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Effects of the Context-Based Learning Approach on the Teaching of Chemical Changes Unit

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ABSTRACT
In this study, the effects of context-based teaching (CBT) on the teaching of 'chemical change unit' (CCU) was examined under five main headings: student motivation, constructivist learning environment, student achievement, transferring chemistry knowledge to the subjects of daily life, and student and teachers' opinions on the implementation. The effects of CBT on the experimental and control group students were determined by Chemistry Motivation Questionnaire (CMQ), Constructivist Learning Environment Questionnaire (CLEQ), Chemical Changes Achievement Test (CCAT), and Chemical Changes-Context-Based Questions (CC-CBQ). At the end of the study, the only significant difference found in favour of the experimental group was the results of CB-CBQ. Opinions of students and teachers are generally pleasing but they stated that CBT is not suitable for the university entrance exam. In the assessment of the students, CBT would attract more attention if the exams taken contained context-based questions.

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Introduction

The importance given to science education has increased with the rapid advance of science and technology. In the 1970s, rather than education that does not focus on practice in teaching, the training focused on teaching science in daily life started to spread more. In the definitions of scientific literacy, both the practice of science in daily life and the impact of science and technology on society were emphasized. After the 1990s, with the development of science and technology, scientific literacy has come to be viewed as understanding the interaction between science-technology and society within the framework of 'Science-Technology-Society', people's knowledge about how scientific and technological developments are, and they are informed about the effects of these developments on the society, and to be able to express their opinions (Çepni et al., 2004; Holbrook & Rannikmae, 2009).

In science courses, the teaching of summary information makes subjects abstract and makes science education more difficult for students. Instead, teaching science subjects in relation to life will contribute to making science courses more understandable for students. This will also contribute to students' scientific literacy levels (Ayas, 1995; DeBoer, 2000; Gilbert, 2006). The importance of research on the assessment of students increased with the increasing importance of education as a result of progress in science and technology. At the same time, some international student assessment programs such as PISA (Program for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) have been implemented. PISA aims to assess the ability of 15-year-old students to use their knowledge and skills learned in school in daily life (Ministry of National Education [MNE], 2020). TIMSS aims to evaluate the knowledge and skills students gain in

mathematics and science. TIMSS is applied to the 4th and 8th-grade students. The results of international student assessments such as PISA and TIMSS have shown that many countries have common problems in science teaching. Important of these problems; students have problems in using the knowledge of science they have, and they are less interested in science lessons and their interest decreases as they pass to upper grade (Nentwig et al., 2007). Turkey has similar results (MNE, 2015; 2020), and updates have been made in the curriculum based on these results.

Problems encountered in chemistry/science education, described by Gilbert (2006) are 1-Overload, 2-Isolated Facts, 3-Lack of transfer, 4-Lack of relevance, and 5-Inadequate emphasis. For students who would prefer not to pursue chemistry education in the future and for the development of scientific literacy, the emphasis on traditional chemistry education is not appropriate for students (Gilbert, 2006; Gilbert et al., 2011). As the most important reason for the improvement of curricula according to the context-based approach, we can say; studies have shown that students find the courses boring because they see the materials as difficult, boring, and unrelated to their lives. Even though it is thought that the reason most students do not choose to take chemistry courses is related to lack of skill in students, there are some studies showing that they do not choose chemistry courses due to lack of interest (Kegley et al., 1996).

The important feature of context-based science teaching is that it presents science concepts to students in contexts that reveal their relationship with current life (İlhan et al., 2016; Schwartz, 2006; Sadi-Yılmaz, 2013). In this respect, it is important that the contexts made/selected for context-based teaching (CBT) are of a quality that will attract the attention of students and that they are prepared according to certain criteria (Bülbül et al., 2019). One of the important issues focused on in context-based teaching is to emphasize the transfer of scientific knowledge to everyday life (Bennet & Lubben, 2006; Gilbert, 2006). In this respect, it is necessary to measure the students' transfer of scientific knowledge to everyday life for the course conducted with CBT, with studies revealing the effect of CBT. Considering this aspect, the preparation and use of context-based questions gain importance. The criteria for context-based questions are explained by Benckert (1997) and Elmas and Eryılmaz (2015). In the same manner, İlhan and Hoşgören (2017), developed a test containing context-based questions. Curriculum development studies have been carried out regarding the context-based approach and different applications have been put forward according to the countries.

Context-based teaching practices are included in science curricula under different names (ChemCom, CiC, Salters, Chip, Chik, etc.) in America, England, Netherlands, Germany, and Israel (Pilot & Bulte, 2006). In Turkey; The 9th-grade physics curriculum in 2007, the 10th and 11th-grade curriculum in 2008, and the 12th-grade curriculum in 2009 were developed according to the context-based learning approach (Akdeniz & Paniç, 2012). Many studies revealed that different teaching methods could be used together with context-based teaching. Some of these studies are that the storytelling method in the study of Demircioğlu et al. (2009), the REACT method in the study of Karslı & Yiğit (2017), and the drama method in the study of Bülbül & Aktaş (2013). To minimize the problems encountered in science education in many countries, researches on the social environment, culture, and language for science education have made great progress (Bennet et al., 2005; Choi & Johnson, 2005; Gilbert, 2006; Ramsden, 1997). Many parts of the context-based approach are based on the fundamentals of the constructivism learning approach. Social constructivist theory played an important role in the development of CBT (Gilbert, 2006; İlhan, 2010). The social constructivist theory emphasizes the importance of culture and language and indicates that knowledge is constructed through social interactions (Fosnot, 2005).

In CBT the use of contexts from daily life is emphasized (Gilbert, 2006). Hull and Greveelk (1998) announced that elating, experience, application, collaboration, and displacement were important for the CBT. By giving different names, curricula have been designed according to CBT in many countries (Bennet & Lubben, 2006; Hofstein & Kesner, 2006; Nentwig, et al., 2007; Schwartz, 2006). Many studies, for example, on the use of CBT in chemistry teaching explain the relation of chemistry concepts with daily life (Bulte et al. 2006; Gilbert, 2006; Kuhn & Müller, 2014; Magwilang, 2016; Stolk et al. 2009). Daily life practices are considered an important factor in increasing motivation

(Glynn et al., 2009). This study is important in terms of quantitatively examining the effect of CBT on student motivation.

In addition to being preferred for providing science education related to meaningful daily life, a context-based approach was used in eliminating misconceptions in many studies (Ayvacı & Şenel-Çoruhlu, 2009; Barker & Millar, 1999). Studies are showing that CBT has different results in different student levels. Suryawati and Osman (2018) reported that CBT is more effective in students with low cognitive levels. Examining the change in the achievements of students on different chemistry subjects with context-based teaching reveals the importance of the study.

There are many studies in the literature (Choi & Johnson, 2005; Overman et al. 2014; Ramsden, 1997; Schwartz, 2006) that reveal the effect of CBT with different dimensions. However, no studies were found in which many variables were examined simultaneously for CBT. It can be said that in different studies, for CBT, the details in the whole photograph are handled and examined one by one (such as the parts that make up the puzzle). An important reason for the current study is; the effects of CBT application (contexts, worksheets, videos, laboratory applications, etc.) are investigated in multiple aspects (motivation, constructivist learning environment, academic success, context-based questions, the opinions of students and teachers about the applications) rather than one. In this study, the effect of CBT was investigated with both qualitative and quantitative data. In these respects, the study is important. This study actually tried to reveal the whole of the photograph (as the whole form of the puzzle) about the effect of CBT.

Research Questions (RQ)

In the present study the answers to the following questions were addressed;

RQ1: What is the effect of CBT on students' chemistry motivation in the chemical change unit?

RQ2: In the chemical changes unit, what is the effect of the CBT on the 'Constructivist Learning Environment'?

RQ3: In the chemical changes unit, what is the impact of CBT on the academic success of students in chemistry?

RQ4: What is the effect of the CBT on the ability of students to transfer chemistry knowledge to the situations in daily life in the chemical change unit?

RQ5: What are the views of teachers and students about the processing of the chemical change unit according to the CBT?

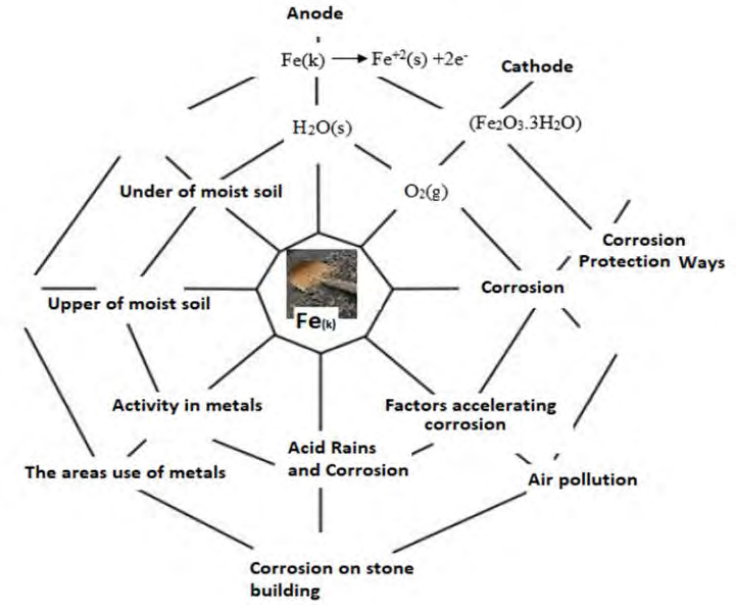
Purpose of the Study

In this study, the effect of the CBT in the teaching of 'chemical change unit' (CCU) was examined under five main headings. These were; i- the impact of the CBT on student motivation, ii- the constructivist learning environment, iii- student achievement, iv- transferring chemistry knowledge to the subjects of daily life, and v- student and practice teachers' opinions on the implementation of CBT.

In the present study, it was aimed that students learn chemistry topics in terms of contexts in our life rather than introducing chemistry directly. To exemplify this, the oxidation-reduction reactions are given in the rusting shovel context (Figure 1).

Figure 1

Chemical Subjects in the Rusted Shovel Context



Note. (Adapted from Schwartz, 2006)

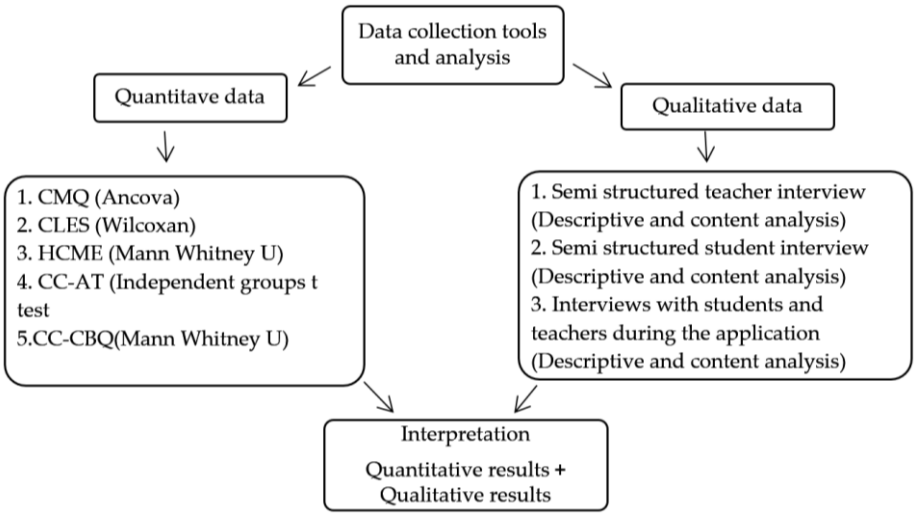
Method

Research Design

This study was conducted using the mixed-method research design, particularly triangulation design. Qualitative and quantitative data collection tools were used. In mixed-method research, triangulation design is based on the collection and analysis of different but complementary data to explain the research problem (Creswell & Plano Clark, 2007; Çepni, 2014). Figure 2 shows the mixed-method research design of this study related to results, data collection, and data analysis.

Figure 2

Research Design of Study



Chemistry Motivation Questionnaire (CMQ); Constructivist Learning Environment Survey (CLES); High school chemistry midterm exam scores (HCME); Chemical Changes Achievement Test (CC-AT); Chemical Changes-Context Based Questions (CC-CBQ) were used as data collection tools.

Participants of the Study

The sample of the study consists of 177 high school 9th grade students. The experimental group of the study consisted of 41 female, 48 male students, and the control group consisted of 35 female and 53 male students. Participants of the study were selected according to convenience sampling. Convenience sampling is a sampling method that can be preferred when the researcher is not able to use different sampling methods and has an advantage in terms of cost and time (McMillan & Schumacher, 2006; Yıldırım & Şimşek, 2011). In the study, the researcher conducted the practice with volunteer three chemistry teachers. Official permission for practice was received from the Directorate of National Education.

Data Collection Tools

The names of data collection tools are summarized in Figure 2 and are explained in detail below.

Chemistry Motivation Questionnaire (CMQ)

CMQ consisting of 22 items and 1-to-5 Likert-type was used to determine the motivation to learn. CMQ used in the study was developed as SMQ (Science Motivation Questionnaire) by Glynn et al. (2009). For the 22 items of CMQ, adapted to Turkish by İlhan et al. (2012), Cronbach's Alpha reliability coefficient is 0.821.

Constructivist Learning Environment Survey (CLES)

In order to investigate the second research question of the study and to determine the effect of the application on the constructivist learning environment, The Likert-type Constructivist Learning Environment Questionnaire (CLES), which was developed by Taylor and Fraser (1991), was used. Cronbach's Alpha reliability coefficient of CLES, adapted to Turkish by Tatar (2007) is 0.86.

High school chemistry midterm exam score (HCME)

In order to investigate the third research question of the study, the results of the midterm exam (chemistry) prepared by chemistry teachers were used to determine whether there was a difference between the levels of chemistry lesson of the experimental and control group students before the application.

Chemical Changes Achievement Test (CC-AT)

In order to examine the fourth research question of the study, the students' chemistry course achievement levels were determined through the results obtained from the CC-AT. CC-AT was developed by the researcher for use in this study. CC-AT was prepared by three chemistry teachers, the researcher, and secondary schools chemistry textbooks were used. In the development of the CC-AT, it was prepared by taking into consideration the gains in the High School Chemical Changes Unit and using the specification table. In the development of the test, 42 questions were prepared prior to the implementation and the number of questions was decreased to 28 after the pilot study. The

reliability coefficient of the multiple choices (five-choice) CC-AT calculated with KR-20 was calculated as 0.75 (Sadi-Yılmaz, 2013). Students' prior knowledge about their chemical changes achievement is sufficient enough to be compared as the pre-test. CC-AT was applied to students as a post-test after implementation.

Chemical Changes–Context-Based Questions (CC-CBQ)

In order to examine the fifth research question of the study, the level of transfer of chemistry knowledge to daily life at the end of the CBT period was examined with the CC-CBQ. In the development of the CC-CBQ, in accordance with the suggestions of three chemistry teachers and two students who are PhD students in chemistry education and two lecturers were asked to finalize their questions. The CC-CBQ contains 18 questions (Sadi-Yılmaz, 2013). The highest score that can be obtained from the questions is 100. Scoring and analysing of all questions were made according to the chemistry subject content and knowledge to the daily life. To score the questions, we developed a coding scheme based on the descriptions of chemistry subject content and knowledge of daily life. The answers given to the questions were scored by reading by the two researchers separately. CC-CBQ was planned to apply as a pre-test and post-test to the experimental and control group students, but it was used as a post-test because the teachers preferred to do it only as a final test. The reason for this, the teacher, who carried out the application, said that the students' previous knowledge about the subject was insufficient and the comparison to be obtained would not yield good results.

Semi-Structured Teacher and Student Interview Form

After the CBT was completed, the opinions of the three teachers about the practice and the opinions of the students in the experimental group were obtained. Open-ended questions were asked to teachers and students. Two teachers used the note-taking technique to obtain their opinions, while a teacher expressed their opinions orally. The general frameworks of the teachers' views are about education-teaching practices, the impact of CBT on students' achievement and motivation, chemistry courses. The general framework of the students' views is about worksheets given to students, contexts, videos they watched, chemical changes achievement, and chemical changes context-based questions.

Informal Interviews with Teachers and Students

The researcher participated in the interview as a participant-observer to help the teachers and gathered data through interviews with teachers and students.

Data Analysis

Chemistry Motivation Questionnaire (CMQ)

Data obtained from CMQ were analyzed with One-Way Analysis of Covariance (ANCOVA). In the analysis of the data, one-factor covariance analyses (ANCOVA) were used to determine whether the difference between the post-test scores corrected according to the pre-test scores of the groups is significant (Büyüköztürk, 2010).

Constructivist Learning Environment Survey (CLES), High School Chemistry Midterm Exam (HCME), and Chemical Changes-Context-Based Questions (CC-CBQ)

While repeated measurements (pre-post) were analyzed with the Wilcoxon Signed-Rank test, the Mann–Whitney U-test was used to determine the differences between the two groups. Since the

data obtained from CLES, HCME, and CC-CBQ did not fulfill the conditions for parametric analyses, the data were analyzed with the "Wilcoxon signed-rank test" and the "Mann Whitney U test".

Chemical Changes Achievement Test (CC-AT)

It is thought that students' prior knowledge of chemical changes achievement is not sufficient to compare as a pre-test. Instead of this, data obtained by using the HCME as a pre-test were analyzed. Data were obtained by using the CC-AT as a pro-test for the experimental and control group students. The data of CC-AT were analyzed by using the independent samples t-test.

Informal Interviews with Teachers and Students and Semi-Structured Teacher and Student Interview Form

Qualitative data were obtained by the interviews with the teachers and students, and the content and descriptive analysis of these data was done.

Implementation of Study

Chemistry courses were conducted according to the CBT in the experimental group students and the current curriculum in the control group students (Table 1 and Table 2).

Worksheets

Worksheets used for the CBT were developed by the researcher in this study. In the preparation of CBT worksheets on the unit of chemical changes group was taken into domestic and literature search. In the development of the worksheets, three chemistry teachers and two chemistry education experts (PhD and Prof. Dr) were interviewed.

Videos

In the study, four videos related to the unit of chemical changes determined by the researcher and the teachers were shown to the students (Table 1).

Laboratory Practices

Five demonstration experiments were conducted in the laboratory with the experimental group students. In the control group, chemistry subjects were processed from textbooks and supplementary resource books, and then multiple-choice questions were solved. In the experimental and control groups, chemistry lessons were taught in approximately 8 weeks, two hours per week (Table 1 and Table 2).

Table 1

CBT Course in Experiment Group

Topic	Contextual worksheet	Laboratory Application	Web addresses of videos in the courses	Application period (Week)
Physical and chemical change	Drain opener	Preparation of NaOH solution and soap making		1 week (2 hours)

Combustion reaction	Fossil fuels and global warming	Mg strip and ether burning	http://www.youtube.com/watch?v=A7Rc9o81uis	1 week (2 hours)
Precipitation reaction	Unwanted calcification in washing machines and teapots	Obtaining precipitate from $Pb(NO_3)$, Kl, and HCl solutions		2 weeks (4 hours)
Neutralization reaction	Acid rains	Making salt and water from HCl and NaOH solutions	http://www.youtube.com/watch?v=wiZVC6P8vmU	1 week (2 hours)
Oxidation-reduction reactions	Rusted Shovel	Immersion of iron, magnesium, and copper strips into CuSO4 solution	http://www.youtube.com/watch?v=1HebpebicDQ	2 weeks (4 hours)
Polymerization and Hydrolysis	Unbreakable glass		http://www.youtube.com/watch?v=c7ihpZhCj6k	1 week (2 hours)

Table 2

Chemistry Course in Control Group

Topic	Application in course	Application period Week (hours)
Physical and chemical change	The teaching was carried out by using the existing curriculum textbooks, mostly using the method and question-answer technique of the teacher and solving multiple-choice questions from different sources at the end of the course.	1(2 hours)
Combustion reaction		1(2 hours)
Precipitation reaction		2(4 hours)
Neutralization reaction		1(2 hours)
Oxidation-reduction reactions		2(4 hours)
Polymerization and Hydrolysis		1(2 hours)

Results

Results for RQ1

In order to determine the effect of CBT on students' motivation, CMQ was applied to the experimental and control group students before and after the application. Calculations were made on the total and mean scores obtained from the CMQ. The data obtained from the CMQ were analyzed with ANCOVA. The mean scores of the control group pre-test and the post-test were 3.549 and 3.40, respectively. The mean scores of the experimental group pre-test and the post-test were 3.457 and 3.536, respectively. According to the results of the ANCOVA, the difference between the adjusted post-test mean scores of the students in the experimental and control groups (Table 3) was not statistically significant [$F(1,145) = 2.127$, $p > .05$].

Table 3

ANCOVA Results for Adjusted Post-test CMQ in the Experimental and Control Groups

Source	Sum of Squares	Df	Mean Squares	F	Significance Level (p)
Pre-test	.002	1	.002	.008	.931
Groups	.624	1	.624	2.127	.147
Error	42.510	145	.293		
Total	1821.041	148			

Note. Df: Degrees of Freedom

Results RQ2

The Wilcoxon signed-rank test was used to determine whether the difference between CLES pre-test scores and post-test scores was statistically significant (Table 4). There was no statistically significant difference between the pre-test and post-test scores of the experimental group [z=0.238, p>.05], or the control group [z=1.54, p>.05].

Table 4

Wilcoxon Signed Ranks Test Results for CLES Scores.

Experimental Group CLES Scores	Pretest-posttest	N	Mean Rank	Sum of Rank	z	p
	Negative Ranks	33	30.62	1010.5	.238[a]	.812
	Positive Ranks	29	32.50	942.5		
	Ties	1	-	-		
Control Group CLES Scores	Pretest-posttest	N	Mean Rank	Sum of Rank	z	p
	Negative Ranks	28	29.55	827.5	1.54[a]	.123
	Positive Ranks	23	21.67	498.5		
	Ties	1				

Note. [a] Based on positive ranks

Results for RQ3

It is thought that students' prior knowledge of chemical changes achievement is not sufficient to compare as a pre-test. Instead of this, data obtained by using the High school chemistry first midterm exam scores (HCME) as a pre-test were evaluated. The high school midterm score did not show a normal distribution. In the study, Mann Whitney U tests were performed to determine whether there was a difference between the HCME levels of the experimental and control group students before the application. Mann Whitney U test results showed no statistically significant difference between the groups [U=3296; p>.05] (Table 5).

Table 5

Mann Whitney U Test Results for High School Midterm Score

Group	N	Mean Rank	Sum of Ranks	U	p
Experimental	89	95.97	8541	3296	.069
Control	88	81.95	7212		

At the end of the application, an independent sample t-test was used to determine whether there was a significant difference between the CC-AT scores of the experimental group and the control group. According to the results of independent sample t-test analysis (Table 6), no statistically significant difference was found between the groups [t(167) = 1,450, p >.05].

Table 6

Results of Independent Sample t-test for CC-AT of Experimental and the Control Group

Group	N	Mean	SD	Df	t	p
Experimental	87	46.91	10.728	167	1.450	.149
Control	82	44.30	12.587			

Results for RQ4

CC-CBQ was answered by 86 experimental groups and 51 control group students. The mean of the students' grades in the experimental group was found to be 50.48 in the 40.06 control group. CC-CBQ was applied to both groups at the end of the study. Since the data obtained from CC-CBQ did not fulfil the conditions for parametric analyses, it was found appropriate to perform the Mann-Whitney U test from nonparametric tests to determine whether there was a statistically significant difference between the groups. A statistically significant difference was found in favour of the experimental group among the results of CC-CBQ among the experimental and control group students in Table 7 ($U = 1063.00$; $p < .05$).

Table 7

Mann Whitney U test Results for CC-CBQ

Group	N	Mean Rank	Sum of Ranks	U	p
Experimental	86	82.14	7064.00	1063,00	.00
Control	51	46.84	2389.00		

Results for RQ5

The interviews with the teachers and the written opinions received from the teachers are given in Tables 8 and 9. Similarly, the opinions of the students in the experimental group about the application of CBT are given in Table 10.

Table 8

Application Teachers' Views on Current (Traditional) Course Processing Processes

Theme /Topic	Categories	Code	Teacher's nickname	Teachers' views
Learning environment	Alternative Applications	A waste of time	C, Z, T	"Students are considered to be a loss of time in activities other than question-solving."
	Laboratory,	Laboratory Use Laboratory Safety	C, Z Z	"I rarely use the lab." "I'm having trouble getting security in the lab."
	Time	Inadequate course duration	T, C, Z,	"Chemistry course hours are insufficient for the course. Teachers want to finish the subject and students want to solve more questions."
	Teaching Material	Books	C, Z, T	"Coursebooks are used." "University preparatory books are used."
Assessment and evaluation	Question types	Multiple choice Question	C, Z, T	"Multiple choice questions are solved."
	Problem solution	Teacher-centred Student-centred	C, Z, T C, Z, T	"The teacher solves the questions." "Students are solving the questions."
	Anxiety	Grade anxiety Exam anxiety	C, Z, T	"Students are worried about grades and exams."

When Table 8 is examined, it is seen that there is a teacher-centred course processing process in the current teaching approach. It is seen that the teachers and students solve the multiple-choice questions in the question solution section, and also the students are worried about exams and grades. In the courses, textbooks, as well as preparatory books for university exams, are used. It is seen that the students consider different applications in the courses other than question-solving as a waste of time and the teachers cannot use the laboratories intensively in the courses.

Table 9

Teachers' Views on Course-Processing Processes According to their CBT

Theme /Topic	Categories	Code	Teacher's nickname	Teachers' views
Positive	Chemistry lesson	Curiosity	C, Z	"CBT raises students' interest in chemistry "
		Attention	C	"CBT draws students' attention to chemistry courses"
	Laboratory applications	Drawing attention	Z	"CBT, laboratory applications have attracted the students' attention."
	Videos		Z	"Videos attracted the most attention from students in CBT"
	Exercise sheets		C	"The exercise sheets prepared according to CBT attracted the attention of students."
Neutral	Effects on students	Motivation, interest, success	Z	"CBT did not have much effect on the student's motivation, interest in the course and the level of success in the course."
Negative	Assessment	Difficulty in preparing questions	C, Z	"It is difficult to prepare questions related to CBT."
		Exam and note anxiety	C, Z, T	"Students do not prefer the CBT because of the exam and grade anxiety."
	Time	The time problem of student and teacher	C	"Lesson duration is insufficient for students and teachers"
Suggestions	Measurement and Evaluation	Different Types of Questions	C	"If the questions in the current teaching system are similar to the questions in the assessment of the CBT, the students' interest in CBT increases."
Criticisms	Laboratory applications	Demonstration Experiments	Z	"It would have been better if students did experiments in the laboratory in CBT."

In Table 9, it is seen that the teachers stated that the content of the course and the questions of the exam in the current curriculum were not in line with the practice of CBT and that the inadequacy of the current course hours had a negative effect on the effectiveness of the practices. However, it was stated that giving in-service training would be more effective if the content and question types in the current curriculum were paralyzed by CBT.

Table 10

The Opinions of the Experimental Group Students about CBT

Theme /Topic	Categories	Frequency(f)	Code	Sample quotations
CBT(Context-Based Teaching)	Positive	33	Raising interest and curiosity	"My interest and curiosity have risen"
			The need to do research	"I needed to do research"
			İncreasing interest	"My interest and success in a profession related to science classes has increased"
			Recognizing the relation of chemistry with daily life	
			Facilitate understanding	"It helped me understand topics more easily"
			Fun applications	"Applications were fun"

		Encouraging course preparation	"I felt the need to be prepared for the course"
		Strengthening	"Reinforces my chemistry knowledge"
		Increased work desire	"My desire to study increased"
		Helpful	"Applications were helpful"
		Teamwork	"Working with friends."
Neutral	3	Beautiful but unusual	"Applications are nice but we're not used to applications"
		Useful but difficult	"It is useful but hard for me."
		Social Science preference	"It's not important to me because I won't choose the math field."
Negative	10	Not suitable for university entrance exam	"It would be better if the applications were suitable for university placement exams"
		Unnecessary applications	"We didn't need these applications, we could solve more questions about current exams"
		Ineffective	Applications were not effective
		Do not like chemistry	"I didn't like it because the apps are a little different"

When Table 10 is examined, it is seen that more positive statements emerged than students' opinions about CBT. The positive opinions are about interest, curiosity, fun, teamwork, the need to do research/study, chemistry related to daily life, and facilitating understanding. When Table 10 is examined, the negative opinions are about not suitable for the university entrance exam, unnecessary applications, ineffective, and do not like chemistry.

Table 11

The Opinions of the Experimental Group Students about the CBT Application

Theme /Topic	Categories	f	Code	Sample quotations
Worksheets	Positive	18	Easy content	"Worksheets look easier"
			Detailed content	"Worksheets explain in more detail"
			Clear content	"The information in the worksheets is more understandable"
			Giving summary information.	"Summary information on worksheets"
			Associating with daily life	"I liked the worksheets because they contain samples from our lives"
			Promoting work	"Working sheets are driving to work"
			Curiosity	"I wonder what I'm looking for in the worksheets"
			Interest	"Increased my interest in the lesson"

	Negative	5	Complex	"Topics were complex"
			Boring	"Working sheets were boring"
Questions in worksheets	Positive	1	Qualified questions	"Very helpful and nice questions"
	Suggestion	2	More emphasis on the lecture	"In the worksheets, there should be lecture instead of questions"
	Negative		Insufficient research opportunities	"I have no opportunities to investigate questions"
Laboratory Applications	Positive	15	Retention of knowledge	"Lab applications have provided retention due to being visual"
			strengthening	"Lab applications strengthen my knowledge"
			Curiosity	"Lab practices have increased my curiosity"
			Interest, funny	"I'm interested in lab applications"
	Suggestion	2	Experiments should be done individually	"It would be nice if everyone experimented"
			Frequency of applications	"Lab applications can be more"
	Negative	2	Ineffective	"Applications were not very effective for me"
Videos	Positive	11	Facilitate understanding	"The videos are visual and auditory, making it easier to understand"
			Retention of knowledge	"It helped me understand my subjects better"
			Associating with daily life	
			Funny	"Application was fun"
	Suggestion	2	Insufficient application time	"Applications can be increased"
	Negative	1	Not understandable	"Videos were not understandable"

When the students' opinions about the applications of CBT are examined in Table 11, more positive opinions about the worksheets, questions in worksheets, laboratory applications, and videos were determined.

Table 12

The Opinions of the Experimental Group Students on the Assessment in CBT

Theme/ Topic	Categories	f	Code	Sample quotations
CC-CBQ	Positive	10	Qualified Questions	"We felt the need to investigate the questions after the exam"
			High score	
			Strengthening	
			Promote research	"Questions encouraged to work"
			Promoting work	
			Providing discussion environment	"Questions raised my curiosity"
			Curiosity	
			Interest	
	Negative	13	Difficult questions	"Questions were difficult"
			Unnecessary questions	
			Unusual question type	"No need for such questions"
			Low score	
			Types of questions that do not match the curriculum	"The questions were the type we were not used to, it was unnecessary"

CC-AT	Positive	4	Easy questions Quality questions Typical question type	"The questions were of the type we were used to"
			Question type appropriate to university exam	"Questions appropriate to university exam"

The opinions of teachers and students in the common denominator are that the practices contribute to the teaching process, but the examination and grade anxiety in the students, the handling of the topics in the current curriculum, and the different types of questions reduce the impact of the CBT.

Discussion

In the present study, no significant difference was found between the experimental group and the control group students in terms of motivation. It can be said that the application did not have a significant effect on the student motivation because of the lesson grade and test anxiety. No significant difference was found in the experimental and control groups in terms of the constructivist learning environment. There are studies (Gül, 2016; Kutu, 2011; Suryawati & Osman, 2018; Ünal, 2008) indicating that CBT does not have a statistically significant effect on the attitudes of the students. There are also many studies (Anugrah et al., 2017; Choi & Johnson, 2005; Elmas & Geban, 2016; İlhan et al., 2016; Kuhn & Müller, 2014; Magwilang, 2016; Majid & Rohaeti, 2018; Pilot & Bulte, 2006; Ramsden, 1997; Ulusoy & Önen, 2014) show that CBT contributes to students' motivation, achievement, interest, and attitude towards chemistry courses. Choi & Johnson (2005) investigated whether there were differentiations according to the attention, relevance, confidence, satisfaction dimensions of motivation. According to the results, there was a significant difference between video teaching and traditional text-based instruction in context-based online courses for only the attention dimension of motivation. In the study conducted by Kuhn and Müller (2014), in terms of the motivation (self-concept, intrinsic motivation/internal motivation, classroom climate/classroom environment) of the students, a significant difference was found between the group in which the science problem was given within the context-based newspaper and the group in which the problem of science was given in the traditional text.

At the end of the study, it was determined that there was no significant difference between the experimental group and control group students' CC-AT scores. Similarly, Bennet and Luben (2006) have expressed the studies of Key (1998) and Barber (2001) it was stated that there was no statistically significant difference between the achievements of the students. In the study conducted by Barber (2001, as cited in Bennet & Luben, 2006), it was found out that in the examination prepared by the Royal Society of Chemistry, the students who are studying according to the CBT are less successful than the students who are studying according to the traditional approach, but in the exams prepared in the advanced level, vice versa. Çeken and Tezcan (2011) examined the effects of classroom presentations including subjects from daily life and classroom discussions involving subjects from daily life to learn about physical and chemical changes in seventh-grade students. At the end of the study, it was stated that there was no significant difference between the success levels of the students in the classroom where the video-based courses were conducted and classroom discussions. On the other hand, Ramsden (1997) stated that there was a slight difference between the success of the students in the groups where the CBT is applied and in the groups where the more traditional approach is applied. However, it is stated that there are some statements indicating that the courses of the CBT are more useful and worth spending time on. The qualitative results of the current study, obtained from the opinions of teachers and students, revealed results consistent with the literature. Suryawati and Osman (2018), stated that CBT contributed more to the success of low cognitive level students. Tekbıyık and Akdeniz (2010) stated that there was no significant difference between the achievement scores of the students in the questions prepared in accordance with traditional and CBT. They also stated that the students did not prefer to solve the questions prepared according to the CBT

because of the question types in schools and university entrance exams. Overman et al. (2014) stated that students and teachers have difficulty in adapting to the chemistry education curriculum prepared according to the CBT. King and Henderson (2018) stated that using environmental contexts increased the success of students.

In the Turkish education system, students are evaluated with multiple-choice exam types after they have learned information in schools and they are settled in universities with similar exams. In this case, students are learning to learn a lot in less time and to have more success on multiple-choice questions. Interviews with teachers and students (Table 10, 11) have shown that CBT does not mean much to students due to this situation.

At the end of the study, it was seen that the students in the experimental group were more successful than the students in the control group according to the questions prepared according to CBT (Table 8). It is a usual result that the students in the experimental group are more successful in this exam because they have been studying the subjects prepared according to the CBT.

Context-based teaching practices can be investigated in many different fields such as objective/objective, content, educational status, assessment, and evaluation in terms of teachers, students, etc. As a matter of fact, when the literature is examined, it is seen that there are studies that deal with these components separately studies such as; While preparing high school entrance and university entrance exam questions, in terms of the components of the curriculum (Çepni et al., 2012), the analysis of exam questions according to Bloom's Taxonomy (Karamustafaoğlu et al., 2003), teachers' ability to write questions suitable for context-based learning at the level of scientific literacy (Çepni et al., 2020). The effects of context-based teaching in education can be taken in more detail in different ways.

Conclusion and Suggestions

At the end of the study, there was no significant difference between the CBT and traditional teaching application groups in motivation, constructivist learning environment, and academic achievement. However, there are different studies indicating that there is a significant difference in favour of CBT in terms of motivation success, etc. in the groups where CBT is applied. This result may be because the exam questions are based on the method of evaluating the students in the current curriculum (evaluation with multiple-choice questions) and parallel with the university entrance exam questions. However, there was a significant difference in favour of the experimental group at the end of CC-CBQ. The experimental group students stated that the questions of CC-CBQ were not suitable for the current curriculum and university exams. Some of the experimental group students stated that applications that will contribute to higher grades from the courses in the school and applications for university placement tests will be more beneficial. In addition, the teachers who carried out the application stated that they preferred to work for the curricula which will contribute to solving the test questions in the university placement test more quickly and correctly.

To get more efficient results from CBT, the following are suggested:

- For the students to see the CBT more meaningful, there should be appropriate questions in the school evaluation and university entrance exams. In other words, the implementation and evaluation process should be parallel. The application and evaluation process must be complementary. Students may be better adapted to CBT if curricula are integrated with CBT.
- It is necessary to carry out the practices that will contribute to the students' awareness of the relationship between the subjects of science and daily life (applications of the CBT) and evaluations from the early schooling period (primary education). In this case, students are more familiar with the CBT and in the following years, better efficiency can be achieved.
- In-service training should be given to the teachers to support them to carry out the courses according to the CBT. In this process, teachers should be encouraged to develop skills such as preparing and using lesson materials appropriate to the CBT and preparing evaluation questions appropriate to the CBT.

● It should be ensured that the materials (printed materials, materials developed in the virtual environment, etc.) that are appropriate for the CBT towards each stage in the curriculum (primary and secondary education) are developed and that students and teachers benefit from them.

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References

Akdeniz, A. R., & Paniç, G. (2012). Yeni fizik öğretim programına ve uygulanmasına yönelik öğretmen görüşleri [Teacher's opinions on the new physics teaching program and its implementation]. *Milli Eğitim Dergisi*, *42*(196), 290-307.

Anugrah, I. R., Mudzakir, A., & Sumarna, O. (2017, September). *Construction of context-based module: how OLED can be used as a context in high school chemistry instruction*. In Journal of Physics: Conference Series (Vol. 895, No. 1, p. 012113). IOP Publishing.

Ayas, A. (1995). A study on program development and application techniques in science: Evaluation of two contemporary approaches. *Hacettepe University Journal of Education Faculty*, 11, 149-155.

Ayvacı, H. Ş., & Çoruhlu, T. Ş. (2009). Effects of explanatory stories on elimination of students' misconceptions about physical and chemical change. *Ondokuz Mayıs University Journal of Education Faculty*, *28*, 93-104.

Barker, V., & Millar, R. (1999). Students' reasoning about chemical reactions: what changes occur during a context-based post-16 chemistry course? *International Journal of Science Education, 21*(6), 645-665.

Benckert, S. (1997), Conversation and context in physics education, Swedish Council for the Renewal of Higher Education. Project Report 161/97.

Bennet, J., Grasel, C., Parchmann, I., & Waddington, D. (2005). Context-based and conventional approaches to teaching chemistry: comparing teachers' views. *International Journal of Science Education*, *27*(13), 1521-1547.

Bennet, J., & Lubben F. (2006). Context–based chemistry: the salters approach. *International Journal of Science Education, 28*(9), 999-1015.

Bulte, A., Westbroek, H., de Jong, O., & Pilot, A. (2006). A research approach to designing chemistry education using authentic practices as contexts. *International Journal of Science Education*, *28*(9), 1063–1086. https://doi.org/10.1080/09500690600702520

Bülbül, M. Ş., Elmas, R., & Eryılmaz, A. (2019). Fizik ve kimya disiplinleri için ilgi çekici olan bağlamların bağlam disiplin ilişkisi kapsamında belirlenmesi [Determining the appealing contexts for physics and chemistry regarding the context discipline relationship]. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi*, *50*, 451-479. https://doi.org/10.21764/maeuefd.364766

Bülbül, M. Ş., & Aktaş, G. (2013). Fizik dersleri için bağlam temelli drama uygulamalari [Context based drama applications for physics courses]. *Eğitim ve Öğretim Araştırmaları Dergisi*, *2*(1), 381-389.

Büyüköztürk, Ş. (2010). *Sosyal bilimler için veri analizi el kitabı [Handbook of data analysis for social sciences]*. Pegem Akademi.

Creswell, J. W., & Plano-Clark, V. L., (2007). *Designing and conducting mixed methods research*. Sage.

Choi, J. H. & Johnson, D. S. (2005). The effect of context-based video instruction on learning and motivation in online courses. *The American Journal of Distance Education*, *19*(4), 215–227.

Çeken, R., & Tezcan, R. (2011). The effects of teaching the physical and chemical changes using video and discussion teaching techniques on success levels of the 7 grade students. *Kastomonu Eduction Journal*, *19*(1), 221-228.

Çepni, S., Ayvacı, H. Ş., & Bacanak, A. (2004). *A new perspective on science education: Science-technology-society*. Top-Kar Matbaacılık.

Çepni, S., Kara,Y., Çil, E. (2012). Middle school science and items of high school entrance examination: examining the gap in Turkey. *Journal of Testing and Evaluation*. *40*(3), 501-5011. 10.1520/JTE104274

Çepni, S. (2014). *Araştırma ve proje çalışmalarına giriş [Introduction to research and project work].* Celepler Matbaacılık.

Çepni, S., Ormancı, Ü., & Ülger, B. B. (2020). Examination of context-based question writing skills of science teachers participated in a scientific literacy course. *Journal of Qualitative Research in Education*, *8*(4), 1249-1270. https://doi.org/10.14689/issn.2148-2624.8c.4s.8m

DeBoer, G. (2000). Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching*, *37*(6), 582–601.

Demircioğlu, H., Demircioğlu, G., & Çalık, M. (2009). Investigating the effectiveness of storylines embedded within a context-based approach: the case for the Periodic Table. *Chemistry Education Research and Practice, 10*(3), 241-249.

Elmas, R., & Geban, Ö. (2016). The effect of context based chemistry instruction on 9th grade students' understanding of cleaning agents topic and their attitude toward environment. *Education and Science*, *41*(185). https://doi.org/10.15390/EB.2016.5502

Elmas, R., & Eryılmaz, A. (2015). How to write good quality contextual science questions: criteria and myths. *Journal of Theoretical Educational Science, 8*(4), 564-580. https://doi.org/10.5578/keg.10135

Fosnot, C. T. (2005). Constructivism: theory, perspectives and practice. Tecaher College.

Gilbert, J. K. (2006). On the nature of "context" in chemical education. *International Journal of Science Education*, *28*(9), 957-976.

Gilbert, J. K., Bulte, A. M., & Pilot, A. (2011). Concept development and transfer in context-based science education. *International Journal of Science Education, 33*(6), 817-837.

Glynn, M. S., Taasoobshirazi, G., & Brickman, P. (2009). Science motivation questionnaire: construct validation with nonscience majors. *Journal of Research in Science Teaching*, *46*(2), 127-146.

Gül, Ş. (2016). Teaching "photosynthesis" topic through context-based instruction: an implementation based REACT strategy. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, *10*(2), 21-45.

Hofstein, A., & Kesner, M. (2006). Industrial chemistry and school chemistry: Making chemistry studies more relevant. *International Journal of Science Education*, *28*(9), 1017–1039. https://doi.org/10.1080/09500690600702504

Holbrook, J., & Rannikmae, M. (2009). The meaning of scientific literacy. *International Journal of Environmental and Science Education, 4*(3), 275-288.

Hull, D., & Greveelk, J. H. (1998). *Technical preparation: the next generation*. Center Occupational Research and Development.

İlhan, N. (2010). *The effect of context based approach on the learning of chemical equilibrium* [Unpublished Doctoral Dissertation]. Ataturk University.

İlhan, N., & Hoşgören, G. (2017). Fen bilimleri dersine yönelik yaşam temelli başarı testi geliştirilmesi: Asit baz konusu [Developing of context based achievement test towards science: Acids and bases]. *Fen Bilimleri Öğretimi Dergisi*, *5*(2), 87-110.

İlhan, N., Yıldırım, A., & Yılmaz, S. S. (2012). Chemistry motivation questionnaire: the study of validity and reliability. *Mustafa Kemal University Journal of Social Sciences Institute*, *9*(18), 297-310.

İlhan, N., Yıldırım, A. & Sadi-Yılmaz, S. (2016). The effect of context-based chemical equilibrium on grade 11 students' learning, motivation and constructivist learning environment. *International Journal of Environment & Science Education*, *11*(9), 3117-3137.

Karamustafaoğlu, S., Sevim, S., Karamustafaoğlu, O., & Çepni, S. (2003). Analysis of Turkish high-school chemistry-examination questions according to Bloom's taxonomy. *Chemistry Education Research and Practice*, *4*(1), 25-30.

Karslı, F., & Yiğit, M. (2017). Effectiveness of the REACT strategy on 12th grade students' understanding of the alkenes concept. *Research in Science & Technological Education*, *35*(3), 274-291.

Kegley, S., Stacy, A. M., & Gutwill, J. P. (1996). Environmental chemistry in the general chemistry laboratory, part, ii: evaluation of an alternative curriculum. *The Chemical Educator*, *1*(4), 1-20.

King, D., & Henderson, S. (2018). Context-based learning in the middle years: achieving resonance between the real-world field and environmental science concepts. *International Journal of Science Education*, *40*(10), 1221-1238. https://www.doi.org/10.1080/09500693.2018.1470352

Kuhn, J., & Müller, A. (2014). Context-based science education by newspaper story problems: A study on motivation and learning effects. *Perspectives in Science*, *2*(1-4), 5-21. 10.1016/j.pisc.2014.06.001

Kutu, H. (2011). *Teaching 9th grade chemistry lesson "chemistry in our lives" unit with context-based ARCS teaching model* [Unpublished Doctoral Dissertation]. Ataturk University.

Magwilang, E. B. (2016). Teaching chemistry in context: Its effects on students' motivation, attitudes and achievement in chemistry. *International Journal of Learning, Teaching and Educational Research*, *15*(4), 60-68.

Majid, A. N., & Rohaeti, E. (2018). The effect of context-based chemistry learning on student achievement and attitude. *American Journal of Educational Research, 6*(6), 836-839. 10.12691/education-6-6-37.

McMillan, J. H., & Schumacher, S. (2006). *Research in education: evidence-based inquiry* (6th edition). Pearson Publishing.

Ministry of National Education (MNE) (2020, February 12). PISA Turkey official website. http://pisa.meb.gov.tr/

Ministry of National Education (MNE) (2020, February 12). TIMSS Turkey official website. http://timss.meb.gov.tr/.tr/

Nentwig, P. M., Demuth, R., Parchmann, I., Ralle, B., & Gräsel, C. (2007). Chemie im Kontext: Situating learning in relevant contexts while systematically developing basic chemical concepts. *Journal of Chemical Education, 84*(9), 1439. https://www.doi.org/10.1021/ed084p1439

Overman, M., Vermunt, J. D., Meijer, P. C., Bulte, A. M. W., & Brekelmans, M. (2014). Students' perceptions of teaching in context-based and traditional chemistry classrooms: comparing content, learning activities, and interpersonal perspectives. *International Journal of Science Education, 36*(11), 1871-1901. https://www.doi.org/10.1080/09500693.2013.880004

Özay-Köse, E., & Çam Tosun, F. (2011). Effect of "context based learning" in students' achievement about nervous system. *Journal of Turkish Science Education, 8*(2), 91-106.

Pilot, A., & Bulte, A. M. (2006). The use of "contexts" as a challenge for the chemistry curriculum: Its successes and the need for further development and understanding. *International Journal of Science Education, 28*(9), 1087-1112.

Ramsden, J. M. (1997). How does a context-based approach influence understanding of key chemical ideas at 16?. *International Journal of Science Education 19*(6) 697-710.

Schwartz, A. T., (2006). Context-based chemistry education contextualised chemistry education: The American experience. *International Journal of Science Education, 28* (9), 977–998.

Sadi Yılmaz, S. (2013). *The Effects of the context- based learning approach on the training of chemical changes unit* [Unpublished Doctoral Dissertation]. Ataturk University.

Stolk, M. J., Bulte, A. M. W., de Jong, O., & Pilot, A. (2009). Strategies for a professional development programme: Empowering teachers for context-based chemistry education. *Chemistry Education Research and Practice, 10*(2), 154–163. https://doi.org/10.1039/B908252M

Suryawati, E., & Osman, K. (2018). Contextual learning: innovative approach towards the development of students' scientific attitude and natural science performance. *Eurasia Journal of Mathematics, Science and Technology Education, 14*(1), 61-76. https://doi.org/10.12973/ejmste/79329

TIMSS Turkey. (2017, November 25). What is TIMSS. http://timss.meb.gov.tr/?page_id=24

Tatar, E., (2007). *Effect of problem based learning approach on understanding of the first law of thermodynamics* [Unpublished Doctoral Dissertation]. Ataturk University.

Tekbıyık, A., & Akdeniz, A.R. (2010). An investigation on the comparison of context based and traditional physics problems. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 4*(1), 123-140.

Ünal, H. (2008). *Investigation of the effects of conducting elementary science and technology course in accordance with context-based approach on teaching "matter-heat"* [Unpublished Master's Dissertation]. Ataturk University.

Van Driel, J. H., Bulte, A.M.V., & Verloop, N. (2005). The conceptions of chemistry teachers about teaching and learning in the context of a curriculum innovation. *International Journal of Science Education 27*(3), 303-322. https://doi.org/10.1080/09500690412331314487

Ulusoy, F. M., & Onen, A. S. (2014). A research on the generative learning model supported by context-based learning. *Eurasia Journal of Mathematics, Science & Technology Education, 10*(6), 537–546. https://doi.org/10.12973/eurasia.2014.1215a

Yıldırım, A., & Şimşek, H. (2011). *Sosyal bilimlerde nitel araştırma yöntemleri [Qualitative research methods in social sciences]*. Seçkin.