study, FCEAT was used before and after the treatments in both experiment and control groups. The pre-test scores was used as a covariate in the analyses and the post-test scores was used to compare the effects of two instructional methods on students' understanding of fossil fuels and clean energy resources topics.

3.4.2. Attitude toward Environment Scale (ATES)

Leeming et. al. (1995) constructed and validated Children's Environmental Attitude and Knowledge Scale (CHEAKS) for measuring students' attitudes toward environment and their knowledge on environmental issues. Alp et. al. (2006) translated and adopted CHEAKS into Turkish. The Cronbach's alpha reliability coefficient for the attitude subscale of the Turkish version was reported as 0.92 and 0.94 in two studies (Alp et. al., 2006; Elmas, 2012).

The attitude subscale of Turkish version of Children's Environmental Attitude and Knowledge Scale was used in this study and called as Attitude toward Environment Scale (ATES). In the present study, the Cronbach's alpha reliability coefficient was calculated as 0.92.

Attitude toward Environment Scale consists of 31 items with a 5-point Likert type scale and it was rated as 1 for strongly agree and 5 for strongly disagree by the participants of the study. In the scale, there were two negatively stated items (item 13 and item 31) whom were reversed in the coding process. In this study, ATES was used as a pre-test before the treatments and as a post-test after the treatments in order to assess tenth grade Anatolian and vocational high school students' attitudes toward environment in both experimental and control groups for determining the differences in two instruction methods (see Appendix B).

3.4.3. Student Questionnaire about Context Based Instruction (SQCBI)

İlhan (2010) constructed and validated Student Questionnaire about Context Based Instruction (SQCBI) in order to determine and reveal students' opinions and thoughts about context-based instruction. The instrument includes eight items. The first and second items include both Likert type and open-ended questions; whereas the other six items include only open-ended questions.

In the present study, SQCBI was used as a post-test after the treatment in experimental group in order to determine tenth grade high school students' opinions and thoughts about context-based instruction. In the data collection procedure students did not write their personal information such as name and surname on the questionnaire so that they could have freely stated their opinions and thoughts (see Appendix C).

3.4.4. Science Process Skills Test (SPST)

Okey, Wise, and Burns (1982) constructed and validated Science Process Skills Test for measuring middle and high school students' science process skills. Identifying variables, stating and identifying hypotheses, defining and designing investigations operationally, graphing and interpreting data are five intellectual abilities that the instrument measures. Geban, Askar, and Ozkan (1992) translated and adopted SPST

into Turkish. The instrument includes 36 multiple choice items with four alternatives. For each item, students' correct answers scored as 1 point, therefore the maximum score that a student could gain was 36 points.

In various studies, different Cronbach's alpha reliability coefficients were found in its Turkish implementations such as 0.81 in its first implementation (Geban, Askar, and Ozkan, 1992), 0.85 (Uzuntiryaki, 2003; Pabuccu, 2004; Bulbul, 2010), 0.59 (Tasdelen, 2011), 0.72 (Elmas, 2012) and 0.88 (Cigdemoglu, 2012). In the present study, the Cronbach's alpha reliability coefficient of the instrument was calculated as 0.65.

In this study, SPST was used before the treatments in order to assess tenth grade Anatolian and vocational high school students' science process skills in both experimental and control groups and students' scores were used as a covariate in the analysis (see Appendix D).

3.5. Instructional Materials

For 10^{th} grade chemistry class Fossil Fuels and Clean Energy Resources topics, context-based instructional materials are developed within the context of this study. Those materials consist of two sections which are student lesson materials and teacher's guide.

Teacher's guide includes phrases and questions that motivate and direct students for more effective discussions and for a better understanding of the topic as well as possible answers of the questions in the student lesson materials. Moreover, teacher's guide includes the answers of the student worksheets, the objectives of the curriculum and the lesson hours allocated for the topic. The teacher's guide that was used in the experimental group included in the Appendix E.

In Figure 3.1, the model used for developing student lesson materials is given. By

this way, the validity and reliability of the developed instructional materials are tried to be met. In the next paragraphs, the explanation of the steps of the model is explained.

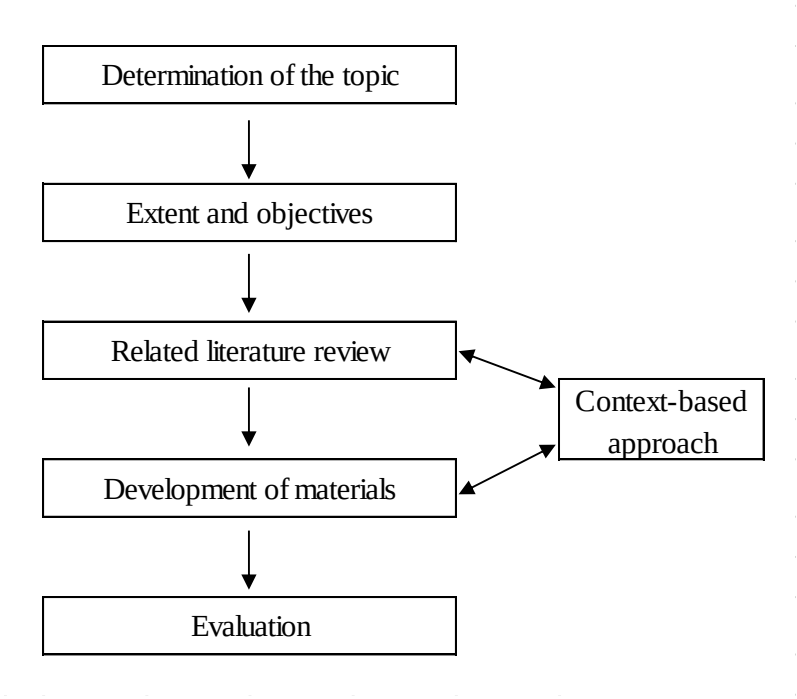

Figure 3.1 Instructional material development model

There are four units in the 10th grade chemistry curriculum which are (1) Acids, Bases and Salts, (2) Mixtures, (3) Energy in Industry and in Living Organisms, and (4) Chemistry is Everywhere. The third unit has three chapters which are (1) Fossil Fuels, (2) Clean Energy Resources, and (3) Energy in Living Organisms (MEB, 2013). In Turkey, it is the first time that the third unit which is "Energy in Industry and in Living Organisms" has been taught in high school chemistry lessons.

For this study the Fossil Fuels and Clean Energy Resources chapters in the third unit were specifically chosen. First of all, these chapters do not require any mathematical background and do not include any arithmetic calculations. Secondly, the Fossil Fuels and Clean Energy Resources chapters are seen as the most important chapters in the whole 10th grade chemistry curriculum by the researcher as those chapters might develop students' attitudes toward environment and students might have the

possibility of application of the topics they learned in their daily lives. Thirdly, these chapters are very suitable for establishing connections with daily life. In chemistry instruction, the fundamental purpose is to cover the chemical content in the curriculum as well as providing students to improve their thinking skills, social skills, data handling and establishing the connection between chemistry and daily life. Therefore, in consideration of those evaluations, the context-based instructional materials are developed for the two chapters of unit three which are Fossil Fuels and Clean Energy Resources.

For determining the extent and the objectives of the materials developed, the chemistry curriculum is considered. There are thirteen objectives for unit three (Energy in Living Organisms) in the curriculum. Among those thirteen objectives, eight objectives are related to the first and second chapters of the unit which are Fossil Fuels and Clean Energy Resources chapters. Those eight objectives are (1) Explains formation of the coal and types of coals, (2) Scrutinizes superiority and drawback of the coal as a fuel, (3) Explains the formation process of crude oil, (4) Relates common petroleum products and refining of petroleum, (5) Knows main petroleum components, (6) Discriminates types of hydrocarbons according to molecular structures, (7) Gives examples for producing fuels from herbal resources, (8) Knows clean energy resources (MEB, 2013). The content of the materials used in the study is limited to those eight objectives given in the curriculum for Fossil Fuels and Clean Energy Resources chapters.

In this study, instructional materials are proposed to be developed through context-based approach. Hence, when the literature is searched it is laid emphasis on which properties of an instructional material should have for context-based approach. When the instructional materials which are developed according to context-based approach is examined, it is seen that those materials include daily-life contexts and activities related to the contexts (Bennett et al., 2005; Netwig and Waddington, 2005; Netwig et al., 2007). Furthermore, when the content of context-based instructional materials are examined, they are lesson materials that provides the constructivist learning from

the point of application form of instructional methods. In the literature there is not a detailed study about how context-based approach should be used in the process of developing an instructional material. However, the properties of a context-based instructional material are mentioned in detail. What should be the properties of contexts and the criteria about application are listed by Gilbert (2006). Therefore, in this study the instructional materials are developed appropriate to the context-based approach related to fossil fuels and clean energy resources topics via considering the properties and the criteria which are mentioned in detail in Chapter II. Moreover, the activities are developed in a way that they will make students actively involved in the lessons including group works, group discussions, classroom discussions and research projects that they will make presentations.

The researcher took opinions of a total of 7 experts including 4 chemistry teachers and 3 academicians in the field about the developed instructional materials. Some experts stated the necessity of enriching the examples in some certain topics. Considering the evaluations of the experts and after the necessary arrangements, final version of the instructional material is put into final form and made ready for the classroom application.

After the developed instructional materials are enriched via visual elements, they are copied and prepared as booklets for the use of students. At the end of each topic, student worksheets are also included in the booklet. Student worksheets consist of multiple choice questions, true-false questions and short answer questions. These questions are prepared via investigating many resources in detail such as curriculum objectives, test banks and chemistry text books.

The topics in the material are given in the Table 3.4 with the objectives and the lessons hours. As it is presented in the table, the total lesson hours planned for the whole instructional material are 12 which mean 6 weeks since there are two chemistry lesson hours in a week.

Table 3.4 Objectives and lesson hours

Topic	Objectives	Application Duration
Coal	1. Explains formation of the coal and types of coals 2. Scrutinizes superiority and drawback of the coal as a fuel	3 Lesson Hours
Petroleum	3. Explains the formation process of crude oil 4. Relates common petroleum products and refining of petroleum 5. Knows main petroleum components	3 Lesson Hours
Hydrocarbons	6. Discriminates types of hydrocarbons according to molecular structures	2 Lesson Hours
Herbal Energy Resources	7. Gives examples for producing fuels from herbal resources	2 Lesson Hours
Other Clean Energy Resources	8. Knows clean energy resources	2 Lesson Hours

3.6. Treatment

This study focused on two different groups; experiment group and control group. The experimental group was instructed by context-based instruction (CBI) and the control group was instructed by traditional instruction (TI). Two chemistry teachers were the implementers of the treatments which lasted for six weeks.

The study was conducted in the second semester of the 2014-2015 academic year. The week before the study, students were informed about the study and were handed out Student Lesson Materials in the form of a booklet including worksheets which were to be answered by students in and out of the class time. These worksheets were designed to improve students' understanding of chemical concepts, ideas and principles related to the topics.

One week before the study, the students in both groups were administered FCEAT-pre to assess students' prior knowledge in the fossil fuels and clean energy resources and ATES-pre in order to assess their prior attitudes toward environment. The students in both groups were also administered SPST in order to assess their science process skills which might be used as covariate in data analysis. After the treatments the FCEAT-post and ATES-post were administered to both groups. The test durations were standardized for both groups in order to assure treatment verification. Moreover, the experimental group was administered Student Questionnaire about Context Based Instruction in order to assess students' opinions about the context-based instruction.

3.6.1. Treatment in the Experimental Group

Informal interviews were made with the two chemistry teachers as a first step. The interviews revealed that the teachers had no knowledge about the context-based instruction. The teachers expressed that they had not attended any in-service training about the new curriculum and therefore they did not adapt to the new curriculum. In addition to this, the teachers pointed out that they had even no knowledge about fossil fuels and clean energy resources since the subjects are new in the curriculum and it was the first time that they will teach the subjects.

The teachers were informed about the theoretical perspectives and the implications of context-based approach in detailed by the researcher. In the process of preparation of context-based lesson materials the researcher and the teachers conducted an elaborate study. The Student Lesson Materials that were used in the experimental group included in the Appendix F.

The experimental group was instructed by using Student Lesson Materials which were originally developed on the basis of context-based approach. Related to the contexts in the Student Lesson Materials, usually group discussions and classroom discussions were made.

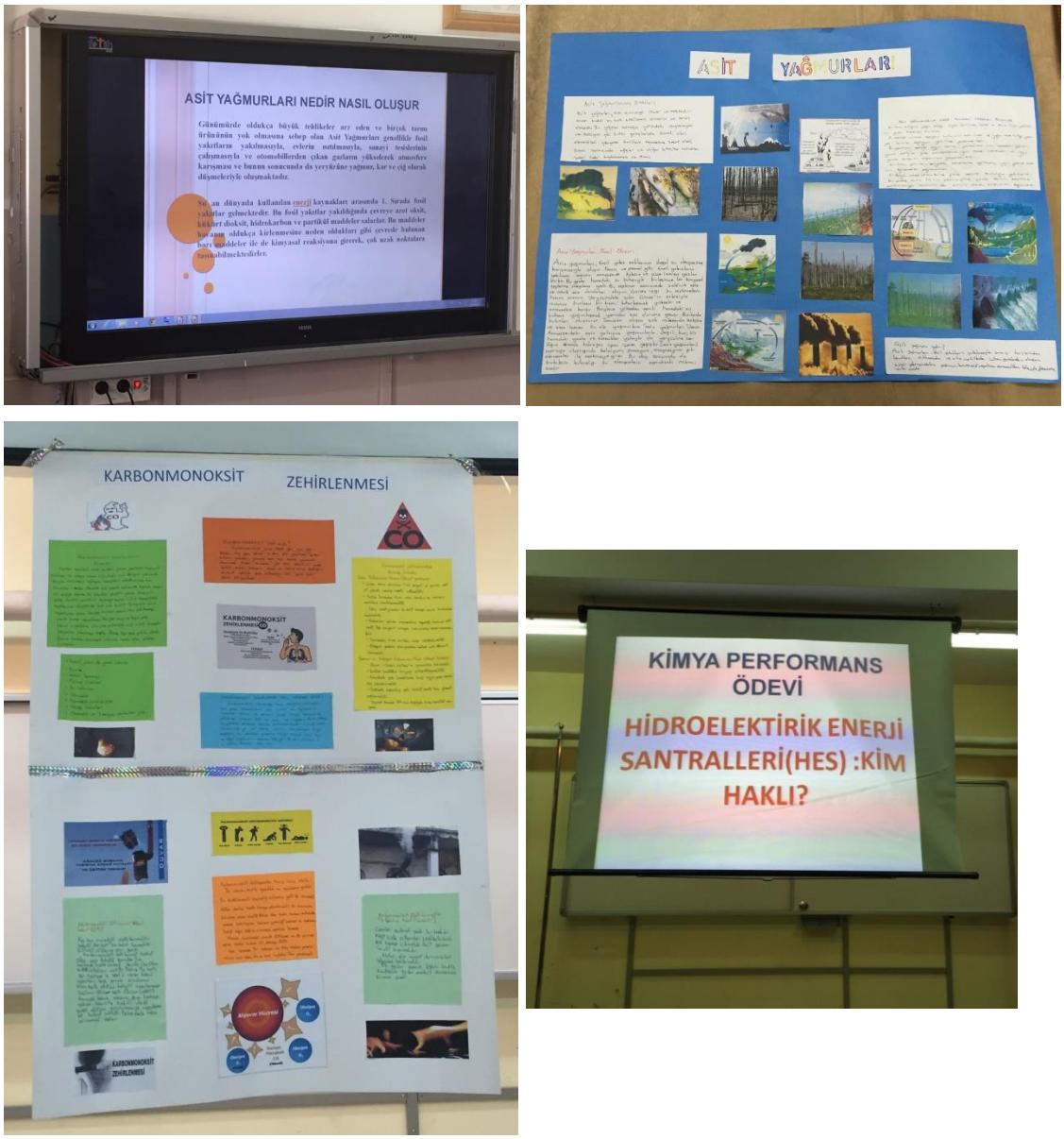

Figure 3.2 Photos of presentations and posters

The teachers were usually guiding the classroom during the lessons and facilitating the discussions rather than teaching the students directly. Furthermore, in guidance of the teachers, students in the experimental group prepared projects by working in groups and made poster and PowerPoint presentations at the end. Each group includes 4 or 5 students whom were chosen by the teachers at the first week of the implementation. Teachers handed out the Group Projects (see Appendix G) to each

group considering students' choices and their field of interests.

In context-based education using poster presentations are seen as an efficient way of assessment (Anthony et al., 1998). The posters prepared by groups were hung up on the board and member of groups presented their projects whereas some groups made PowerPoint presentations by using smart boards. Sometimes students in the classroom asked questions to the group members about the projects and short discussions on the projects were made during the presentations. The group members looked very willing to participate in these discussions. Each presentation took about 5-10 minutes. The photos taken during the presentations and posters were presented in Figure 3.2.

3.6.2. Treatment in the Control Group

The control group was instructed by traditional instruction which was the regular way for the teachers to teach the subject-matters. According to the researcher's observations, the teachers primarily used lecturing as a way of instruction. Teachers explained the topics to the students and asked questions about their understandings about the content either standing in front of the board or sitting on their desks. Students were listening and expressing their ideas and thoughts to the teachers in return and they were also taking notes of the important points. Compared to the experimental group, the students were asking fewer questions. Teacher-centered instruction was conducted in that teachers were at the center of the instruction process as a source of knowledge. Subsequent to teaching the concepts, teachers were giving the worksheets which were also given to the experimental group. Sometimes the questions in the worksheets were solved in the classes through the guidance of the teachers and sometimes teachers assigned the worksheets as homework as practiced in the experimental groups. The reason for giving the worksheets both to the control group and to the experimental group is to assure that the difference found between groups was only due to the type of instruction, not due to the content loads.

3.7. Data Analyses

3.7.1. Statistical Procedures

The quantitative data gathered via instruments in the present study was entered to Predictive Analytics Software (PASW) Statistics 18 program. The variables entered to the statistical program were student name and surname, school type (Anatolian or vocational), group membership (experimental or control group), and the scores of FCEAT-pre, ATES-pre, FCEAT-post, ATES-post and SPST. First of all descriptive statistical analyses were conducted and mean, standard deviation, variance, skewness, kurtosis, Q-Q plots and histograms were obtained. Secondly, inferential statistical analyses were conducted. Multivariate analysis of covariance (MANCOVA) was conducted due to the fact that there are two dependent, two independent and three covariates in the present study. Before conducting MANCOVA, several analyses such as correlational and reliability analyses were conducted in order to check its assumptions which are normality, independence of observations, equality of variances, multicollinearity and homogeneity of regression slopes. After conducting MANCOVA, follow-up analyses of covariance (ANCOVA) were conducted in order to determine the effect of each dependent variable. Descriptive statistical analyses were explained in Section 4.1. and inferential statistical analyses were explained in Section 4.2.

3.7.2. Power Analysis

Power is the probability of rejecting a null hypothesis in the case of being false (Hinkle, Wiersma & Jurs, 2003). Power of a test is closely related to the sample size of the study. In fact power is not an issue if the sample size is 100 subjects or more (Stevens, 2009, p.6). In the present study a total number of 113 students participated to the study. Therefore, power was not an issue for this study. Notwithstanding, in the next paragraphs the statistical power analysis for the present study was briefly explained.

Alpha, the probability of rejecting a null hypothesis, value was set to 0,05 and beta value, the probability of failing to reject a false null hypothesis, was set to 0,20. They are Type I error and Type II error respectively. The power value (1-β) became 0,80. Cohen, Cohen, West and Aiken (2003) suggested to set the effect size (f2) to a medium value of 0,15.

In order to calculate the minimum required sample size the formula n=L/f2+kA+kB+1 was used (Cohen & Cohen, 1983, p.155) where n value is the minimum required sample size and L value was given in the table (Cohen & Cohen, 1983, p.527) which was found to be 12,83. The value of kA in the formula is the number of covariates which was 3 in the present study (SPST, FCEAT-pre and ATES-pre scores). The values of kB in the formula can be found by subtracting 1 from levels of each fixed factor. The kB value in the present study is 2 because both fixed factors which are school type and treatment had two levels (kB=(2-1)+(2-1)=2). Therefore, when we put these values into the aforementioned formula we get 92 as the minimum required sample size for the present study (n=12,83/0,15+3+2+1=91,53). The calculated sample size value was smaller than 113 which was the sample of the present study. Therefore, it can be concluded that the sample size was enough regarding the statistical power.

3.7.3. Unit of Analysis

In the present study the unit of analysis was the students participated to the study and the experimental unit were the intact classes. In order to meet the assumption of independence of observations, unit of analysis and experimental unit should be the same. However, it is not possible to provide independence of observations practically in experimental studies due to the human factor as human beings are social organisms. Fortunately, during the data collection procedure it was assumed that the researcher and the teachers achieved preventing any interaction among students.

3.8. Treatment Fidelity and Verification

In experimental researches treatment fidelity is defined as "the strategies that monitor and enhance the accuracy and consistency of an intervention to ensure it is implemented as planned and that each component is delivered in a comparable manner to all study participants over time" (Smith, Daunic, Taylor, 2007). In fact treatment fidelity is a way of confirmation of the treatment as it was planned before the study in order to enhance validity and reliability of behavioral interventions.

For treatment fidelity and verification, the context-based instructional materials developed in the study were prepared according to the theoretical framework of Gilbert (2006). The details of the theoretical framework were explained in the literature section. The expert opinions were considered and evaluated for the verification for the compatibility of the materials to the theory. Furthermore, the implementers were trained for the treatment through several meetings in order to ensure their understandings about the implementation of the context-based instruction. Besides, as assessment tools for treatment fidelity and verification, the teachers were monitored during the treatment. The researcher attended almost half of the lessons in both experimental and control groups. At the end of the implementation, researcher gathered student opinions about the treatment via a questionnaire for the purpose of assessing the treatment fidelity.

3.9. Assumptions and Limitations

3.9.1. Assumptions

The assumptions of the present study are as follows;

1. The measurement instruments (achievement tests and the questionnaires) were administered to the participants in both experimental and control groups under standardized conditions.

2. All of the students responded to each item in each instrument faithfully and sincerely.

3. Independence of observations which means that there were not any interaction between students in experimental and control group was ensured.

4. The teachers were not biased for the implementation of any method of instruction.

5. The teachers completely followed the instructions in the Teacher's Guide during the implementation of context-based instruction.

6. Teachers' enthusiasm toward context-based instruction and their personality traits did not affect the results of the study.

3.9.2. Limitations

The limitations of the present study are as follows;

1. This study was limited to Fossil Fuels and Clean Energy Resources topics in 10th grade chemistry curriculum.

2. This study was conducted in two districts of Ankara where majority of the students are from medium socioeconomic status.

3. This study was conducted in Anatolian and vocational schools.

4. The assumption of independence of observations was a limitation for statistical analyses in the present study.

5. The assumption of normality was a limitation for statistical analyses in the present study.

6. The number of participants in the study was a limitation regarding the representativeness of the population.

CHAPTER 4

RESULTS

4.1. Descriptive Statistics

The number of students in experimental and control groups and in Anatolian and vocational high schools are presented in the following table. The number of students in experimental and control groups in Anatolian high school are equal and in vocational high school are almost equal. The total number of the students participated to the study is 113.

Table 4.1 Descriptive Statistics

	School Type		
	Anatolian	Vocational	Total
Experimental Group	31	25	56
Control Group	31	26	57
Total	62	51	113

Data cleaning were conducted via excluding absentees before the analysis and the data were checked in order to determine whether there was any error in entering the data. Besides, the two reverse items in the Attitude toward Environment Scale were considered. The summary of the descriptive statistics for all data, for experimental group, and for control group are presented in Tables 4.2, 4.3 and 4.4 respectively.

Table 4.2 Descriptive Statistics for All Data

	N	Mean		Std. Dev.	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
FCEAT-pre	113	37,6991	1,39281	14,80582	219,212	,479	,227	,653	,451
FCEAT-post	113	62,3451	1,35257	14,37804	206,728	-,409	,227	,337	,451
ATES-pre	113	140,0177	1,89792	20,17512	407,035	-1,316	,227	2,828	,451
ATES-post	113	146,7965	1,87863	19,97014	398,806	-,624	,227	1,115	,451
SPST	113	15,5841	,37749	4,01276	16,102	-,020	,227	-,240	,451
Valid N (listwise)	113								

Table 4.3 Descriptive Statistics for Experimental Group

	N	Mean		Std. Dev.	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
FCEAT-pre	56	39,8214	2,00634	15,01406	225,422	,884	,319	1,268	,628
FCEAT-post	56	68,8393	1,66120	12,43130	154,537	-,203	,319	-,257	,628
ATES-pre	56	146,6786	2,13202	15,95460	254,549	-1,568	,319	4,945	,628
ATES-post	56	151,9464	2,25017	16,83872	283,543	,150	,319	-,327	,628
SPST	56	15,1607	,53742	4,02165	16,174	,089	,319	-,025	,628
Valid N (listwise)	56								

Table 4.4 Descriptive Statistics for Control Group

	N	Mean		Std. Dev.	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
FCEAT-pre	57	35,6140	1,91072	14,42562	208,098	,039	,316	-,416	,623
FCEAT-post	57	55,9649	1,76749	13,34429	178,070	-,688	,316	,332	,623
ATES-pre	57	133,4737	2,89013	21,81997	476,111	-1,084	,316	2,119	,623
ATES-post	57	141,7368	2,86097	21,59987	466,555	-,789	,316	,808	,623
SPST	57	16,0000	,52922	3,99553	15,964	-,125	,316	-,283	,623
Valid N (listwise)	57								

4.2. Inferential Statistics

Inferential statistics include certain types of procedures that allow researchers to make inferences about a population based on findings from a sample (Fraenkel & Wallen, 2009, p.216). In this part, the determination of the covariates, assumptions of MANCOVA, results of MANCOVA and follow-up ANCOVAs are presented respectively.

4.2.1. Determination of Covariates

A covariate is a variable that has a potential relationship with the dependent variable (Field, 2005, p.727). One or more covariates can be used in the MANCOVA analysis. Covariates are statistically controlled so that they may increase the possibility of finding differences between groups as well as aid for adjusting previous differences between groups.

In the present study, FCEAT-pre, ATES-pre and SPST scores were considered as possible covariates due to the fact that they might have been correlated with FCEAT-

post and ATES-post scores. In order to reveal pre-existing differences between groups, independent samples t-tests for FCEAT-pre, ATES-pre and SPST were performed. The results of the independent samples t-tests are summarized in the Table 4.5.

Table 4.5 Independent-samples t-tests for FCEAT-pre, ATES-pre, and SPST

	Levene's test of equality of variances		T-test for equality of means		
	F	Sig.	t	df	Sig.
FCEAT-pre	,444	,506	1,519	111	,132
ATES-pre	5,789	,018	3,677	111	,000
SPST	,347	,557	-1,113	111	,268

As shown in Table 4.5, the mean difference between the ATES-pre scores of students in control group and experimental group is significant ($t(102,6)=0,000$ $p<0,05$), whereas there is no significant mean difference between control group and experimental group with respect to students' FCEAT-pre scores ($t(111)=0,132$ $p>0,05$) and SPST scores ($t(111)=0,268$ $p>0,05$). Therefore it can be concluded that ATES-pre scores of students can be used as a covariate during inferential statistics. As a second step, in order to check the relationships between the dependent variables and the potential covariates which were FCEAT-pre, ATES-pre and SPST scores, all correlations were calculated as shown in Table 4.6.

Table 4.6 Correlations between potential covariates and dependent variables

	FCEAT-pre	ATES-pre	SPST	FCEAT-post	ATES-post
FCEAT-pre	1	,123	-,049	,328*	-,029
ATES-pre	,123	1	,092	,135	,478*
SPST	-,049	,092	1	-,002	,274*
FCEAT-post	,328*	,135	-,002	1	,091
ATES-post	-,029	,478*	,274*	,091	1

* Correlation is significant at the 0.01 level (2-tailed).

In order to choose continuous variables as covariates, the main point is that covariates should be highly correlated with the dependent variables and should have low correlations among themselves (Stevens, 2009, p.293). According to the Table 4.6, there is not any significant correlation among potential covariates which are FCEAT-pre, ATES-pre and SPST. However, these potential covariates have significant correlations with at least one of the dependent variables. Therefore, it is reasonable to choose FCEAT-pre, ATES-pre and SPST as a set of covariates to go on further analyses.

4.2.2. Assumptions of MANCOVA

Assumptions have critical importance in performing any further statistical procedures with parametric tests (Field, 2005). Multivariate analysis of covariance has five assumptions which are (1) normality, (2) independence of observations, (3) equality of variances, (4) multicollinearity, and (5) homogeneity of regression slopes.

4.2.2.1. Normality

Univariate normality and multivariate normality should be checked before conducting MANCOVA analysis. For checking univariate normality, as a first step skewness and kurtosis values were controlled. For a normal distribution, skewness and kurtosis values should be between -2 and +2. The skewness and kurtosis values are between -2 and +2 except the kurtosis values of ATES-pre scores as it is presented in Table 4.7. This exception is not a serious violation as the sample size of the study is considerably large (Tabachnick & Fidell, 2007, p.80).

Table 4.7 Skewness and kurtosis values

	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
FCEAT-pre	,479	,227	,653	,451
FCEAT-post	-,409	,227	,337	,451
ATES-pre	-1,316	,227	2,828	,451
ATES-post	-,624	,227	1,115	,451
SPST	-,020	,227	-,240	,451

As a second step, the histograms and Q-Q plots were drawn in order to check normality visually as they represent the shape of distribution. For the purpose of determining the distribution of the scores, Tabachnick and Fidell (2007, p.80) recommend using graphs such as histograms. The histograms and Q-Q plots are presented in Figure 4.1.

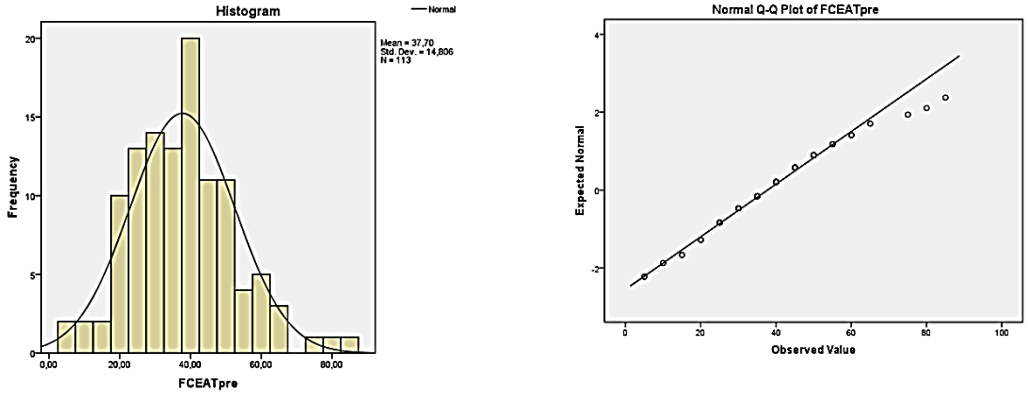

Figure 4.1 Histograms and Q-Q plots

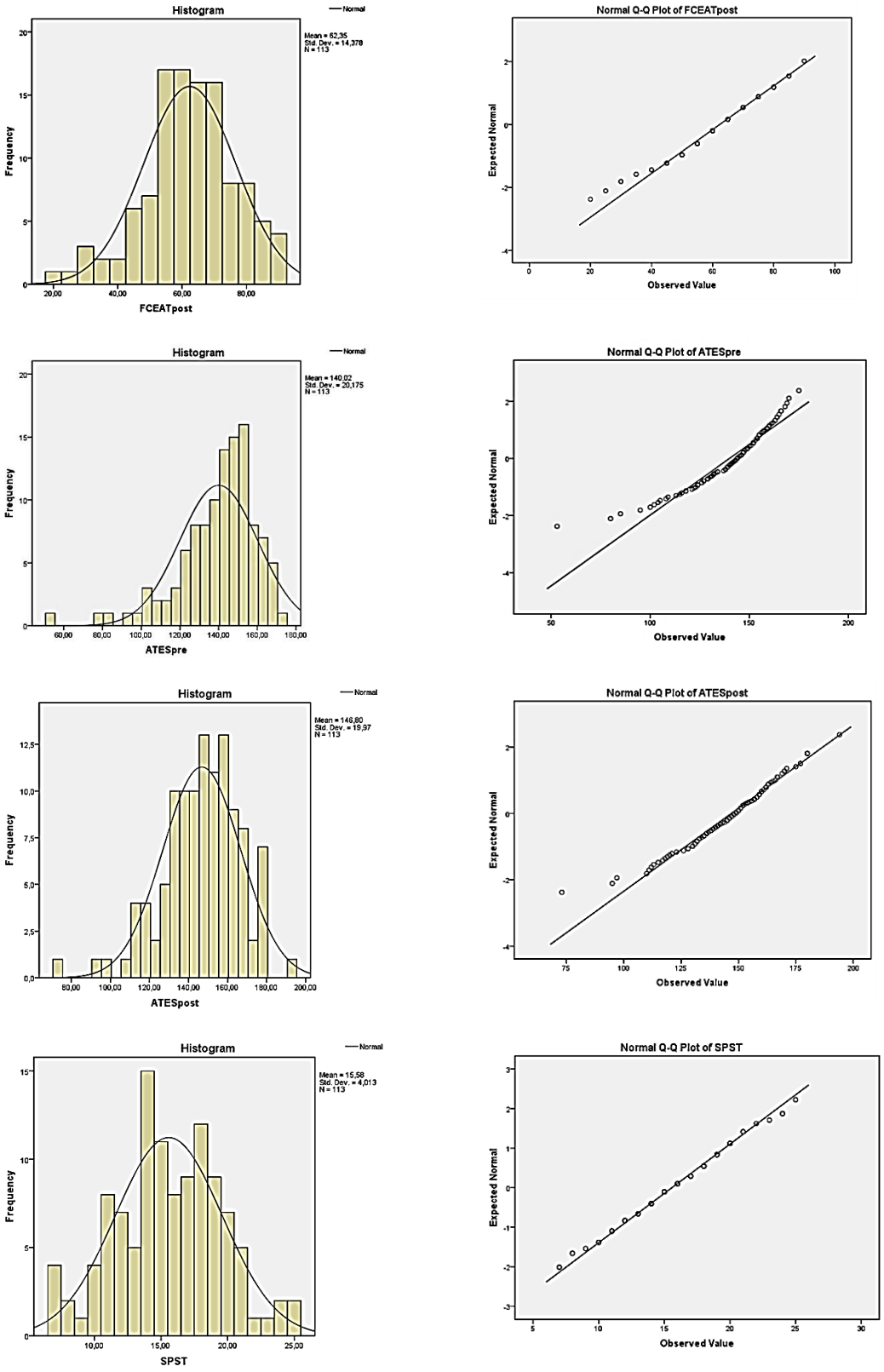

Figure 4.1 (Continued)

Multivariate normality is an extension of normal distribution to multiple variables (Field, 2005, p.739). Multivariate normality was checked by Box's Test of Equality of Covariance Matrices whose result is presented in Table 4.8. According to the test, this assumption was met since the significance value was greater than 0,001 (Field, 2005, p.599).

Table 4.8 Box's Test of Equality of Covariance Matrices

Box's M	25,135
F	2,699
df1	9
df2	116837,681
Sig.	,004

4.2.2.2. Independence of Observations

Independence of observations is another assumption of MANCOVA. Researcher met this assumption via preventing students' interactions when they were taking the tests in the classrooms. Besides, during the procedure of data entrance to the computer program, researcher was watchful and controlled for in order not to violate this assumption.

4.2.2.3. Equality of Variances

Homogeneity of variance is the assumption that the variance of one variable is relatively similar at all levels of another variable (Field, 2005, p.733). It is controlled by Levene's test of equality of error variances. In order to meet the assumption, it is expected to find insignificant values for the dependent variables which means that variances are similar or equal across groups. The results of Levene's test are presented in Table 4.9. The significance values are 0,015 and 0,059 which mean that

the assumption was violated. However, the violation of this assumption is reasonably robust if the sample size of groups are similar (Field, 2005, p.599). Therefore, due to the fact that the sizes of groups were similar in the present study, the violation of the assumption, homogeneity of variance, was not a problem for the analyses.

Table 4.9 Levene's Test of Equality of Error Variances

	F	df1	df2	Sig.
FCEAT-post	3,660	3	109	,015
ATES-post	2,554	3	109	,059

4.2.2.4. Multicollinearity

Multicollinearity refers to the relationship among independent variables. The independent variables of the present study were FCEAT-pre, ATES-pre and SPST scores. When the correlations among independent variables are very high (r = 0.9 and above), multicollinearity exists (Field, 2005, p.175). According to the values in the Table 4.10 which presents the correlations among independent variables, there is not a high correlation which means that the assumption was not violated.

Table 4.10 Correlations Among Independent Variables

	FCEAT-pre	ATES-pre	SPST
FCEAT-pre	1	,123	-,049
ATES-pre	,123	1	,092
SPST	-,049	,092	1

* Correlation is significant at the 0.01 level (2-tailed).

4.2.2.5. Homogeneity of Regression Slopes

The final assumption that was checked for MANCOVA analysis is homogeneity of regression slopes. It is the assumption that the relationship between the covariate and the dependent variable is constant across different treatment levels (Field, 2005, p.733). Similar slopes on the regression line for each group indicates that the assumption was met, otherwise MANCOVA analyses cannot be conducted. The assumption can be checked by homogeneity of regression test. The results are presented in the Table 4.11.

Table 4.11 Tests for Homogeneity of Regression Slopes

Potential Covariates	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
FCEAT-pre	FCEAT-post	15,326	1	15,326	,112	,738
	ATES-post	44,108	1	44,108	,229	,633
ATES-pre	FCEAT-post	261,328	1	261,328	1,918	,170
	ATES-post	31,774	1	31,774	,165	,686
SPST	FCEAT-post	1,543	1	1,543	,011	,916
	ATES-post	41,094	1	41,094	,213	,645

Any significant interaction effect means the violation of the assumption of homogeneity of regression (Garson, 2012). All the significance values in the Table 4.11 were greater than 0.05 which means that the assumption was met.

4.2.3. Results of MANCOVA

Multivariate analysis of covariance (MANCOVA) can be used to examine two or more dependent variables at the same time, in respect of one or more independent variables regarding one or more covariates (Davis, 2003). In the present study, the dependent variables are Fossil Fuels and Clean Energy Resources Achievement Test

post-test scores (FCEAT-post) and Attitudes toward Environment Scale post-test scores (ATES-post); the independent variables are method of instruction and school type. The covariates of the study are Fossil Fuels and Clean Energy Resources Achievement Test pre-test scores (FCEAT-pre), Attitudes toward Environment Scale pre-test scores (ATES-pre) and Science Process Skills Test scores (SPST). The preliminary analyses for checking the assumptions of MANCOVA which are normality, independence of observations, equality of variances, multicollinearity, and homogeneity of regression slopes are presented in Section 4.2.2. The assumptions were met without serious violations and two-way MANCOVA was performed using PASW 18 statistical program. The results of the MANCOVA analyses are presented in Table 4.12.

Table 4.12 Results of MANCOVA

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Observed Power
Treatment	,786	14,307	2,000	105,000	,000	,214	,990
School Type	,981	1,021	2,000	105,000	,364	,019	,082
Treatment* School Type	,930	3,951	2,000	105,000	,022	,070	,457

The first null hypothesis of the study tests the effect of instruction method; the treatment. The Wilks' Lambda value is 0,786 which is significant $F(2,105) = 14,31$, $p = 0,00$; partial eta squared = 0,214 resulting the rejection of the first null hypothesis. Therefore, it can be concluded that there is a significant mean difference on the collective dependent variables of tenth grade students' FCEAT-post and ATES-post scores when students' FCEAT-pre, ATES-pre and SPST scores are controlled. The value of partial eta squared means that 21,4% of the multivariate variability in the dependent variables is explained by the method of instruction. The effect size can be evaluated as large because partial eta squared is greater than 0,138 (Cohen, 1988, p.22). The observed power value is 0,99 which is greater than the previously assigned power of the study which is 0,80.

The second null hypothesis of the study tests the effect of type of school. The Wilks' Lambda value is 0,981 which is not significant F(2,105) = 1,02, p = 0,364; partial eta squared = 0,019 resulting failure of the rejection of the second null hypothesis. Therefore, it can be concluded that there is no significant mean difference on the collective dependent variables of tenth grade students' FCEAT-post and ATES-post scores between Anatolian and vocational high school students when students' FCEAT-pre, ATES-pre and SPST scores are controlled.

The third null hypothesis of the study tests the effect of method of instruction and school type interaction. The Wilks' Lambda value is 0,930 which is significant F(2,105) = 3,951, p = 0,022; partial eta squared = 0,07 resulting the rejection of the third null hypothesis. Therefore, it can be concluded that there is a significant interaction effect of treatment and school type on the population means of collective dependent variables of tenth grade students' FCEAT-post and ATES-post scores when students' FCEAT-pre, ATES-pre and SPST scores are controlled. The value of partial eta squared means that 7% of the multivariate variability in the dependent variables is explained by the interaction of method of instruction and school type interaction. The effect size can be evaluated as medium (Cohen, 1988, p.22). The observed power value is 0,457 which is not greater than the previously assigned power of the study which is 0,80. However, the power of the test is not an important issue if the sample size is greater than 100 (Stevens, 2009, p.6).

When the effects of covariates to the adjustment of the dependent variables are considered, the analyses which is presented in Table 4.13 indicates that all three covariates had significant contributions to the dependent variables. For FCEAT-pre the Wilks' Lambda value of 0,095 was significant F(2,105) = 5,542, p = 0,005, partial eta squared = 0,095. For ATES-pre the Wilks' Lambda value of 0,799 was significant F(2,105) = 13,225, p = 0,000, partial eta squared = 0,201. For SPST the Wilks' Lambda value of 0,911 was significant F(2,105) = 5,136, p = 0,007, partial eta squared = 0,089. The effect size for FCEAT-pre and SPST was medium whereas the effect size for SPST was large (Cohen, 1988, p.22).

Table 4.13 Results of MANCOVA Regarding the Covariate

Effect	Wilks' Lambda	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Observed Power
FCEAT-pre	,095	5,542	2,000	105,00	,005	,095	,649
ATES-pre	,799	13,225	2,000	105,00	,000	,201	,983
SPST	,911	5,136	2,000	105,00	,007	,089	,605

4.2.4. Follow-up ANCOVAs

Follow-up univariate analyses of covariance (ANCOVA) were performed in order to determine the effect of each dependent variable one by one. The results of follow-up ANCOVAs are presented in Table 4.14.

The fourth, fifth and sixth null hypotheses of the study test the effect of instruction method, school type, and interaction of instruction method and school type for FCEAT-post test scores. The seventh, eighth and ninth null hypotheses of the study test the effect of instruction method, school type, and interaction of instruction method and school type for ATES-post test scores.

The fourth null hypothesis of the study tests the effect of instruction method for FCEAT-post test scores. The results showed that the difference between the FCEAT-post mean scores of tenth grade students who were taught via context-based instruction and who were taught via traditional instruction is statistically significant when the effects of the pre-test scores of SPST, FCEAT-pre and ATES-pre are controlled ($F(1,106) = 24,207$, $p = 0,000$, partial eta squared = 0,186) resulting the rejection of the fourth null hypothesis.

Table 4.14 Results of Follow-up ANCOVAs

Dependent Variable	Source	df	F	Sig.	Partial Eta Squared	Observed Power
FCEAT-post	Corrected Model	6	7,719	,000	,304	1,000
	Intercept	1	24,956	,000	,191	,999
	FCEAT-pre	1	9,824	,002	,085	,874
	ATES-pre	1	,000	,990	,000	,050
	SPST	1	,544	,462	,005	,113
	Treatment	1	24,207	,000	,186	,998
	School Type	1	1,936	,167	,018	,281
	Treatment* School Type	1	2,159	,145	,020	,308
ATES-post	Corrected Model	6	9,293	,000	,345	1,000
	Intercept	1	27,950	,000	,209	,999
	FCEAT-pre	1	1,646	,202	,015	,246
	ATES-pre	1	26,660	,000	,201	,999
	SPST	1	9,643	,002	,083	,868
	Treatment	1	3,925	,050	,036	,501
	School Type		,164	,686	,002	,069
	Treatment* School Type	1	5,553	,020	,050	,646

The fifth null hypothesis of the study tests the effect of school type for FCEAT-post test scores. According to the results, mean scores of Anatolian and vocational tenth grade high school students do not differ significantly when the effects of the pre-test scores of SPST, FCEAT-pre and ATES-pre are controlled ($F(1,106) = 1,936$, $p = 0,167$, partial eta squared = 0,018) resulting the failure of rejection of the fifth null hypothesis.

The sixth null hypothesis of the study tests the interaction effect of instruction method and school type for FCEAT-post test scores. It can be concluded from the results that there is no statistically significant interaction effect between instruction

method and school type on tenth grade high school students' FCEAT-post test scores when their pre-test scores of SPST, FCEAT-pre and ATES-pre are controlled ($F(1,106) = 2,159$, $p = 0,145$, partial eta squared = 0,020) resulting the failure of rejection of the sixth null hypothesis.

The seventh null hypothesis of the study tests the effect of instruction method for ATES-post test scores. It was found that that the difference between the ATES-post mean scores of tenth grade students who were taught via context-based instruction and who were taught via traditional instruction is statistically significant when the effects of the pre-test scores of SPST, FCEAT-pre and ATES-pre are controlled ($F(1,106) = 3,925$, $p = 0,050$, partial eta squared = 0,036) resulting the rejection of the seventh null hypothesis.

The eighth null hypothesis of the study tests the effect of school type for ATES-post test scores. According to the results, mean scores of Anatolian and vocational tenth grade high school students do not differ significantly when the effects of the pre-test scores of SPST, FCEAT-pre and ATES-pre are controlled ($F(1,106) = 0,164$, $p = 0,686$, partial eta squared = 0,002) resulting the failure of rejection of the eighth null hypothesis.

The ninth null hypothesis of the study tests the interaction effect of instruction method and school type for ATES-post test scores. According to the results presented in Table 4.14, there is statistically significant interaction effect between instruction method and school type on tenth grade high school students' ATES-post test scores when their pre-test scores of SPST, FCEAT-pre and ATES-pre are controlled ($F(1,106) = 5,553$, $p = 0,020$, partial eta squared = 0,050) resulting the rejection of the ninth null hypothesis.

For each dependent variable two plots were drawn in order to find out the effects of FCEAT-post (Figure 4.2) and ATES-post (Figure 4.3), and estimated marginal means are presented in Table 4.15. The plots are parallel to the findings as expected.

It is clear that context-based instruction in an effective way of teaching for both types of schools on students' conceptual understanding of fossil fuels and clean energy resources topics. Besides, context-based instruction was more beneficial for vocational high school students than for Anatolian high school students. On the other hand, context-based instruction was not effective for improving students' attitudes toward environment for Anatolian high school student whereas it seems to be effective for vocational high school students.

Table 4.15 Estimated Marginal Means

Dependent Variable	Group	School Type	Mean
FCEAT-post	Experimental Group	Anatolian High School	68,291
		Vocational High School	68,518
	Control Group	Anatolian High School	59,509
		Vocational High School	52,702
ATES-post	Experimental Group	Anatolian High School	145,814
		Vocational High School	154,706
	Control Group	Anatolian High School	146,741
		Vocational High School	140,430

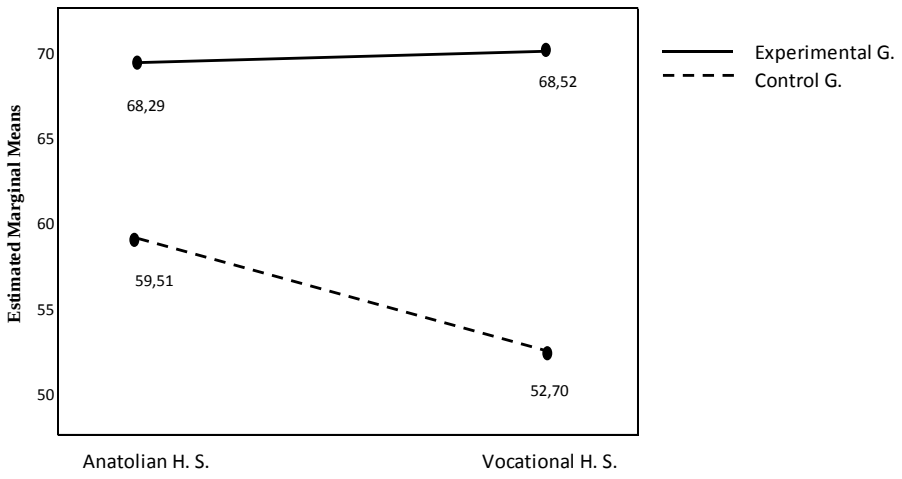

Figure 4.2 Estimated Marginal Means of FCEAT-post

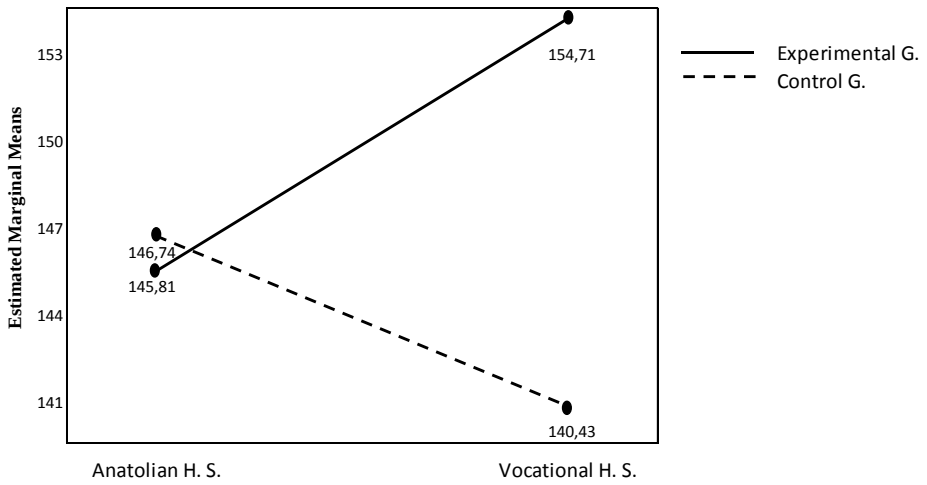

Figure 4.3 Estimated Marginal Means of ATES-post

4.3. Students' Opinions Related to the Treatment

In order to determine and reveal students' opinions and thoughts about context-based instruction Student Questionnaire about Context Based Instruction (SQCBI) was utilized. The results of the questionnaire were reported without considering school type due to the two reasons. Firstly the effect of school type was not statistically significant in the analyses. Secondly, the students mentioned similar statements in both schools.

A total of 56 students who were in experimental group filled in the questionnaire. In the data collection procedure it was announced to the students that there was no need for their personal information in order to obtain freely stated opinions and thoughts. The qualitative data obtained were analyzed via codes and themes. Some of the statements of students were given in quotes as examples.

Students' opinions and thoughts were evaluated in four themes which are (1) the effect of CBI on students' liking chemistry and desire for learning chemistry, (2) the choices of students for the method of instruction (CBI or TI), (3) the effect of CBI on learning chemistry, and (4) the connection of chemistry to daily life.

Two open ended questions and four 5-point Likert scale items were for determining the effect of CBI on students' liking chemistry and desire for learning chemistry. The mean of the level of students' liking chemistry before the treatment were 3,59 whereas it was 4,13 after the treatment. This result showed that the level of students' liking chemistry increased after the treatment. Moreover, 73% of the students stated that there were differences for liking chemistry before and after the treatment whereas 27% of the students stated that there were no differences for liking chemistry before and after the treatment. On the other hand, the mean of the level of students' desire for learning chemistry before the treatment were 3,81 whereas it was 3,94 after the treatment. This result showed that the level of students' desire for learning chemistry increased after the treatment. Besides, 80% of the students stated that there were differences for desire for learning chemistry before and after the treatment whereas 20% of the students stated that there were no differences for desire for learning chemistry before and after the treatment.

The answers of the students about the reasons for differences about liking chemistry can be summed up in three main headings. The first one was about gaining a better understanding about chemistry topics, which was expressed by 45% of the students. Some of the related quotes were as follows;

> "Indeed there has been a difference because I have understood better via this method of instruction and the topics were catchy for me"

> "Beforehand I didn't like chemistry much but as I started to understand chemistry topics, I liked chemistry"

> "I have better understood the subjects after the lessons and therefore I studied chemistry willingly"

The second one was about the connection of chemistry to daily life and the

instructional materials, which was stated by 32% of the students. Some of the related quotes were given below.

> "Since chemistry lessons are closely related to our daily life, I started to like chemistry more"

> "The textbook of chemistry is boring, but the materials we used in the lessons are not boring"

The third one was about enjoyment and interest, which was expressed by 23% of the students. There were two quotes below related to that;

> "Chemistry lessons became enjoyable and became like a swiftly flowing river via this instructional method"

> "Chemistry was not drawing my attention before, as the lessons was to be taught in this way, it has drawn my interest more"

The answers of the students about the reasons for desire for learning chemistry can be summed up in three main headings. The first one was about the connection of chemistry to daily life and the instructional materials, which was expressed by 36% of the students. Some of the related quotes were as follows;

> "The materials we used during the lessons remembered me that chemistry lesson does not only include mathematical calculations"

> "Because chemistry has a great place in our daily life"

The second one was about gaining a better understanding about chemistry topics,

which was expressed by 33% of the students. There were two quotes below related to that;

> "Now, I understand chemistry topics better when compared to the previous lessons"

> "Via activities in the lessons, my chemistry knowledge reinforced, and therefore I have understood chemistry topics better"

The third one was about enjoyment and interest, which was expressed by 31% of the students. Some of the related quotes were given below.

> "This method of instruction aroused my interest toward boring chemistry lessons"

> "I wanted to learn chemistry previously, but now I am more willing to learn chemistry as it is very enjoyable"

The second theme that was arised when students' opinions and thoughts were evaluated was the choices of students for the method of instruction (CBI or TI). A great majority of the students, 98%, preferred CBI and 2% of the students stated that the method of instruction was not an issue for them. Among the students who preferred CBI, 26% stated no reasons for their choice whereas others stated several reasons summed up in three main headings, which are activities related to daily life and instructional materials (28%), comprehensibility and increase in achievement (28%), and enjoyment and increase in interest (18%). Some of the related quotes were given below.

> "As well as the group projects, the activities and the discussions related to daily life conducted in the lessons made the subject matters comprehensible and catchy for me"

"The instructional materials were prepared very well and this made CBI very efficient for learning chemistry"

"I want to learn chemistry via CBI because I became more successful in chemistry lessons and enthusiastic about chemistry after that approach (treatment)"

"Because I got pleasure in the chemistry lessons and our lessons were very enjoyable due to the implementation of CBI"

"I understood chemistry better via CBI and therefore my chemistry scores in the exams will probably increase"

The third theme was the effect of CBI on learning chemistry. Among the students who replied the related item in the questionnaire, none of them expressed negative aspects of CBI on learning chemistry and 30% did not state any explanations for the positive aspects of CBI. Other students stated several reasons summed up in three main headings, which are understanding and learning (30%), activities related to daily life and instructional materials (27%), and enjoyment (13%). Some of the related quotes were given below.

"The discussions about real life contexts resulted in a better understanding on the subject matter for me"

"Previously I was asking myself where I will use the concepts I learn, but now I understood that chemistry is everywhere in my life"

"I comprehended the chemistry topics better via activities, powerpoint presentations, and discussions in the classroom"

One of the students who did not follow and listen chemistry lessons previously stated that;

> "I don't like chemistry lessons in fact I hate, however, a little bit I was able to listen and follow the lessons"

This quote is important for showing the impact of CBI because even for a student who does not deal with any chemistry topics has positively affected by the treatment.

The fourth theme was the connection of chemistry to daily life. 87% of the students stated that CBI contributed to them for establishing relationship between their daily lives and chemistry whereas 13% of the students stated that CBI had not any contribution to the establishment of such a relationship. Some of the students who expressed the connections gave examples related to the subject matters such as petrol and global warming. Some of the related quotes were as follows;

> "As well as the disadvantages I know the properties of gasoline that we buy for our car, and I am aware about the importance of the protection of environment"

> "At my home, I separate the garbage for recycling with my family in order to protect environment"

Furthermore, some of the students stated about the roles in their daily lives due to the knowledge they gained in the lessons. Some of the related quotes were given below.

> "I can make comments on the issues when talking to the adolescents, besides I can participate to the discussions about the issues related to the topics I learned such as pollution and energy issues"

> "Out of the school, now I am able to understand posters, questionnaires and bills related to the topics we learned in the classroom and I am also able to tell and explain them to other people"

To sum up, opinions and thoughts of the students in the experimental group was revealed by Student Questionnaire about Context Based Instruction and they are evaluated in four themes. The results showed that in general CBI had positively affected students in terms of liking chemistry, learning chemistry and establishing connection between chemistry and daily life. Moreover, CBI was seen as a better way of instruction compared to traditional instruction, and during the implementation of CBI most of the students were pleased to express their ideas freely via discussions and activities as well as taking responsibilities via preparing presentations and posters.

CHAPTER 5

CONCLUSIONS, DISCUSSION AND IMPLICATIONS

5.1. Conclusions and Discussion of the Results

The main purpose of the present study was to investigate the effectiveness of context-based instruction as compared to traditional instruction on tenth grade high school students' understanding of fossil fuels and clean energy resources topics and their attitudes toward environment in Turkish classrooms. For that purpose a quasi-experimental study was conducted with a pre-test post-test control group design including a sample of 113 high school students from two different types of schools from two similar districts in terms of socioeconomic status and culture. The independent variables were method of instruction which were context-based instruction and traditional instruction, and school type which were Anatolian and vocational high schools. The student outcomes that were focused on in the study were their achievements in fossil fuels and clean energy resources topics and their attitudes toward environment which were the dependent variables. Moreover, in order to statistically control the possible effects on the dependent variables, students' prior knowledge on fossil fuels and clean energy resources topics and prior attitudes toward environment were considered as covariates in the statistical analyses because students' prior achievement scores and attitude scores are important for their final scores and they can explain up to 70% of the variation in their final scores (Gooding et. al., 1990). Students' science process skills were also controlled and considered as covariates in the statistical analyses because it is probable that students' science process skills may affect their achievement scores. Taking into consideration the

aforementioned purpose, design and the variables, this study established some evidence for the effectiveness of context-based instruction on both students' achievement in chemistry and developing more positive attitudes toward environment in Turkish classrooms, which can be considered as the main contribution to the literature in the field.

In Turkey, the applied educational system is single-center oriented and it includes over-load of curricula. Besides the system wants the teachers strictly abide by the curricula which include predetermined aims and objectives. Furthermore, chemistry curriculum was not based on the principles of context-based instruction. Nevertheless, researchers in the field in Turkey tried to adapt the principles of context-based instruction to the existing curricula in recent years (Acar & Yaman, 2011; Balta & Eryilmaz, 2011; Cigdemoglu, 2012; Demircioglu, Demircioglu & Calık, 2011; Ekinci, 2010; Elmas, 2012; İlhan, 2010; Kutu & Sozbilir, 2011; Sunar, 2013).

In the present study, the topics taught via context-based instruction were fossil fuels and clean energy resources. It was the first time in chemistry curriculum in Turkey that these two topics had been introduced. The two topics include several concepts not requiring any mathematical calculations which can be considered as a limitation for teaching and learning chemistry. Therefore, including various concepts and not necessitating any mathematical calculations, the topics make the study feasible and practical in evaluating the effectiveness of context-based instruction (Elmas, 2012). Furthermore, although the two topics are closely related to students' everyday lives, they are presented in the school textbooks of students in a way that the concepts are something out of and irrelevant to daily life. In the present study, the utilized lesson materials which were designed according to context-based instruction supported students' chemistry achievement and attitudes toward environment because the students realized that the chemistry knowledge they learned are meaningful and connected to their daily lives, which makes them more interested in chemistry lessons (Parchmann et al., 2006) and results in gaining achievement in chemistry (Gutwill-Wise, 2001).

One of the main results of the study was about the achievement of students on understanding fossil fuels and clean energy resources topics. The achievement of students who were taught via context-based instruction was significantly greater than the students who were taught via traditional instruction in both schools. The students from both Anatolian and vocational high schools benefited from context-based instruction in almost same degree (X_{EG} = 68,3 for Anatolian HS and X_{EG} = 68,5 for vocational HS). This finding of the study about the effectiveness of context-based instruction on students' achievement was consistent with the findings of previous international studies (Barber, 2000; Barker & Millar, 1996; Barker & Millar, 1999; Barker & Millar, 2000; Gutwill-Wise, 2001; Lubben, Campbell & Dlamini, 1997; Ramsden, 1997; Smith & Bitner, 1993; Wierstra, 1984) as well as the findings of research studies conducted in Turkish context (Acar & Yaman, 2011; Çam, 2008; Demircioglu, Demircioglu, & Calık, 2009; İlhan, 2010; Kutu & Sozbilir, 2011; Özay Köse & Çam Tosun, 2011; Peşman, 2012; Tekbıyık, 2010; Toroslu, 2011; Ültay, 2012; Ünal, 2008; Yaman, 2009; Yayla, 2010). On the other hand, there are several international studies presenting consisting findings with the present study (Benckert,1997; Cooper,Yeo & Zadnik, 2003; Murphy, Lunn & Jones, 2006; Rayner, 2005; Wade & Saxe, 1996; Wierstra & Wubbels, 1994), but they have important methodological problems, which results in uncertain findings about the effectiveness of context-based instruction on students' achievement. Therefore, it can be concluded that there has not been a consensus on the effectiveness of context-based instruction in the literature (Taasoobshirazi & Carr, 2008) due to the failure of not including control groups or pre-tests and the failure in the designs as well as the theoretical backgrounds of the implementations (Medrich, Calderon & Hoachlander, 2003). Considering previous research studies, this study is of utmost importance in that it includes a careful design, a control group, pre-tests, and evidence based on statistical analyses as well as an effective methodology based on a theory.

The reason for the findings of the study about the effectiveness of context-based instruction on students' achievement may be due to the context-based instructional materials and the activities students performed in the experimental group. The

instructional materials were prepared in a way that students gained a chance for a deeper understanding about the topics through classroom discussions and activities, which was resulted a significant increase in achievement. Moreover, during the lessons, students discussed about the issues in the contexts and presented their ideas by using a chemical language. At the end of each topic they also solved exercises either individually or in groups, besides they prepared group projects and presented their projects at the end of the lessons. All of these activities in the context-based instruction contributed to students' understanding about the topics as well as their chemistry achievement.

Furthermore, through the lessons in experimental group, students worked in groups collaboratively, presented their ideas, communicated and produced; whereas students in control group worked alone, competed one another instead of collaboration and took information from the teacher. Besides, in experimental group teacher behaved as an advisor or a coach showing way of learning; whereas in control group teacher behaved as an expert answering the questions directly. These differences in both students' roles and teachers' roles in experimental and control groups may have contributed to students' chemistry achievement in experimental group.

Compared with traditional instruction which slightly emphasizes the connection of chemistry to daily life and in which pure chemical facts are given strictly, context-based instruction establishes a link between chemistry and daily life through several activities (Barber, 2000; Barker & Millar, 2000; Gutwill-Wise, 2001). In the present study, for instance, the topic about fossil fuels was closely related to students' daily lives. Students evaluated and discussed the role of coal and petroleum in the society as well as advantages-disadvantages of using coal and petroleum using the organic structures of the substances in order to understand the context. In this way, students gained a better understanding about the topic by utilizing the context and using specific chemical language. Therefore, in the present study students probably apprehended that chemistry topics were not abstract things that was not connected to everyday life, on the contrary they understood that chemistry were related to every part of their lives, which might possibly contributed to their achievement.

When the results related to students' attitudes toward environment are considered, it was found that the difference between the ATES-post mean scores of tenth grade students who were taught via context-based instruction and who were taught via traditional instruction was significant. Nevertheless, partial eta squared value was calculated as 0,036 which refers a small effect size. It means that only 3,6% of the variance of the dependent variable accounted for by the treatments. In fact, the difference between experimental and control groups was only in vocational high school (X_{EG} = 154,7 and X_{CG} = 140,4). On the other hand, the means for experimental and control groups in Anatolian high school were very close (X_{EG} = 145,8 and X_{CG} = 146,7). Therefore, it can be concluded that the statistically significant difference between groups was due to the difference on only one type of school which was vocational high school. This situation can also be evaluated as an explanation for the calculated small effect size. Moreover, this small effect size may be explained by the complex structure of attitudes. As it is known, it is difficult to change affective variables such as attitudes and self-efficacy beliefs in a short term treatment. The treatment in the study took six weeks and this duration was possibly not long enough to change students' attitudes toward environment utterly and persistently as reported in previous short term studies (Elmas, 2012; Kutu & Sozbilir, 2011). But in long term implementations of context-based approaches, it was reported that students developed more positive attitudes such as in Salters course (Ramsden, 1997), in ChemConnections (Gutwill-Wise, 2001), in CiC course (Schwartz, 2006), and in Chemie im Kontext project (Parchmann et al., 2006).

Furthermore, as was just mentioned in the previous paragraph, the means of ATES-post scores of students in each group were quite high considering that the highest score that a student could get in the scale was 180. These high ATES-post scores of students raised the researcher's doubt for the sincerity of the students It was probable that most of the students in the study might have answered the questionnaire as what was expected from them by the society due to the fact that being a person sensitive toward the protection of environment is considered as a good thing parallel to the society's value judgment. Therefore, one of the assumptions of the present study was that the students responded to each item in each instrument faithfully and sincerely.

In some previous studies, attitude changes toward environment and chemistry were reported (Demircioglu, Demircioglu, & Calık, 2009; Gutwill-Wise, 2001; İlhan, 2010; Rayner, 2005; Schwartz, 2006; Sutman & Bruce, 1992; Ultay & Calık 2011) whereas there were studies which reported no significant changes in students' attitudes toward environment and chemistry (Elmas, 2012; Gutwill-Wise, 2001; Kutu & Sozbilir, 2011; Parchmann et al., 2006). In general there is an increase in students' attitudes when they are instructed via context-based instruction (Barber, 2000; Gutwill-Wise, 2001; Parchmann et al., 2006). However, the studies reporting no change in attitudes have some limitation such as errors in the edition of the instructional materials, the ideas of the students about being a part of an experiment (Gutwill-Wise, 2001) and the high complexity level of the contexts (Parchmann et al., 2006). Even though there are studies reporting no attitude changes in context-based instruction, there has been a consensus about the effectiveness of context-based instruction on attitudes of students especially in long term implementations (King, 2012).

In this study, the effect of school type for students' FCEAT-post and ATES-post scores was not statistically significant. The underlying reason for this finding may be due to the socioeconomic status. The two schools in the study were from two districts which are very similar in terms of distance to the city center, cultural traits and socioeconomic status, and great majority of the students were belonged to medium socioeconomic status families. According to OECD (2012), the level of student achievement in schools is closely related to their parents' socioeconomic status. This finding of the study about the effect of school type on students' achievement and attitudes toward environment was consistent with the findings of the study of Elmas (2012). Moreover, in previous studies, some researchers applied similar treatments in terms of instructional approaches, and found similar increase in students' achievement in different types of schools in Turkish context (Bektas, 2011; Bulbul, 2010; Tekbıyık, 2010). On the other hand, some researchers reported that achievement of students changes according to school types (Berberoglu & Kalender, 2005; Demirel, 1986; Jimenez, Lockheed, & Paqueo, 1991; Newhouse & Beegle, 2006) owing to the fact that private high schools and some general high schools are

well equipped in terms of instructional materials, technological devices and qualifications of teachers.

In the present study the interaction effect of instruction method and school type for students' ATES-post scores was statistically significant. The reason for that finding was due to the fact that there was only high difference between ATES-post scores of experimental and control groups in vocational high school (X_{EG} = 154,7 and X_{CG} = 140,4) but there was not high difference between ATES-post scores of experimental and control groups in Anatolian high school (X_{EG} = 145,8 and X_{CG} = 146,7).

In order to reveal students' opinions about the context-based instruction, Student Questionnaire about Context Based Instruction was utilized. The students expressed pleasure for the treatment. In addition, they stated that the treatment increased their motivation toward chemistry and they realized that there is a connection between chemistry topics and their daily lives. The reason for those statements of students should be due to the effectiveness of the treatment because the implemented lesson materials include questions that prompt students to think about the subject matter and to make discussions on the issues related to their everyday lives. Furthermore, the detailed teacher guides also contributed to the effectiveness of the treatment as they aided teachers via showing ways for the implementation of context-based instruction properly.

The findings of the present study have not only statistical importance but also have practical importance. The partial eta squared value and observed power values were evidence for that. In the results of MANCOVA, value of partial eta squared was calculated as 0,214 which means that 21,4% of the multivariate variability in the dependent variables was explained by the method of instruction. This effect size value can be evaluated as large because partial eta squared is greater than 0,138 (Cohen, 1988, p.22). Moreover, observed power value was 0,99 which means that it is highly probable to ascertain the true effect of the treatment.

To conclude, the main purpose of the present study was to investigate the effectiveness of context-based instruction as compared to traditional instruction on students' achievement and attitudes toward environment. The results of this study showed that context-based instruction is an effective way of teaching chemistry in high schools. Utilizing context-based instructional materials and conducting the activities in the classroom resulted in a better understanding on the topics and students developed more positive attitudes. Through context-based instruction, the students realized and appreciated that there was a clear link between chemistry and everyday life, which is the main contribution of context-based instruction. Moreover, although attitudes are known to be resistant to changes especially in short term, it was found that students' attitudes toward environment were developed positively in the present study, which also shows the effectiveness of the implementation. Furthermore, the findings of the present study were statistically and practically significant.

5.2. Internal Validity

In research studies ensuring internal validity is very important for evaluating the results of the study correctly. Fraenkel and Wallen (2009, p.G4) defines internal validity as "the degree to which observed differences on the dependent variable are directly related to the independent variable, not to some other (uncontrolled) variable". In a research study, there are several possible threats to internal validity such as attitude of subjects, instrument decay, data collector characteristics, and so on… Among these threats, the most crucial and critical ones were subject characteristic and attitude of subjects threats for the present study. In the following paragraphs the possible threats to internal validity was briefly explained related to the present study.

Subject characteristic (e.g. age, intelligence, prior knowledge etc.) threat was tried to be eliminated by a statistical procedure, multivariate analyses of covariance, in which the effects of some characteristics of the participants are eliminated to some extent.

At the beginning of the study students' SPST, ATES-pre, and FCEAT-pre scores were obtained and used as covariates in the statistical analyses in order to statistically equalize students at least on these variables and come over this threat to internal validity. Moreover, random assignment of intact classes to experimental and control groups was also assumed to have contribution to eliminate subject characteristic threat. However, there are a great number of subject characteristics and it is not possible to eliminate all of them practically and lack of randomization in assignment of students to groups was a limitation for this threat in the present study.

Attitude of subjects was also a threat to internal validity and it includes Hawthorn effect, John Henry effect and demoralization effect. Hawthorn effect occurs when students in experimental groups develop positive attitudes and feelings because of the implementation. John Henry effect occurs when students in the control groups realize that they are not taking special treatment and try harder than usual. It is not completely possible to eliminate these threats practically. However, in order to eliminate attitude of subjects threat the two teachers were trained to behave in a way that the context-based instruction were a part of the regular instruction. Furthermore, some colored question sheets were given to control groups to control these threats. Whatever a researcher does, attitude of subjects threat is always a limitation for all research studies because students communicate each other and realize what is going on in the research study.

Testing, implementation, location, maturation, history, mortality and instrumentation were threats to internal validity which were eliminated by the researcher or not an issue for the present study. Due to the pre-test post-test design of this study, testing was a threat to internal validity. Because each of the experimental and control groups took the pre-test and because the duration between the pre-test and post-test tests were long enough not to remember (six weeks), this threat was assumed to be controlled. Implementation is also a threat to internal validity in experimental researches. In the present study, two teachers implemented the two methods which are traditional instruction and context-based instruction. Besides, during the lessons in both groups researcher randomly attended to the classes several times and

observed the implementation. Therefore, implementation threat was controlled in the present study.

Another threat to internal validity is location. In the present study, this threat was controlled because the conditions of schools were similar. Maturation threat to internal validity was not an issue in the study because the research study lasted for only six weeks. Moreover, during the research study, no important events that affect the students positively or negatively occurred. Therefore, history threat to internal validity was also controlled. Besides, mortality is the loss of subject through the research study. In the present study, some students did not attend to class during the testing sessions. These students were not more than 10% of the sample and were not taken into consideration in the data analyses. This threat was not an issue for the study.

Instrument decay, data collector characteristics, and data collector bias are the threats to internal validity related to instrumentation. Since all of the instruments (FCEAT, ATES, and SPST) used to collect data included multiple choice questions, scoring of the instruments was not an issue. Therefore, instrument decay was not a threat for the present study. Furthermore, data collector characteristics and data collector bias threats to internal validity were eliminated by the researcher via training the teachers for using standard procedures during collecting data.

5.3. External Validity

Fraenkel and Wallen (2009, p.G3) define external validity as the degree to which the findings of a particular research study are generalizable to groups and environments outside the setting of the research study. The present study was conducted in Etimesgut and Sincan districts of Ankara. In Etimesgut district there are 7 vocational and 10 Anatolian high schools whereas in Sincan district there are 12 vocational and 7 Anatolian high schools. There are a total number of 19 vocational and 17 Anatolian high schools in both districts. Because these two districts are very similar in terms of distance to the city center, cultural traits, and socioeconomic status, one school from

each district selected conveniently without regarding the district. Anatolian high school was in Etimesgut district and vocational high school was in Sincan district.

Although the schools equipped with technological devices and laboratories, science teachers use them seldom as in the whole country. The districts where the schools situated are far from the city center and medium socioeconomic status people live in these districts. Therefore, great majority of the students were belonged to medium socioeconomic status families. 113 students comprised the sample of the present study and it was not more than 10% of the accessible population. Therefore, the generalizability of the study can be said to be limited due to having the sample very limited and low proportion to accessible population. Moreover, the results of the study could only be generalized to Anatolian and vocational high school students but not to other types of schools such as private high schools.

5.4. Implications

1. Context-based instruction is more effective than traditional instruction on students' understanding on fossil fuels and clean energy resources topics. Therefore context-based instruction can be used as an alternative method of instruction in high schools.

2. Context-based instruction enlightens students for the applications of chemistry to their daily lives. This makes students more interested in chemistry and contributes to their motivation for learning chemistry.

3. The materials developed in the study for context-based instruction can be used in the classrooms by chemistry teachers in high schools, by curriculum developers in designing effective chemistry courses, and by chemistry textbook writers.

4. There are not a lot of materials developed for context-based instruction in our country. Therefore, the similar studies to the present study should be supported for the development of context-based materials.

5. Adoption of context-based instruction to chemistry curriculum might be taken into consideration by curriculum developers in Ministry of National Education. The whole chemistry curriculum might be grounded at context-based instruction.

6. In in-service teacher training programs of Ministry of National Education, context-based instruction may be presented to chemistry teachers and enable teachers for the implementation of the context-based instruction in their classrooms.

7. In education faculties of universities, context-based instruction may be included, and in this way, pre-service teachers would be aware of this instruction method.

5.5. Recommendations for Further Research

1. In order to increase generalizability, similar research studies can be conducted with an increased sample size, various school types, different grade levels and various chemistry topics.

2. Similar research studies can focus on the effects of context-based instruction on different affective variables such as motivation and self-efficacy.

3. Similar research studies can take into account different parameters such as gender, intelligence and socioeconomic status.

4. Including more chemistry topics, similar studies can be conducted with longer periods of time.

5. The effect of context-based instruction on students' several skills such as science process skills and higher order thinking skills can be investigated in similar research studies.

6. Similar research studies can be conducted to investigate the effects of context-based instruction on retention of knowledge.

7. Qualitative research studies can be conducted to explore the effects of context-based instruction on students' understandings of chemistry concepts as well as improvement of students' affective variables.

8. Similar research studies can be conducted to monitor and explore the effects of context-based instruction on students' future career plans and choices.

9. Different assessment methods can be used in a similar research study to assess the achievement of students in a context-based instruction.

10. The effects of teachers' pedagogical content knowledge on the implementation of context-based instruction can be investigated in a future research study.

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APPENDIX A

FOSSIL FUELS AND CLEAN ENERGY RESOURCES ACHIEVEMENT TEST

1. Fosil kaynaklı bir yakıt olan kömür ile ilgili aşağıda verilen ifadelerden hangisi <u>yanlıştır</u>?

A) Kömürün yakıt olarak kullanılması asit yağmurlarını oluşturan sebeplerden biridir.
B) Kömür yakıldığında atmosfere CO_2, NO ve SO_2 gibi gazlar salınır.
C) Demir – çelik sanayisinde kullanılır.
D) Kömür doğal bir yakıt olduğu için yakılması doğaya zarar vermez.
E) Termik santrallerde kullanılır.

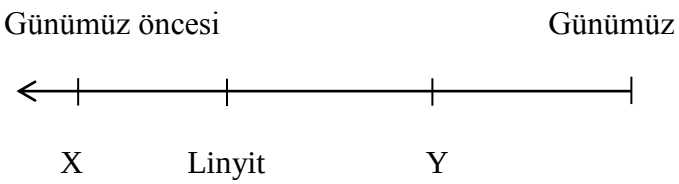
2. Aşağıdakilerden hangisi bir kömür türü <u>değildir</u>?

A) Linyit
B) Antrasit
C) Fuel oil
D) Alt bitümlü
E) Bitümlü

3. Kömür ile ilgili aşağıda verilen ifadelerden hangisi <u>yanlıştır</u>?

A) Karbonlaşma sürecinin uzunluğu arttıkça kömürün kalitesi (enerji miktarı) artar.
B) Kömürleşme birkaç bin yıllık bir süre içerisinde gerçekleşebilir.
C) Kütlece karbon yüzdesi fazla olan kömürün ısıl değeri yüksek olur.
D) Demir-çelik endüstrisinde taş kömürü gibi enerji değeri yüksek olan kömürler kullanılır.
E) Deltalar, lagünler, göller, nehirler ve akarsu taşıma ovaları kömür oluşumu için uygun ortamlardır.

4. Kömürleşme süresi (milyon yıl)



Yukarıdaki zaman skalasında yerleri belirtilen X ve Y maddeleri aşağıdakilerden hangisindeki gibi olabilir?

	X	Y
A)	Antrasit	Turba
B)	Antrasit	Taş kömürü
C)	Turba	Taş kömürü
D)	Turba	Antrasit
E)	Taş kömürü	Bitümlü

5. Aşağıdaki ürünlerden hangisi ham petrolün bileşenlerinden <u>değildir</u>?

A) Petrol eteri
B) Turba
C) Zift
D) Sıvı parafin
E) Motorin

6. Petrol ile ilgili aşağıda verilen ifadelerden hangisi <u>yanlıştır</u>?

A) Fosil kaynaklı bir yakıttır.
B) İçerdiği temel elementler karbon (C) ve hidrojen (H) dir.
C) Damıtılmasıyla benzin, motorin gibi maddeler elde edilir.
D) Yer altından çıkarılan tüm petroller aynı özelliktedir.
E) Yüzlerce farklı bileşenden oluşan bir karışımıdır.

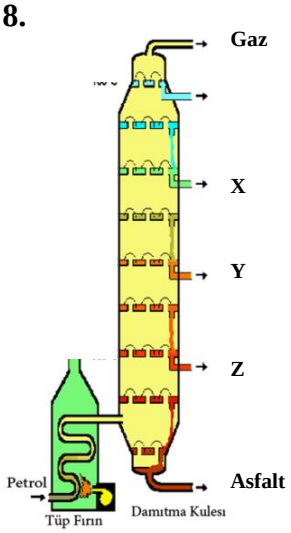
7. Petrol oluşumunda bitki ve hayvan kalıntıları,

I. ısı ve basınç,
II. bakteri,
III. kataliz

etkenlerinden hangileri altında kimyasal bozunma ve moleküler değişime uğrar?

A) Yalnız I
B) Yalnız II
C) I ve III
D) II ve III
E) I, II ve III

8.



Şekilde ham petrolün ayrımsal damıtılmasında kullanılan destilasyon kolonunda bir bölüm verilmiştir.

Bu kolonun en üstünde **gaz** en altında **asfalt** elde edilmiştir.

Buna göre ham petrolden elde edilen X, Y, Z ürünlerinin kaynama sıcaklık aralıkları arasındaki ilişki nedir?

A) X>Y>Z
B) Y>Z>X
C) Z>Y>X
D) Y>X>Z
E) X>Z>Y

9. Alken ve alkinler ile ilgili,

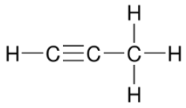
I. En basit üyeleri iki karbonludur.
II. Doymamış hidrokarbonlardır.
III. Oksijen ile yanma tepkimesi verirler.

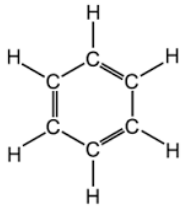
ifadelerinden hangileri doğrudur?

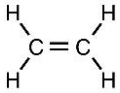
A) Yalnız II
B) I ve II
C) I ve III
D) II ve III
E) I, II ve III

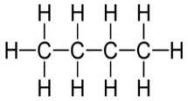
10. Aşağıda formülü verilen bileşiklerden hangisinin adı <u>yanlış</u> verilmiştir?

A)  Pentan

B)  Propin

C)  Benzen

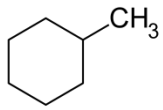
D)  Eten

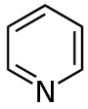
E)  Bütan

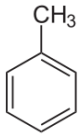
11. Hidrokarbonlar ile ilgili aşağıda verilen ifadelerden hangisi <u>yanlıştır</u>?

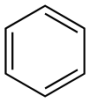
A) Oksijen ile tepkimelerinden CO_2 ve H_2O oluşur.
B) Yanıcı değildirler.
C) Alkanlar doymuş hidrokarbonlar olarak sınıflandırılırken alken ve alkinler doymamış hidrokarbonlar olarak sınıflandırılır.
D) Düz zincirli oldukları gibi halkalı yapıda da olabilirler.
E) Organik bileşiklerdir.

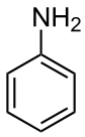
12. Aşağıda verilen bileşiklerden hangisi aromatik bileşik <u>değildir</u>?

A) 

B) 

C) 

D) 

E) 

13. Aşağıdaki maddelerden hangisi bitkisel kaynaklardan elde edilen yakıtlara örnek olarak <u>verilemez</u>?

A) Etanol
B) Biyogaz
C) Doğal gaz
D) Trigliserit
E) Biyodizel

14. Enerji kaynakları genelde yenilenebilir ve tükenebilir olmak üzere iki grup altında toplanırlar.

Buna göre,

I. Rüzgâr enerjisi
II. Petrol
III. Doğal gaz
IV. Güneş enerjisi
V. Kömür

enerji kaynaklarının yenilenebilir ve tükenebilir şeklinde sınıflandırılması aşağıdakilerden hangisinde doğru olarak verilmiştir?

	<u>Yenilenebilir</u>	<u>Tükenebilir</u>
A)	I, II ve III	IV ve V
B)	I ve II	II, IV ve V
C)	I ve IV	II, III ve V
D)	I ve V	II, III ve IV
E)	IV ve V	I, II ve III

15. Alternatif enerji kaynakları kullanılarak,

I. Çevre kirliliğinin önüne geçilir.
II. Enerji maliyetleri azalır.
III. Dışa bağımlılık azalır.

kazanımlardan hangileri elde edilebilir?

A) Yalnız I B) I ve II C) I ve III
D) II ve III E) I, II ve III

16. Aşağıdakilerden hangisi biyogazın kullanım alanlarından <u>değildir</u>?

A) Doğrudan yakarak ısınma ve ısıtma
B) Motor yakıtı olarak kullanımı suretiyle ulaşım
C) Türbin yakıtı olarak kullanımı ile elektrik üretimi
D) Su ile karıştırılarak petrol eldesi
E) Mevcut doğalgaza katılarak maliyetlerin düşürülmesi

17. Aşağıdakilerden hangisi rüzgâr enerjisinin avantajlarından <u>değildir</u>?

A) Sessizdir ve gürültü kirliliği yapmaz.
B) Kaynağı güvenilirdir, tükenme ve zamanla fiyatının artma riski yoktur.
C) İşletmeye alınması kısa sürede gerçekleşebilir.
D) Ücra yerlerde elektrik tedarik etmek için iyi bir yöntemdir.
E) Atmosferde bol ve serbest halde bulunur.

18.

X: Termal turizmde kullanılan ve kaynağı su olan enerji.
Y: Hareket halindeki havanın kinetik enerjisinden yararlanılan enerji.
Z: Kaynağı okyanus ve denizler olan enerji.

Yukarıda X, Y ve Z ile tanımlanan enerjiler aşağıdakilerden hangisinde doğru verilmiştir?

	X	Y	Z
A)	Güneş	Rüzgâr	Jeotermal
B)	Jeotermal	Rüzgâr	Dalga
C)	Güneş	Dalga	Hidroelektrik
D)	Jeotermal	Güneş	Dalga
E)	Hidroelektrik	Güneş	Jeotermal

19. Hidroelektrik santraller ile ilgili,

I. Çevreye zararlı gazlar yayarlar.
II. Yakıtı kömür olan termik santraller kadar çevreyi kirletmezler.
III. Kuruldukları yöredeki ekolojik dengeyi değiştirirler.

yargılarından hangileri doğrudur?

A) Yalnız I
B) I ve II
C) I ve III
D) II ve III
E) I, II ve III

20.

I. Hidrojen enerjisi içten yanmalı motorlarda doğrudan kullanılabilir.
II. Güneş enerjisi santrallerinin maliyeti çok yüksektir.
III. Hidrojen enerjisi ve güneş enerjisi temiz enerji kaynaklarındandır.

Yukarıdaki ifadelerden hangileri doğrudur?

A) Yalnız I
B) I ve II
C) I ve III
D) II ve III
E) I, II ve III

APPENDIX B

ATTITUDE TOWARD ENVIRONMENT SCALE

Sevgili öğrenciler,
Bu ankette, çevreye ilişkin tutum cümleleri ile her cümlenin karşısında "Kesinlikle katılıyorum", "Katılıyorum", "Kararsızım", "Katılmıyorum" ve "Kesinlikle katılmıyorum" olmak üzere beş seçenek verilmiştir. Her cümleyi dikkatle okuduktan sonra kendinize uygun sadece bir seçeneği işaretleyiniz. Cevaplarınız gizli tutulacaktır. Yardımlarınız için şimdiden teşekkür ederiz.

Ad Soyad : **Okul :** **Sınıf :**

	Kesinlikle katılıyorum	**Katılıyorum**	**Kararsızım**	**Katılmıyorum**	**Kesinlikle katılmıyorum**
1. Hayvanların hayatını korumak için bazı hayvansal ürünleri satın almaktan vazgeçebilirim.					
2. Klimayı daha az kullanarak enerji tasarrufu yapabilirim.					
3. Su tasarrufu için banyo yaparken daha az su kullanabilirim.					
4. Çevre korumasına yardımcı olmak için kendi cebimden bir miktar para verebilirim.					
5. Hava kirliliğini azaltmak için mümkün olduğunca toplu taşıma araçlarına binebilirim.					
6. Evdeki atıkları geri dönüşüm için ayırabilirim (cam, plastik, kağıt vs.).					
7. Vahşi hayvanların korunmasına yardımcı olmak için kendi cebimden bir miktar para verebilirim.					
8. Enerji tasarrufu için sarfiyatı az olan lambalar kullanabilirim.					
9. Su tasarrufu için ellerimi sabunlarken musluğu sürekli açık tutmayabilirim.					

10.	İnsanları çevre konusunda bilgilendirmek için çeşitli faaliyetlerde bulunabilirim.					
11.	İnsanlara, çevre kirliliğini azaltmakta yardımcı olmaları için mektup, e-mail yazabilirim.					
12.	İnsanları geri kazanma yöntemlerini kullanmaya ikna etmeye çalışabilirim.					
13.	Bir çevre sorununu çözümlemek için hiç çaba sarf etmedim.					
14.	Çevre sorunlarının çözümüne nasıl yardımcı olunabileceği konusunda ailemle konuşurum.					
15.	Dişlerimi fırçalarken su tasarrufu için musluğu sürekli açık tutmam.					
16.	Enerji tasarrufu için evde gereksiz yanan ışıkları söndürürüm.					
17.	Ailemden hayvan kürkünden yapılmış ürünleri almamalarını isterim.					
18.	Aileme bazı çöpleri geri dönüşüm kutusuna atmalarını söylerim.					
19.	Çevre konuları ile ilgilenen resmi örgütlere çevre kirliliğini azaltmak için ne yapabileceğimi sorarım.					
20.	Çoğunlukla çevre konulu belgeselleri seyrederim.					
21.	Musluğu gereksiz yere açık bırakmam.					
22.	Buzdolabının kapağını uzun süre açık bırakmam.					
23.	Evimizin balkonuna gelen kuşları beslerim.					
24.	Geri dönüşümü sağlanabilecek olan atıkları ayırırım.					
25.	İnsanların çevre konusunda duyarlı olmadıklarını düşünmek beni üzer.					
26.	Kirliliğin çevreye verdiği zarar beni tedirgin eder.					
27.	İnsanların şişe ve kâğıtları kullandıktan sonra geri dönüşüm kutusuna attığını görünce mutlu olurum.					
28.	Bazı firmaların, hayvanlar üzerinde kimyasal maddeleri denediklerini düşündüğümde üzülürüm.					
29.	İnsanların enerji tasarrufu yapmaya çalıştıklarını görmek beni mutlu eder.					
30.	Susuz kalmaktan korkarım.					
31.	Çevre sorunlarıyla ilgilenmem.					
32.	Çevre kirliliğinin bizlere verebileceği zarar beni korkutur.					
33.	İnsanların geri dönüşümü mümkün olan atıkları geri dönüşüm kutularına atmadıklarını görmek beni üzer.					
34.	Hayvanların yaşam alanlarına bina yapıldığını görünce üzülürüm.					
35.	Gereğinden fazla su tüketimi beni üzer.					
36.	Boşa sarf edilen enerjinin ne kadar fazla olduğunu düşünmek beni üzer.					

APPENDIX C

STUDENT QUESTIONNAIRE ABOUT CONTEXT BASED INSTRUCTION

Aşağıdaki ilk iki soru derslerinizin Yaşam Temelli Öğrenme (YTÖ) yaklaşımına (derslerde günlük yaşam ile ilgili bağlamlar, etkinlikler, proje ödevlerinin vb.) göre işlenmeden önceki ve sonraki fikirlerinizin belirtilmesine yöneliktir. Diğer sorular ise, yaşam temelli öğrenme yaklaşımının uygulamaları hakkındaki görüşlerinizin belirlenmesine yöneliktir.

Katkılarınızdan dolayı teşekkür ederiz.

1.

Dersler YTÖ yaklaşımına göre **işlenmeden önceki** durumda *(Derslerde günlük yaşam ile ilişkili bağlam, etkinlik, tartışma, proje ödevi, vb.* ***kullanılmaması)*** kimya dersini sevme *(ilgi, merak vb.)* derecenizi belirtiniz.	Hiç Sevmiyordum	Sevmiyordum	Kararsızım	Seviyordum	Çok Seviyordum
	1 ○	2 ○	3 ○	4 ○	5 ○
Dersler YTÖ yaklaşımına göre **işlendikten sonra** *(Derslerde günlük yaşam ile ilişkili bağlam, etkinlik, tartışma, proje ödevi, vb.* ***kullanılması)*** kimya dersini sevme *(ilgi, merak vb.)* derecenizi belirtiniz.	Hiç Sevmiyorum	Sevmiyorum	Kararsızım	Seviyorum	Çok Seviyorum
	1 ○	2 ○	3 ○	4 ○	5 ○

Dersler YTÖ yaklaşımına göre işlenmeden önce ve sonra, kimya dersini sevme (ilgi, merak vb.) dereceniz arasında bir fark var ise bunun nedenlerini açıklayınız.

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2.

YTÖ yaklaşım ile derslerin **işlenmeden önceki** (Derslerde günlük yaşam ile ilişkili bağlam, etkinlik, tartışma, proje ödevi, vb. kullanılmaması) kimyayı öğrenme isteğinizin derecesini belirtiniz. *(kimyayı öğrenmenin gerekliliği)*	Hiç öğrenmek istemiyordum	Öğrenmek istemiyordum	Kararsızım	Öğrenmek istiyordum	Öğrenmeyi çok istiyordum
	1 ○	2 ○	3 ○	4 ○	5 ○

YTÖ yaklaşımı ile **derslerin işlenmesinden sonra** (Derslerde günlük yaşam ile ilişkili bağlam, etkinlik, tartışma, proje ödevi, vb. kullanılması) kimyayı öğrenme isteğinizin derecesini belirtiniz. *(kimyayı öğrenmenin gerekliliği)*	Hiç öğrenmek istemiyorum	Öğrenmek istemiyorum	Kararsızım	Öğrenmek istiyorum	Öğrenmeyi çok istiyorum
	1 ○	2 ○	3 ○	4 ○	5 ○

Derslerin YTÖ yaklaşımına göre işlenmesi, kimya dersini öğrenme isteğinizde bir değişiklik oluşturdu mu? Bunun nedenlerini açıklayınız?

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3. Derslerinizin geleneksel yaklaşımlar mı *(öğretmenin ders anlatıp sizin dinlediğiniz)*, yoksa YTÖ *(sınıfta etkinlik yapılması, tartışma, deney, proje ödevi hazırlama)* yaklaşımı ile mi işlenmesini istersiniz? Neden? Açıklayınız.

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4. Yaşam temelli öğretime göre derslerde kullanılan ders materyalleri *(ders içerisinde günlük hayatla ilişkili olarak sunulan bağlamlar, tartışmalar, laboratuvar etkinlikleri, verilen ödevler)* kimya konularını öğrenmenizi nasıl etkiledi? Görüşlerinizin olumlu ve olumsuz yönlerini sebepler belirterek açıklayınız.

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5. Derslerde farklı değerlendirme modellerinin *(Performans değerlendirmesi, yapılan etkinliklerin sözlü ve yazılı notuna yansıması, kendini ve grup arkadaşını değerlendirme vb.)* kullanılması hakkında düşünceleriniz nelerdir?

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6. Yaşam temelli öğretim yaklaşımında size verilen görev ve sorumluluklar hakkındaki görüşleriniz nelerdir? *(Kimya kavramlarını öğrenmenizde size daha fazla sorumluluk verilmesi, etkinlikler ve proje ödevleri gibi)* Size verilen bu görev ve sorumluluklar size neler kazandırıyor ya da kaybettiriyor? Açıklayınız.

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7. Yaşam temelli öğretim yaklaşımında, öğretmeninizin görev ve sorumlulukları hakkındaki görüşleriniz nelerdir? *(Kimya kavramlarını öğrenmenizde öğretmenin daha az ders anlatması bunun yerine etkinlik yaptırması gibi)* Bu durum size neler kazandırıyor ya da kaybettiriyor? Açıklayınız.

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8. Derslerin Yaşam temelli öğrenmeye işlenmesi, okulda öğrendiğiniz kimya bilgilerini günlük hayatla ilişkilendirmenizde herhangi bir etki sağladı mı? Sağladıysa örnek vererek açıklayınız.

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Diğer düşünceleriniz?

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Anketi doldurduğunuz için teşekkür ederiz.

APPENDIX D

SCIENCE PROCESS SKILLS TEST

AÇIKLAMA: Bu test, özellikle Fen ve Matematik derslerinizde ve ilerde üniversite sınavlarında karşınıza çıkabilecek karmaşık gibi görünen problemleri analiz edebilme kabiliyetinizi ortaya çıkarabilmesi açısından çok faydalıdır. Bu test içinde, problemdeki değişkenleri tanımlayabilme, hipotez kurma ve tanımlama, işlemsel açıklamalar getirebilme, problemin çözümü için gerekli incelemelerin tasarlanması, grafik çizme ve verileri yorumlayabilme kabiliyetlerini ölçebilen sorular bulunmaktadır. Her soruyu okuduktan sonra kendinizce uygun seçeneği işaretleyiniz.

1. Bir basketbol antrenörü, oyuncuların güçsüz olmasından dolayı maçları kaybettiklerini düşünmektedir. Güçlerini etkileyen faktörleri araştırmaya karar verir. **Antrenör, oyuncuların gücünü etkileyip etkilemediğini ölçmek için aşağıdaki değişkenlerden hangisini incelemelidir?**

a. Her oyuncunun almış olduğu günlük vitamin miktarını.
b. Günlük ağırlık kaldırma çalışmalarının miktarını.
c. Günlük antreman süresini.
d. Yukarıdakilerin hepsini.

2. Arabaların verimliliğini inceleyen bir araştırma yapılmaktadır. Sınanan hipotez, benzine katılan bir katkı maddesinin arabaların verimliliğini artırdığı yolundadır. Aynı tip beş arabaya aynı miktarda benzin fakat farklı miktarlarda katkı maddesi konur. Arabalar benzinleri bitinceye kadar aynı yol üzerinde giderler. Daha sonra her arabanın aldığı mesafe kaydedilir. **Bu çalışmada arabaların verimliliği nasıl ölçülür?**

a. Arabaların benzinleri bitinceye kadar geçen süre ile.
b. Her arabanın gittiği mesafe ile.
c. Kullanılan benzin miktarı ile.
d. Kullanılan katkı maddesinin miktarı ile.

3. Bir araba üreticisi daha ekonomik arabalar yapmak istemektedir. Araştırmacılar arabanın litre başına alabileceği mesafeyi etkileyebilecek değişkenleri araştırmaktadırlar. **Aşağıdaki değişkenlerden hangisi arabanın litre başına alabileceği mesafeyi etkileyebilir?**

a. Arabanın ağırlığı
b. Motorun hacmi
c. Arabanın rengi
d. a ve b

4. Ali Bey, evini ısıtmak için komşularından daha çok para ödenmesinin sebeplerini merak etmektedir. Isınma giderlerini etkileyen faktörleri araştırmak için bir hipotez kurar. **Aşağıdakilerden hangisi bu araştırmada sınanmaya uygun bir hipotez değildir?**

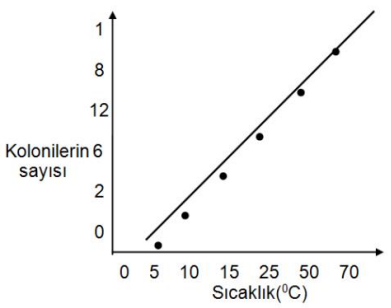
a. Evin çevresindeki ağaç sayısı ne kadar az ise ısınma gideri o kadar fazladır.
b. Evde ne kadar çok pencere ve kapı varsa, ısınma gideri de o kadar fazla olur.
c. Büyük evlerin ısınma giderleri fazladır.
d. Isınma giderleri arttıkça ailenin daha ucuza ısınma yolları araması gerekir.

5. Fen sınıfından bir öğrenci sıcaklığın bakterilerin gelişmesi üzerindeki etkilerini araştırmaktadır. Yaptığı deney sonucunda, öğrenci aşağıdaki verileri elde etmiştir:

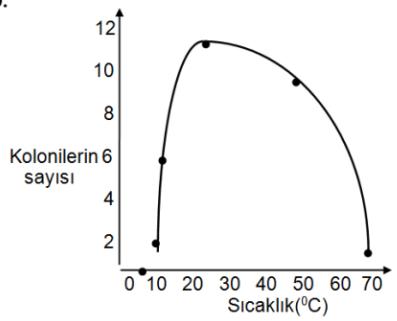
Deney odasının sıcaklığı (^{0}C)	Bakteri kolonilerinin sayısı
5	0
10	2
15	6
25	12
50	8
70	1

Aşağıdaki grafiklerden hangisi bu verileri doğru olarak göstermektedir?

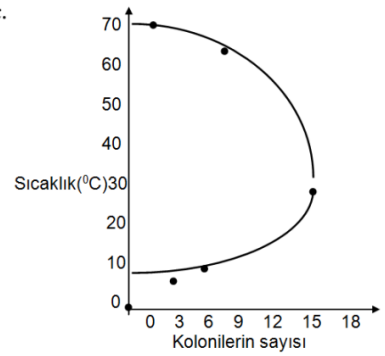
a.



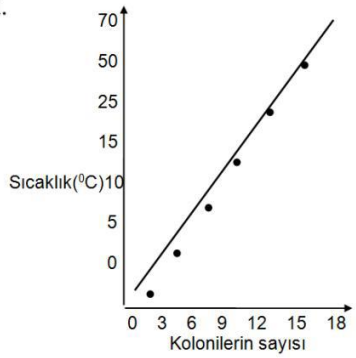
b.



c.



d.



6. Bir polis şefi, arabaların hızının azaltılması ile uğraşmaktadır. Arabaların hızını etkileyebilecek bazı faktörler olduğunu düşünmektedir. **Sürücülerin ne kadar hızlı araba kullandıklarını aşağıdaki hipotezlerin hangisiyle sınayabilir?**

a. Daha genç sürücülerin daha hızlı araba kullanma olasılığı yüksektir.
b. Kaza yapan arabalar ne kadar büyükse, içindeki insanların yaralanma olasılığı o kadar azdır.
c. Yollarde ne kadar çok polis ekibi olursa, kaza sayısı o kadar az olur.
d. Arabalar eskidikçe kaza yapma olasılıkları artar.

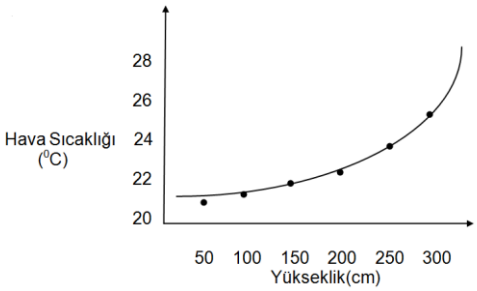
7. Bir fen sınıfında, tekerlek yüzeyi genişliğinin tekerleğin daha kolay yuvarlanması üzerine etkisi araştırılmaktadır. Bir oyuncak arabaya geniş yüzeyli tekerlekler takılır, önce bir rampadan (eğik düzlem) aşağı bırakılır ve daha sonra düz bir zemin üzerinde gitmesi sağlanır. Deney, aynı arabaya daha dar yüzeyli tekerlekler takılarak tekrarlanır. **Hangi tip tekerleğin daha kolay yuvarlandığı nasıl ölçülür?**

a. Her deneyde arabanın gittiği toplam mesafe ölçülür.
b. Rampanın (eğik düzlem) eğim açısı ölçülür.
c. Her iki deneyde kullanılan tekerlek tiplerinin yüzey genişlikleri ölçülür.
d. Her iki deneyin sonunda arabanın ağırlıkları ölçülür.

8. Bir çiftçi daha çok mısır üretebilmenin yollarını aramaktadır. Mısırların miktarını etkileyen faktörleri araştırmayı tasarlar. **Bu amaçla aşağıdaki hipotezlerden hangisini sınayabilir?**

a. Tarlaya ne kadar çok gübre atılırsa, o kadar çok mısır elde edilir.
b. Ne kadar çok mısır elde edilirse, kar o kadar fazla olur.
c. Yağmur ne kadar çok yağarsa, gübrenin etkisi o kadar çok olur.
d. Mısır üretimi arttıkça, üretim maliyeti de artar.

9. Bir odanın tabanından itibaren değişik yüzeylerdeki sıcaklıklarla ilgili bir çalışma yapılmış ve elde edilen veriler aşağıdaki grafikte gösterilmiştir. **Değişkenler arasındaki ilişki nedir?**

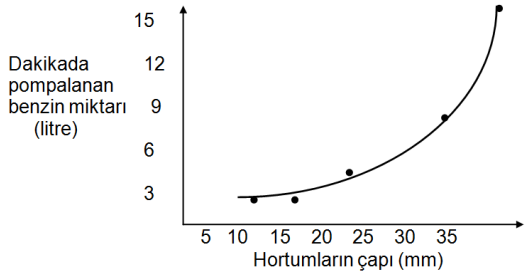


a. Yükseklik arttıkça sıcaklık azalır.
b. Yükseklik arttıkça sıcaklık artar.
c. Sıcaklık arttıkça yükseklik azalır.
d. Yükseklik ile sıcaklık artışı arasında bir ilişki yoktur.

10. Ahmet, basketbol topunun içindeki hava arttıkça, topun daha yükseğe sıçrayacağını düşünmektedir. Bu hipotezi araştırmak için, birkaç basketbol topu alır ve içlerine farklı miktarda hava pompalar. **Ahmet hipotezini nasıl sınamalıdır?**

a. Topları aynı yükseklikten fakat değişik hızlarla yere vurur.
b. İçlerinde farlı miktarlarda hava olan topları, aynı yükseklikten yere bırakır.
c. İçlerinde aynı miktarlarda hava olan topları, zeminle farklı açılardan yere vurur.
d. İçlerinde aynı miktarlarda hava olan topları, farklı yüksekliklerden yere bırakır.

11. Bir tankerden benzin almak için farklı genişlikte 5 hortum kullanılmaktadır. Her hortum için aynı pompa kullanılır. Yapılan çalışma sonunda elde edilen bulgular aşağıdaki grafikte gösterilmiştir.



Aşağıdakilerden hangisi değişkenler arasındaki ilişkiyi açıklamaktadır?

a. Hortumun çapı genişledikçe dakikada pompalanan benzin miktarı da artar.
b. Dakikada pompalanan benzin miktarı arttıkça, daha fazla zaman gerekir.
c. Hortumun çapı küçüldükçe dakikada pompalanan benzin miktarı da artar.
d. Pompalanan benzin miktarı azaldıkça, hortumun çapı genişler.

Önce aşağıdaki açıklamayı okuyunuz ve daha sonra 12, 13, 14 ve 15 inci soruları açıklama kısmından sonra verilen paragrafı okuyarak cevaplayınız.

Açıklama: Bir araştırmada, bağımlı değişken birtakım faktörlere bağımlı olarak gelişim gösteren değişkendir. Bağımsız değişkenler ise bağımlı değişkene etki eden faktörlerdir. Örneğin, araştırmanın amacına göre kimya başarısı bağımlı bir değişken olarak alınabilir ve ona etki edebilecek faktör veya faktörler de bağımsız değişkenler olurlar.

Ayşe, güneşin karaları ve denizleri aynı derecede ısıtıp ısıtmadığını merak etmektedir. Bir araştırma yapmaya karar verir ve aynı büyüklükte iki kova alır. Bunlardan birini toprakla, diğerini de su ile doldurur ve aynı miktarda güneş ısısı alacak şekilde bir yere koyar. 8.00 - 18.00 saatleri arasında, her saat başı sıcaklıklarını ölçer.

12. Araştırmada aşağıdaki hipotezlerden hangisi sınanmıştır?

a. Toprak ve su ne kadar çok güneş ışığı alırlarsa, o kadar ısınırlar.
b. Toprak ve su güneş altında ne kadar fazla kalırlarsa, o kadar çok ısınırlar.
c. Güneş farklı maddeleri farklı derecelerde ısıtır.
d. Günün farklı saatlerinde güneşin ısısı da farklı olur.

13. Araştırmada aşağıdaki değişkenlerden hangisi kontrol edilmiştir?

a. Kovadaki suyun cinsi.
b. Toprak ve suyun sıcaklığı.
c. Kovalara koyulan maddenin türü.
d. Her bir kovanın güneş altında kalma süresi.

14. Araştırmada <u>bağımlı değişken</u> hangisidir?

a. Kovadaki suyun cinsi.
b. Toprak ve suyun sıcaklığı.
c. Kovalara koyulan maddenin türü.
d. Her bir kovanın güneş altında kalma süresi.

15. Araştırmada <u>bağımsız değişken</u> hangisidir?
a. Kovadaki suyun cinsi.
b. Toprak ve suyun sıcaklığı.
c. Kovalara koyulan maddenin türü.
d. Herbir kovanın güneş altında kalma süresi.

16. Can, yedi ayrı bahçedeki çimenleri biçmektedir. Çim biçme makinasıyla her hafta bir bahçedeki çimenleri biçer. Çimenlerin boyu bahçelere göre farklı olup bazılarında uzun bazılarında kısadır. Çimenlerin boyları ile ilgili hipotezler kurmaya başlar. **Aşağıdakilerden hangisi sınanmaya uygun bir hipotezdir?**

a. Hava sıcakken çim biçmek zordur.
b. Bahçeye atılan gübrenin miktarı önemlidir.
c. Daha çok sulanan bahçedeki çimenler daha uzun olur.
d. Bahçe ne kadar engebeliyse çimenleri kesmekte o kadar zor olur.

17, 18, 19 ve 20 nci soruları aşağıda verilen paragrafı okuyarak cevaplayınız.

Murat, suyun sıcaklığının, su içinde çözünebilecek şeker miktarını etkileyip etkilemediğini araştırmak ister. Birbirinin aynı dört bardağın her birine 50 şer mililitre su koyar. Bardaklardan birisine 0 ^{0}C de, diğerine de sırayla 50 ^{0}C, 75 ^{0}C ve 95 ^{0}C sıcaklıkta su koyar. Daha sonra her bir bardağa çözünebileceği kadar şeker koyar ve karıştırır.

17. Bu araştırmada sınanan hipotez hangisidir?

a. Şeker ne kadar çok suda karıştırılırsa o kadar çok çözünür.
b. Ne kadar çok şeker çözünürse, su o kadar tatlı olur.
c. Sıcaklık ne kadar yüksek olursa, çözünen şekerin miktarı o kadar fazla olur.
d. Kullanılan suyun miktarı arttıkça sıcaklığı da artar.

18. Bu araştırmada kontrol edilebilen değişken hangisidir?

a. Her bardakta çözünen şeker miktarı.
b. Her bardağa konulan su miktarı.
c. Bardakların sayısı.
d. Suyun sıcaklığı.

19. Araştırmanın bağımlı değişkeni hangisidir?

a. Her bardakta çözünen şeker miktarı.
b. Her bardağa konulan su miktarı.
c. Bardakların sayısı.
d. Suyun sıcaklığı.

20. Araştırmadaki bağımsız değişken hangisidir?

a. Her bardakta çözünen şeker miktarı.
b. Her bardağa konulan su miktarı.
c. Bardakların sayısı.
d. Suyun sıcaklığı.

21. Bir bahçıvan domates üretimini artırmak istemektedir. Değişik birkaç alana domates tohumu eker. Hipotezi, tohumlar ne kadar çok sulanırsa, o kadar çabuk filizleneceğidir. **Bu hipotezi nasıl sınar?**

a. Farklı miktarlarda sulanan tohumların kaç günde filizleneceğine bakar.
b. Her sulamadan bir gün sonra domates bitkisinin boyunu ölçer.
c. Farklı alnlardaki bitkilere verilen su miktarını ölçer.
d. Her alana ektiği tohum sayısına bakar.

22. Bir bahçıvan tarlasındaki kabaklarda yaprak bitleri görür. Bu bitleri yok etmek gereklidir. Kardeşi "Kling" adlı tozun en iyi böcek ilacı olduğunu söyler. Tarım uzmanları ise "Acar" adlı spreyin daha etkili olduğunu söylemektedir. Bahçıvan altı tane kabak bitkisi seçer. Üç tanesini tozla, üç tanesini de spreyle ilaçlar. Bir hafta sonra her bitkinin üzerinde kalan canlı bitleri sayar. **Bu çalışmada böcek ilaçlarının etkinliği nasıl ölçülür?**

a. Kullanılan toz ya da spreyin miktarı ölçülür.
b. Toz ya da spreyle ilaçlandıktan sonra bitkilerin durumları tespit edilir.
c. Her fidede oluşan kabağın ağırlığı ölçülür.
d. Bitkilerin üzerinde kalan bitler sayılır.

23. Ebru, bir alevin belli bir zaman süresi içinde meydana getireceği ısı enerjisi miktarını ölçmek ister. Bir kabın içine bir litre soğuk su koyar ve 10 dakika süreyle ısıtır. **Ebru, alevin meydana getirdiği ısı enerjisini nasıl ölçer?**

a. 10 dakika sonra suyun sıcaklığında meydana gelen değişmeyi kayeder.
b. 10 dakika sonra suyun hacminde meydana gelen değişmeyi ölçer.
c. 10 dakika sonra alevin sıcaklığını ölçer.
d. Bir litre suyun kaynaması için geçen zamanı ölçer.

24. Ahmet, buz parçacıklarının erime süresini etkileyen faktörleri merak etmektedir. Buz parçalarının büyüklüğü, odanın sıcaklığı ve buz parçalarının şekli gibi faktörlerin erime süresini etkileyebileceğini düşünür. Daha sonra şu hipotezi sınamaya karar verir: Buz parçalarının şekli erime süresini etkiler. **Ahmet bu hipotezi sınamak için aşağıdaki deney tasarımlarının hangisini uygulamalıdır?**

a. Her biri farklı şekil ve ağırlıkta beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.
b. Her biri aynı şekilde fakat farklı ağırlıkta beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.
c. Her biri aynı ağırlıkta fakat farklı şekillerde beş buz parçası alınır. Bunlar aynı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.
d. Her biri aynı ağırlıkta fakat farklı şekillerde beş buz parçası alınır. Bunlar farklı sıcaklıkta benzer beş kabın içine ayrı ayrı konur ve erime süreleri izlenir.

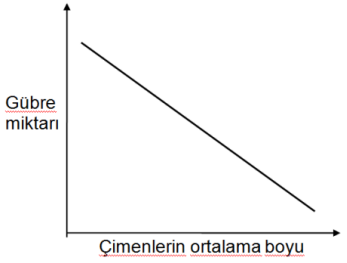
25. Bir araştırmacı yeni bir gübreyi denemektedir. Çalışmalarını aynı büyüklükte beş tarlada yapar. Her tarlaya yeni gübresinden değişik miktarlarda karıştırır. Bir ay sonra, her tarlada yetişen çimenin ortalama boyunu ölçer. Ölçüm sonuçları aşağıdaki tabloda verilmiştir.

Gübre miktarı (kg)	Çimenlerin ortalama boyu (cm)
10	7
30	10
50	12
80	14
100	12

Tablodaki verilerin grafiği yandakilerden hangisidir?

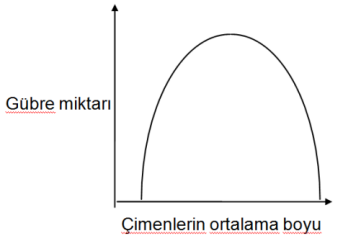
a.

b.



c.

d.



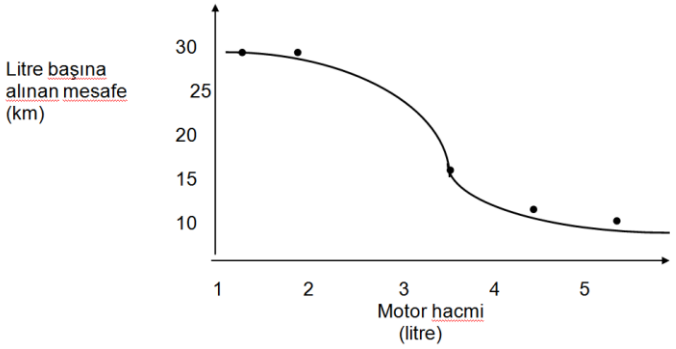
26. Bir biyolog şu hipotezi test etmek ister: Farelere ne kadar çok vitamin verilirse o kadar hızlı büyürler. **Biyolog farelerin büyüme hızını nasıl ölçebilir?**

a. Farelerin hızını ölçer.
b. Farelerin, günlük uyumadan durabildikleri süreyi ölçer.
c. Her gün fareleri tartar.
d. Her gün farelerin yiyeceği vitaminleri tartar.

27. Öğrenciler, şekerin suda çözünme süresini etkileyebilecek değişkenleri düşünmektedirler. Suyun sıcaklığını, şekerin ve suyun miktarlarını değişken olarak saptarlar. **Öğrenciler, şekerin suda çözünme süresini aşağıdaki hipotezlerden hangisiyle sınayabilir?**

a. Daha fazla şekeri çözmek için daha fazla su gereklidir.
b. Su soğudukça, şekeri çözebilmek için daha fazla karıştırmak gerekir.
c. Su ne kadar sıcaksa, o kadar çok şeker çözünecektir.
d. Su ısındıkça şeker daha uzun sürede çözünür.

28. Bir araştırma grubu, değişik hacimli motorları olan arabaların randımanlarını ölçer. Elde edilen sonuçların grafiği aşağıdaki gibidir:



Aşağıdakilerden hangisi değişkenler arasındaki ilişkiyi gösterir?

a. Motor ne kadar büyükse, bir litre benzinle gidilen mesafe de o kadar uzun olur.
b. Bir litre benzinle gidilen mesafe ne kadar az olursa, arabanın motoru o kadar küçük demektir.
c. Motor küçüldükçe, arabanın bir litre benzinle gidebileceği mesafe artar.
d. Bir litre benzinle gidilen mesafe ne kadar uzun olursa, arabanın motoru o kadar büyük demektir.

29, 30, 31 ve 32 inci soruları aşağıda verilen paragrafı okuyarak cevaplayınız.

Toprağa karıştırılan yaprakların domates üretimine etkisi araştırılmaktadır. Araştırmada dört büyük saksıya aynı miktarda ve tipte toprak konulmuştur. Fakat birinci saksıdaki toprağa 15 kg., ikinciye 10 kg., üçüncüye ise 5 kg. çürümüş yaprak karıştırılmıştır. Dördüncü saksıdaki toprağa ise hiç çürümüş yaprak karıştırılmamıştır. Daha sonra bu saksılara domates ekilmiştir. Bütün saksılar güneşe konmuş ve aynı miktarda sulanmıştır. Her saksıdan elde edilen domates tartılmış ve kaydedilmiştir.

29. Bu araştırmada <u>sınanan hipotez</u> hangisidir?

a. Bitkiler güneşten ne kadar çok ışık alırlarsa, o kadar fazla domates verirler.
b. Saksılar ne kadar büyük olursa, karıştırılan yaprak miktarı o kadar fazla olur.
c. Saksılar ne kadar çok sulanırsa, içlerindeki yapraklar o kadar çabuk çürür.
d. Toprağa ne kadar çok çürük yaprak karıştırılırsa, o kadar fazla domates elde edilir.

30. Bu araştırmada <u>kontrol edilen değişken</u> hangisidir?

a. Her saksıdan elde edilen domates miktarı
b. Saksılara karıştırılan yaprak miktarı.
c. Saksılardaki toprak miktarı.
d. Çürümüş yapak karıştırılan saksı sayısı.

31. Araştırmadaki <u>bağımlı değişken</u> hangisidir?

a. Her saksıdan elde edilen domates miktarı
b. Saksılara karıştırılan yaprak miktarı.
c. Saksılardaki toprak miktarı.
d. Çürümüş yapak karıştırılan saksı sayısı.

32. Araştırmadaki <u>bağımsız değişken</u> hangisidir?

a. Her saksıdan elde edilen domates miktarı
b. Saksılara karıştırılan yaprak miktarı.
c. Saksılardaki toprak miktarı.
d. Çürümüş yaprak karıştırılan saksı sayısı.

33. Bir öğrenci mıknatısların kaldırma yeteneklerini araştırmaktadır. Çeşitli boylarda ve şekillerde birkaç mıknatıs alır ve her mıknatısın çektiği demir tozlarını tartar. **Bu çalışmada mıknatısın kaldırma yeteneği nasıl tanımlanır?**

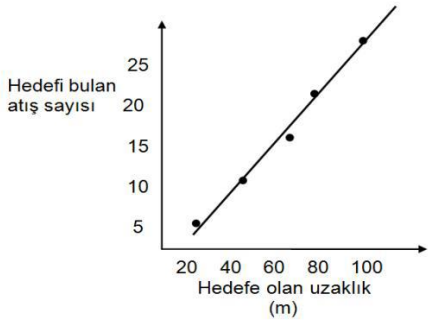
a. Kullanılan mıknatısın büyüklüğü ile.
b. Demir tozlarını çeken mıknatısın ağırlığı ile.
c. Kullanılan mıknatısın şekli ile.
d. Çekilen demir tozlarının ağırlığı ile.

34. Bir hedefe çeşitli mesafelerden 25 er atış yapılır. Her mesafeden yapılan 25 atıştan hedefe isabet edenler aşağıdaki tabloda gösterilmiştir.

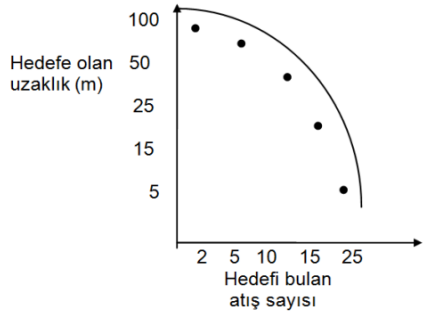
Mesafe(m)	Hedefe vuran atış sayısı
5	25
15	10
25	10
50	5
100	2

Aşağıdaki grafiklerden hangisi verilen bu verileri en iyi şekilde yansıtır?

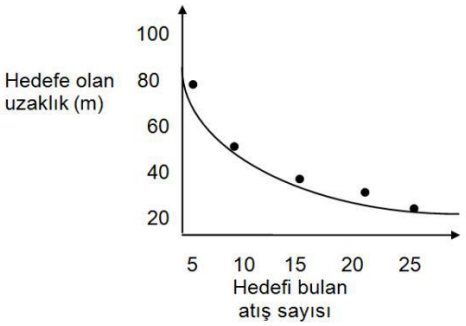
a.



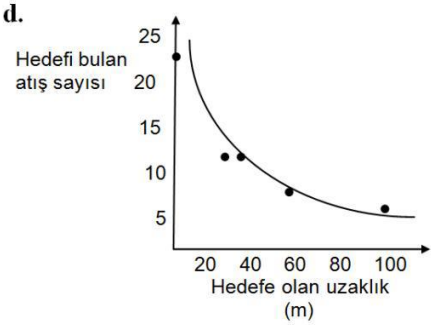
b.



c.



d.



35. Sibel, akvaryumdaki balıkların bazen çok haraketli bazen ise durgun olduklarını gözler. Balıkların hareketliliğini etkileyen faktörleri merak eder. **Balıkların hareketliliğini etkileyen faktörleri hangi hipotezle sınayabilir?**

a. Balıklara ne kadar çok yem verilirse, o kadar çok yeme ihtiyaçları vardır.
b. Balıklar ne kadar hareketli olursa o kadar çok yeme ihtiyaçları vardır.
c. Su da ne kadar çok oksijen varsa, balıklar o kadar iri olur.
d. Akvaryum ne kadar çok ışık alırsa, balıklar o kadar hareketli olur.

36. Murat Bey'in evinde birçok elektrikli alet vardır. Fazla gelen elektrik faturaları dikkatini çeker. Kullanılan elektrik miktarını etkileyen faktörleri araştırmaya karar verir. **Aşağıdaki değişkenlerden hangisi kullanılan elektrik enerjisi miktarını etkileyebilir?**

a. TV nin açık kaldığı süre.
b. Elektrik sayacının yeri.
c. Çamaşır makinesinin kullanma sıklığı.
d. a ve c.

Cevap Anahtarı

1-D	9-B	17-C	25-C	33-D
2-B	10-B	18-B	26-C	34-D
3-D	11-A	19-A	27-D	35-D
4-D	12-C	20-D	28-C	36-D
5-B	13-D	21-A	29-D	
6-A	14-B	22-D	30-C	
7-A	15-C	23-A	31-A	
8-A	16-C	23-C	32-B	

APPENDIX E

SAMPLE TEACHER'S GUIDE

ÖĞRETMEN KILAVUZU 1
Ders: Kimya
Sınıf: 10
Ünite: Endüstride ve Canlılarda Enerji
Konu Baslığı: Fosil yakıtlar - Kömür
Süre: 120 dakika (3 ders saati)
İlgili Kazanımlar: 10.3.1. Kömürün oluşumunu ve kömür türlerini açıklar. 10.3.2. Kömürün bir yakıt olarak üstünlük ve sakıncalarını irdeler. *a. Kömürün asıl bileşeni yanında azotlu ve kükürtlü bileşenlerine değinilir; esas yanma tepkimesi ve onunla birlikte yürüyen yan tepkimelerin ürünleri ve bunların çevreye etkileri işlenir.* *b. Çeşitli kömürlerin özgül yanma ısıları karşılaştırılır.* **Bağlamlar ile İlgili Dikkat Edilecek Noktalar** **Başlık:** Sanayici Ülkeler Kömürden Vazgeçemiyor **Soru:** Yukarıdaki gazete haberinde kömürün önemi vurgulanmaktadır. İnsanlar ve devletler için kömür niçin önemlidir? Günlük hayatınızdaki faaliyetlerinizi düşünerek değerlendiriniz. **Yönlendirici Tümceler:** - Enerji kaynağı olarak kömür - Kömürün maddi değeri - Kömür madenlerindeki işçiler - Evinizde kullandığınız elektrik **Muhtemel Cevaplar:** Devletler için a. Önemli bir enerji kaynağıdır. Elektrik üretimi. b. Parasal değeri yüksektir. Ülke ekonomisine katkı sağlar.

İnsanlar için
a. İş olanağı sağlar, geçim kaynağıdır (madenlerde).
b. Evlerde ısınmayı sağlar.
c. Evlerde elektrik sağlar

Başlık: Temiz Kömür Olur Mu?

Soru: Yukarıdaki makaleden de anlaşılacağı üzere kömür kullanımının insan sağlığına ve doğaya verdiği birçok zarar vardır. Bunula birlikte bir yakıt olarak kömürün üstün yönleri de vardır. Kömürün üstün yönlerini ve kömür kullanımının sakıncalarını tartışınız.
(Gruplar halinde tartışmalar yapılabilir.)

Yönlendirici Tümceler:

- Kömürün doğalgaza göre daha ucuz mu?
- Kömürü ülkemizde mi üretiyoruz, dış ülkelerden mi alıyoruz?
- Kömürün iletilmesi mi daha kolay doğalgazın iletilmesi mi?
- Kömürden kaynaklı sağlık problemleri var mı?
- Elektrik üretmek için kömür kullanılır mı?

Muhtemel Cevaplar:

Kömürün üstün yönleri
a. Üretim maliyeti ucuz, tüketici için de ucuzdur.
b. Yerli kaynaktır, ülkemizin doğal zenginliğidir. Ülkemizi dışa bağımlı yapmaz.
c. İhtiyaç duyulan yerlere ulaştırılması kolaydır.
d. Elektrik santrallerinde kullanılır.

Kömürün kullanım sakıncaları
a. Çevreye, doğaya zararlı gazlar yayar. Kömürün yapısında azotlu ve kükürtlü bileşenler vardır, bu yüzden yanma esnasında zararlı gazlar yayılır.
b. Yaydığı gazların insan sağlığına zararlı etkileri vardır.
c. Uygunsuz kullanım sonucu CO zehirlenmesi olayları yaşanmaktadır.

Başlık: Asit Yağmurları

Soru: Bireysel olarak asit yağmurlarının oluşmasındaki payınızı azaltmak için günlük aktivitelerinizde ne gibi değişiklikler yapabilirsiniz? Her birinin nasıl asit yağmuru salınımını azaltıcı etkisi olduğunu açıklayarak uygulayabileceğiniz üç adet aktiviteyi yazınız.

(Gruplar halinde tartışmalar yapılabilir.)

Yönlendirici Tümceler:

- *İpucu:* Aşağıdaki iki tablo size fikir verebilir. Aşağıdaki tablolarda asit yağmurlarına neden olan SO_2 ve NO_x gazlarının salınım kaynakları verilmiştir. Günlük aktivitelerinizi düşünün.
- Isınmak için evlerde kullandığımız yakıt düşünüldüğünde, günlük hayatımızda neler yapabiliriz?
- Günlük ulaşımımız düşünüldüğünde, neler yapabiliriz?
- Kullandığımız endüstriyel ürünler yerine doğal ürünler (ahşap, cam, yün, pamuk gibi) kullanabilir miyiz?

Muhtemel Cevaplar:

1. Özel araç yerine toplu ulaşımı tercih ederim. (Daha az NOx salınımı olur; ulaşımın yüzdesi çok fazla)
2. Yakın mesafelere yürüyerek giderim.
3. Endüstriyel ürünler yerine doğal ürünleri tercih ederim. Örnek: plastik kalemlik yerine ahşap kalemlik, Örnek: plastik saklama kabı yerine cam saklama kabı
4. Isınmak için kullandığım yakıt miktarını azaltırım (kombiyi kısarım ya da sobaya daha az kömür atarım). Evde biraz daha sıkı giyinirim.

Değerlendirme Soruları (1) Cevap Anahtarı:

1. A
2. B
3. D
4. E
5. C
6. E
7. kok
8. antrasit
9. kömür
10. linyit
11. düşüktür
12. Doğru
13. Yanlış
14. Doğru
15. Yanlış
16. Doğru
17. Yanlış
18. Doğru

APPENDIX F

SAMPLE STUDENT LESSON MATERIALS

FOSİL YAKITLAR

KÖMÜR

SANAYİCİ ÜLKELER KÖMÜRDEN VAZGEÇEMİYOR

Dünya sanayisinin liderleri elektrik üretiminde kömürden vazgeçmiyor. ABD, Çin ve Almanya en fazla kömür tüketen ülkeler sıralamasında başı tutuyor.

Çin, dünyada en fazla kömür üreten, tüketen ve ithal eden ülke. Dünya toplam kömür tüketiminin yarısını tek başına yapıyor. Dünyanın en fazla elektrik tüketen ekonomisi Çin, toplam elektrik ihtiyacının yüzde 79'unu kömürden sağlıyor. Elektrik üretiminde ABD ve Almanya yüzde 40 oranında kömüre bağımlı durumda bulunuyor. Bu ülkelerde kömür elektrik üretiminin ana kaynağı oluyor.

Dünyada elektrik üretiminde kömürün egemenliği devam ediyor. Kömür, dünyada toplam üretilen elektriğin yüzde 41'ini sağlarken, onu en yakın yüzde 21,3'le doğalgaz kaynağı takip ediyor.

SORU: Yukarıdaki gazete haberinde kömürün önemi vurgulanmaktadır. İnsanlar ve devletler için kömür niçin önemlidir? Günlük hayatınızdaki faaliyetlerinizi düşünerek değerlendiriniz.

……
……
……
……
……
……
……
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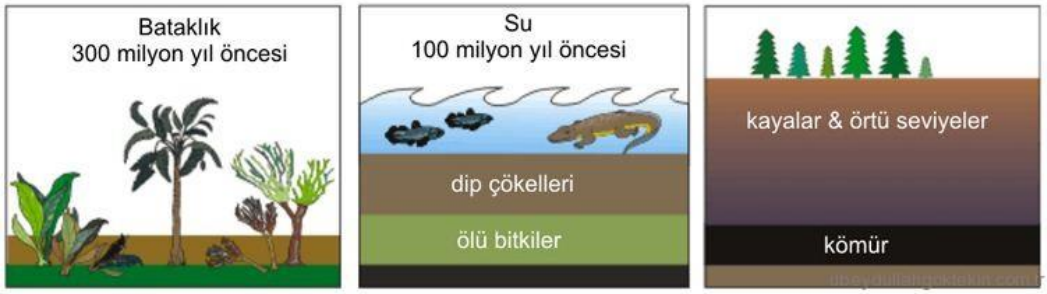
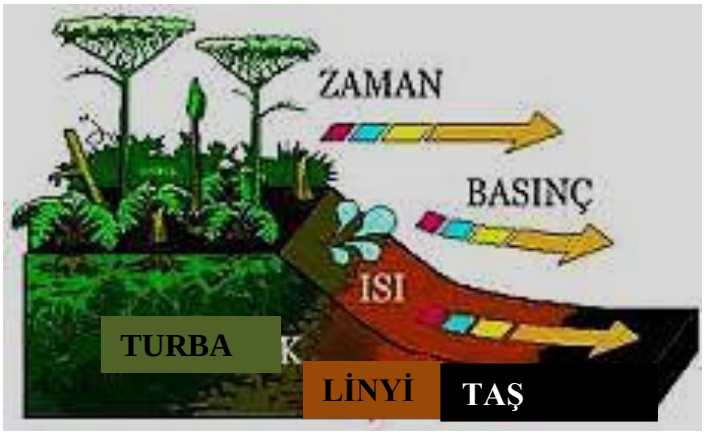
Kömür nasıl oluşur?

Kömür, bitki artıklarının bataklık alanlarda birikmesi sonucunda oluşan tabakaların değişime uğraması ile meydana gelir. Zaman içerisinde bu tabakalar üzerine çeşitli çökeller birikir ve yer kabuğunun hareketleri sonucunda derinliklere gömülürler. Gömülmüş olan bu tabakalar arasındaki organik seviyeler; artan ısı ve basınca maruz kaldıklarında fiziksel ve kimyasal değişikliğe uğrayarak kömürleşme olarak tanımlanan bir süreç geçirir. Bu süreç milyonlarca yıl sürer.



Zaman içerisinde artan basınç ve sıcaklığa maruz kalan organik malzemeler kömürleşmeye başlar.



Hangi ortamlar kömür oluşumu için uygundur?

- Deltalar (en kalın kömür damarlarının oluştuğu ortamlardır)
- Göller, nehirler (göl kıyıları, kalın kömür damarlarının meydana geldiği uygun bataklık ortamlardır)
- Lagünler (deniz etkisinin olduğu ince kömür damarcıklarını meydana getirirler)
- Akarsu taşma ovaları (ince kömür damarcıklarını oluştururlar)

Kömür, yapısında çoğunlukla karbon (C), az miktarda hidrojen (H), oksijen (O), kükürt (S) ve azot (N) elementleri bulunduran bir kayaçtır. Belli bir kimyasal formülle gösterilemeyen kömür doğada kil, alüvyon gibi anorganik yapılı maddelerle karışım halinde bulunur. Heterojen görünümlü olan kömür; gevrek, kırılgan, yanabilen bir maddedir.

Bilindiği gibi yerkürede, çekirdeğe doğru inildikçe sıcaklık artar. Aynı zamanda volkanik faaliyetler ve fay hareketleri nedeniyle de sıcaklık yükselir. Diğer taraftan tortul kayaç tabakası kalınlaştıkça bitki kalıntılarına daha fazla basınç uygulanır. Sıcaklık ve basınçtaki bu yükselme, turba adı verilen organik maddelerden su buharının uzaklaşmasını sağlar. Eğer sıcaklık ve basınç artışı devam ederse organik maddelerin yapısında sırasıyla karbondioksit (CO_2), oksijen (O_2) ve hidrojen (H_2) gazı ayrılır. Sonuçta **turba** olarak bilinen ancak kömür olarak kabul edilmeyen organik kütle, kömüre dönüşmüş olur. Bu sürece **kömürleşme** denir.

Bitki kalıntılarından kömür oluşum sürecine dikkatlice irdelenirse kömürleşme zamanı, nem miktarı, kül ve uçucu madde içeriği vb. açılardan kömürlerin çeşitlilik göstermesi gerektiği söylenebilir.

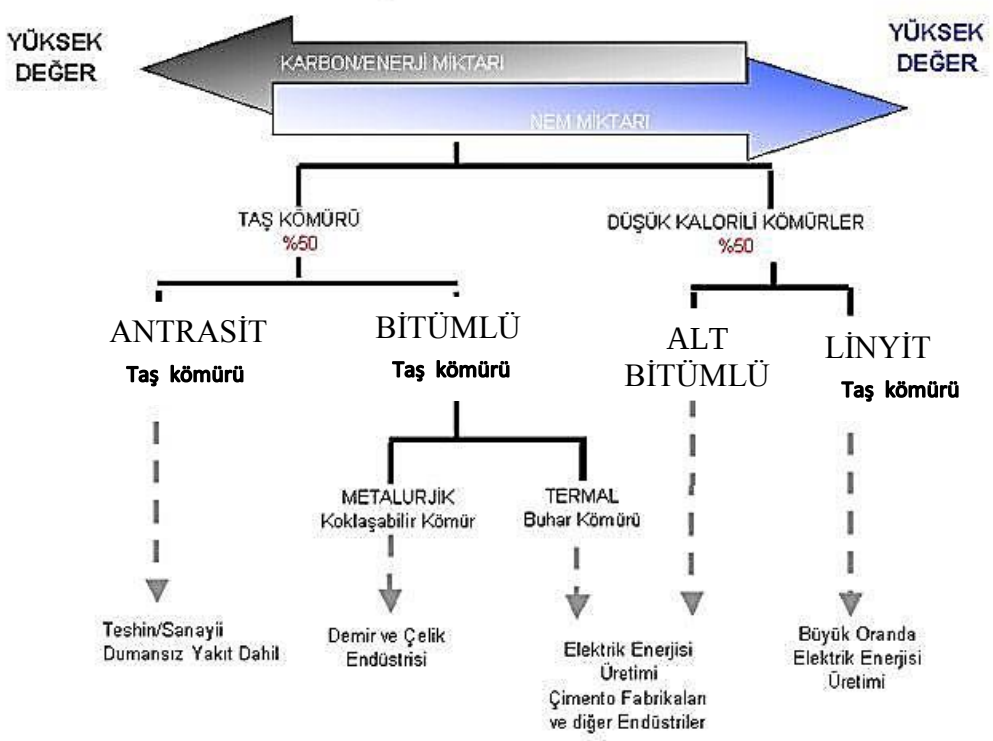
Kömürler, *tane boyutu, kül, kükürt ve nem içerikleri, mineral madde içerikleri, kalorifik değerler, yıkanabilirlik, kurutulabilirlik, biriketlenebilirlik* ve *koklaşabilirlik* parametrelerine göre sınıflandırılır.

Kömürler organik olgunluklarına göre *linyit, alt bitümlü kömür, bitümlü kömür* ve *antrasit* tiplerine ayrılırlar.

Linyit ve kısmen alt bitümlü kömürler genellikle yumuşak, kolayca ufalanabilen ve mat görünüştedirler. Bu tip kömürlerin ana özelliği göreceli olarak çok yüksek nem içerirler ve karbon içerikleri düşüktür. *Antrasit ve bitümlü kömürler* ise genellikle daha sert, dayanıklı, siyah renkli ve camsı parlak görünüştedirler. Göreceli olarak nem içerikleri daha düşük olup, karbon oranları daha yüksektir.

Kömür türü	Kütlece karbon yüzdesi
Linyit	% 70
Alt Bitümlü	% 75
Bitümlü	% 85
Antrasit	% 94

Kömürlerin ısıl değerlerine, yapılarındaki karbon ve nem oranlarına göre sınıflandırılması aşağıda gösterilmiştir.



Kömür türlerinin özgül yanma ısıları yandaki tabloda verilmiştir. Kömürün özgül yanma ısısı, 1 gram kömürün yakılmasıyla açığa çıkan ısı miktarıdır.

Kömür türü	Özgül ısı (kal/g)
Linyit	3400
Alt Bitümlü	5300
Bitümlü	6400
Antrasit	7500

Temiz Kömür Olur Mu?

Fosil yakıtların en kirlisi… Yılda tükettiğimiz kömür miktarı 7,2 milyar ton, üzerimizdeki etkisi ise giderek büyüyor. Ve bugün Dünya'nın yüzleşmesi gereken soru şu: Temiz Kömür Olur mu ?

Çevreiler temiz kömürün bir efsaneden ibaret olduğu görüşünde. Elbette öyle. Örnek mi?

ABD'de, derinlerde yatan kömüre ulaşmak için Apalaş zirvelerinin vadilere dönüştürüldüğü, derelerin asitli su nedeniyle turuncu renkte aktığı Batı Virginia'ya bakın. Ya da havaalanlarındaki sigara salonlarından bile daha duman altı olan Pekin kent merkezine... Çin'de hava kirliliğinin temel kaynağı ve yılda bir milyondan fazla kişinin erken ölüm nedeni kömür. Bu sayılanların yanı sıra bir de maden kazalarında ölen binlerce insan var; gerek Çin'de gerekse diğer ülkelerde…

Kömür elimizdeki en kirli, en ölümcül enerji kaynağı. Ama aynı zamanda da birçok açıdan en ucuz olanı. Ve ona bel bağlamış durumdayız…

(National Geographic, 22/08/2014)

SORU: Yukarıdaki makaleden de anlaşılacağı üzere kömür kullanımının insan sağlığına ve doğaya verdiği birçok zarar vardır. Bunula birlikte bir yakıt olarak kömürün üstün yönleri de vardır. Kömürün üstün yönlerini ve kömür kullanımının sakıncalarını tartışınız.

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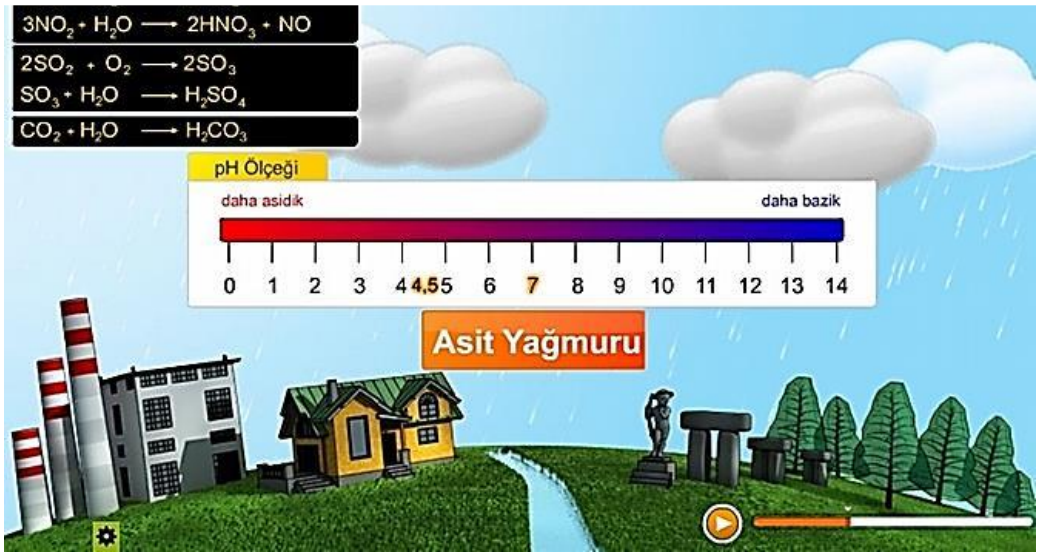
Kömürün esas bileşeni karbon (C) ve hidrojendir (H). Kömürün yapısında az da olsa azotlu (N) ve kükürtlü (S) bileşikler de bulunur.

Kömürün esas yanma tepkimesi, **C (katı) + O_2 (gaz) ⟶ CO_2 (gaz) + Enerji** şeklindedir. Kömürün bu esas yanma tepkimesi ile birlikte yürüyen yan tepkimeler de vardır. Bu yan tepkimeler neticesinde SO_2 ve NO gibi gazlar açığa çıkar.

Kömürün kullanılması sonucu oluşan zararlı etkilerden birisi de asit yağmurlarıdır. Kömür yakıldığında atmosfere CO_2, H_2O, NO ve SO_2 gazları salınır. Bu gazlardan CO_2, SO_2 ve NO ise asit yağmurlarına sebep olur. Asit yağmurları ormanlara ve tüm ekosisteme zarar verir. Aşağıdaki resmin sol üst köşesindeki tepkimeleri inceleyiniz.



Asit Yağmurlarının Doğaya Etkileri

- Özellikle su bulunan bölgelere düşen asit yağmurları, suyun pH dengesini bozduğu için su içerisinde yaşamakta olan canlıları etkiler. Özellikle su içerisinde yaşayan balıkların oldukça fazla etkilenmesi doğadaki besin zincirini önemli ölçüde değiştirir ve bu durum eninde sonunda insan hayatını da önemli ölçüde etkiler.

- Solunum yoluyla çevremizde bulunan havayı akciğerlerimize çekmekteyiz. Bu havanın içerisinde eğer çok fazla miktarda sülfat bulunursa, astım, bronşite ve kanser gibi pek çok hastalığa yakalanma riski artar.

- Ağaçlar kökleri sayesinde topraktan su ve besin alabilmektedir. Ağaçların bu işlemi gerçekleştirebilmeleri için, topraktaki alüminyuma ihtiyaç vardır. Asit yağmurları ise toprakta bulunan alüminyumun çözülmesine neden olur ve bu sebeple ağaçlar topraktan yeteri kadar beslenemez. Bu durum da doğadaki oksijen oranını oldukça etkiler.

- Asit yağmurlarının bir başka zararı da hiç kuşkusuz tarihi eserler üzerindedir. Tarihi eserler yapı itibariyle asidik maddelerden oldukça etkilenir ve üzerlerine düşen asit yağmurları nedeniyle de belirgin bir şekilde tahrip olurlar.

Asit Yağmurlarının İnsan Hayatına Etkileri

Özellikle kentlerde yaşayan birçok insanın astım hastalığı ile mücadele ettiklerini görmekteyiz. Bunun yanında kanser gibi hastalıkların kent hayatı sürdüren insanlarda çok daha fazla görüldüğü de açıktır. Bunun temel sebebi şehir yaşamında çevre havasının aşırı derecede kirletilmesidir. Bu kirlilik ilk etkilerini insanların soluk alış verişlerinde gösterir. Bu kirli havayı soluyan insanlar belirli bir süre sonra çeşitli hastalıklara karşı dirençlerini kaybederler. Bunun yanında asit yağmurlarına maruz kalmış olan besinleri tüketen insanların vücuduna yabancı ve zarar verici maddeler karışır ve bir müddet sonra vücut bu zararlı maddeler ile baş edemez hale gelip hasta düşer. Hava kirliliğin sebep olduğu bu hastalıkların kent yaşamında kırsal yaşama oranla 2 kat daha fazla görüldüğü yapılan araştırmalarla ortaya konmuştur.

SORU: Bireysel olarak asit yağmurlarının oluşmasındaki payınızı azaltmak için günlük aktivitelerinizde ne gibi değişiklikler yapabilirsiniz? Her birinin nasıl asit yağmuru salınımını azaltıcı etkisi olduğunu açıklayarak uygulayabileceğiniz üç adet aktiviteyi yazınız.

(İpucu: Aşağıdaki iki tablo size fikir verebilir. Günlük aktivitelerinizi düşünün)

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Kaynaklara göre dünyada SO_2 salınımı	
Yakıt yakma (termik santraller, ısınma vb.)	%86
Ulaşım	%5
Endüstriyel süreçler	%9

Kaynaklara göre dünyada NO_X salınımı	
Yakıt yakma (termik santraller, ısınma vb.)	%38
Ulaşım	%57
Endüstriyel süreçler	%5

DEĞERLENDİRME SORULARI – 1

1. Kömürleşmenin başlangıç evresi aşağıdakilerden hangisidir?

A) Turba

B) Linyit

C) Antrasit

D) Taş kömürü

E) Kok

2. Kömür ile ilgili aşağıda verilen ifadelerden hangisi <u>yanlıştır</u>?

A) Karbon oranı arttıkça ısıl değeri artar.
B) Antrasit, en kalitesiz kömür türüdür.
C) Kok, doğada bulunmaz fabrikalarda üretilir.
D) Fosil atıklardan uzun yıllarda oluşur.
E) Oluşumu ne kadar eski ise kalitesi o kadar yüksek olur.

3.
I. Bitkilerin öldükten sonra, su altında kalarak bakteriler etkisiyle değişime uğraması sonucunda oluşur.
II. Ölmüş bitkilerin gece fotosentez yaparak fosilleşmesi sonucu oluşur.
III. Bataklıklarda uygun nem ve sıcaklığın oluşması gerekli organik maddelerin ortamda bulunmasıyla bozunmuş, çürüyen bitkilerin fiziksel ve kimyasal değişime uğrayarak yerkabuğunun hareketleri sonucu su altına inmesi ve bataklığın zamanla üstünün örtülmesi gibi olaylar sonucu oluşur.

Yukarıdakilerden hangileri kömürün oluşumunu açıklamak için kullanılabilir?

A) Yalnız I

B) Yalnız II

C) Yalnız III

D) I ve III

E) I, II ve III

4. I. Demir – çelik sanayisi
II. Buharlı motorlar
III. Elektrik üretimi

Yukarıdakilerden hangileri kömürün kullanım alanı olabilir?

A) Yalnız I

B) I ve II

C) II ve III

D) I ve III

E) I, II ve III

5. Kömür ile ilgili,
I. Tüm kömürlerin fiziksel ve kimyasal özellikleri aynıdır.
II. Saf maddedir.
III. Yoğun olarak C ve H den oluşmuştur.
ifadelerinden hangileri doğrudur?

A) Yalnız I

B) Yalnız II

C) Yalnız III

D) II ve III

E) I ve III

6. Kömürde istenmeyen ve kaliteyi düşüren etmenler
I. nem,
II. kül,
III. yüksek azot
verilenlerden hangileridir?

A) Yalnız II

B) I ve II

C) I ve III

D) II ve III

E) I, II ve III

Aşağıdaki cümlelerde boş bırakılan yerleri uygun şekilde doldurunuz.

7. Taş kömürünün fırınlarda ısıtılarak içindeki gazların ayrılmasıyla elde edilen katı yakıta ……. denir.

8. …… kalorisi en yüksek ve en sert doğal kömür türüdür.

9. ……., çok miktarda bitkisel maddenin, havasız bir ortamda ve basınç altında değişmesi sonucunda oluşan, sert, katı ve koyu renkli organik bir kayaçtır.

10. Kömürler organik olgunluklarına göre ……., alt bitümlü kömür, bitümlü kömür ve antrasit tiplerine göre sınıflandırılırlar.

11. Linyitin kalorifik değeri antrasitinkinden ……. .

Aşağıdaki cümlelerde verilen bilginin doğru/yanlış olduğunu belirtiniz.

12. Kömürler yoğunluk, gözeneklilik, sertlik ve parlaklık bakımından farklılık gösterebilir. ( )

13. Kömürler anorganik kökenli maddelerdir. ( )

14. Taş kömürü, kalorisi yüksek olduğundan ülkemizde demir-çelik sanayisinde yakıt olarak kullanılır. ( )

15. Kömürler ısınmada kullanıldığında yalnızca atmosfer kirliliğine neden olur. ( )

16. Kömür içerisinde C, H, S, N ve O elementleri bulunabilir. ( )

17. Turba bir kömür türüdür. ( )

18. Kül ve nemi yüksek olan kömürün kalorisi düşüktür. ( )

APPENDIX G

SAMPLE GROUP PROJECT

GRUP PROJESİ	
Okul:	
Sınıf:	
Grup öğrencileri:	
Proje adı:	Hidroelektrik Enerji Santralleri (HES): Kim Haklı?
Süre:	5 Hafta
Projeyi hazırlama süreci	

Hidroelektrik enerji, temiz enerji kaynakları arasında gösterilmesine rağmen son yıllarda ülkemizde hidroelektrik enerji santrallerine (HES) yönelik yerel bazda tepkiler olduğu bilinmektedir. HES'lerin yapıldığı yerlerde oluşan bu tepkilerin nedenleri nelerdir, örneklerle açıklayınız. Devlet yöneticileri açısından ve yerel halk açısından haklı ve haksız olunan yönleri irdeleyiniz.

Bu projede şu sorulara cevap verilmelidir;

1. HES'lerin yapılmasını destekleyen taraflar ve bu tarafların görüşleri nelerdir?
2. HES'lerin yapılmasını desteklemeyen taraflar ve bu tarafların görüşleri nelerdir?
3. HES'lerin yapıldığı yerlerde olumlu ve olumsuz ne gibi değişiklikler meydana gelmiştir?
4. HES'lere alternatif olabilecek enerji kaynakları var mıdır?

Bütün bunlar için;

1. Bir araştırma planı oluşturunuz; bu planda yapılacak işleri, gerekiyorsa görevli kişileri ve çalışma takvimini belirtiniz.
2. Araştırma için dergiler, kütüphaneler, internet, yakın çevrenizdeki kişi ve kuruluşlardan yararlanabilirsiniz.
3. Projenizin sonunda hazırladığınız raporu 10 dakikalık sürede sunulacak şekilde poster/sunum olarak hazırlayınız.
4. Posterin/Sunumun görselliğini resimlerle, grafikler vb. çalışmalarla artırabilirsiniz.
5. Araştırmanızı en geç …… tarihine kadar bitirmelisiniz.

CURRICULUM VITAE

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High School	İstanbul Çapa Anatolian Teacher High School	1996

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2001-2008	İstanbul, Ankara	Chemistry Teacher

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Advanced English

PUBLICATIONS

İçöz, Ö. F. (2015). Turkish chemistry teachers' views about secondary school chemistry curriculum: A perspective from environmental education. *Journal of Education in Science, Environment and Health, 1*(2), 79-87.

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