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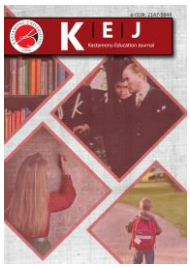

| Research Article / Araştırma Makalesi |

Investigation of the Effect of Teaching the Unit "Chemistry is everywhere" by Argumentation on Academic Achievement and Some Variables

"Kimya Her Yerde" Ünitesinin Argümantasyon Yöntemiyle Öğretiminin Akademik Başarı ve Bazı Değişkenler Üzerine Etkisinin İncelenmesi

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Keywords

1. Argumentativeness
2. Toulmin's argument pattern
3. Attitude
4. Scientific process skills
5. Nature of science

Anahtar Kelimeler

1. Argümantasyon
2. Toulmin Argüman Modeli
3. Tutum
4. Bilimsel Süreç Becerileri
5. Bilimin Doğası

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Abstract

Purpose: This study aimed to investigate the effect of argumentation-oriented instruction on students' academic achievement, argumentation skills, attitudes towards chemistry, understanding the nature of scientific knowledge, science process skills and willingness to argumentation in teaching the unit "chemistry is everywhere", by comparing with the existing teaching method.

Method: The research was conducted via embedded design of mixed research method simultaneously combining quantitative and qualitative approaches. The sample consisted of 66 10th grade highschool students. Data collection tools were 'Chemistry is everywhere' Unit Achievement Test (CEAT), Attitudes Scale towards Chemistry (ASTC), Science Process Skills Test (SPST), Nature of Scientific Knowledge Test (NSKT), Argumentativeness Scale (AS), interviews and verbal-written discussion. Independent samples t-test and Mann-Whitney U test were utilized to analyze the scores of CEAT, ASTC, SPST and NSKT, while Wilcoxon test was used for the analysis of AS. The data of interviews, verbal and written discussion were exposed to content analysis.

Findings: The results of the study found statistically significant differences between the experimental and control groups' mean scores of the CEAT, ASTC, SPST and NSKT in favor of the experimental group. For the experimental group, there was a significant difference between the pre-test and post-test mean scores of AS and the students' argumentation levels mainly remained level 2 containing claim and warrant.

Öz

Amaç: Bu araştırmada "Kimya Her Yerde" ünitesinin öğretiminde bilimsel argümantasyon tabanlı öğrenme yönteminin öğrencilerin akademik başarılarına ve argümantasyon becerilerine etkisinin incelenerek mevcut öğretim yöntemi ile karşılaştırılması amaçlanmıştır. Ayrıca, öğrencilerin kimya dersine yönelik tutumları, bilimsel bilginin doğasıyla ilgili anlayışları, bilimsel süreç becerileri ve tartışmaya katılma isteklilikleri de incelenmiştir.

Yöntem: Bu araştırmada gömülü desen kullanılmıştır. Argümantasyon tabanlı öğrenme yönteminin çeşitli değişkenler üzerindeki etkisinin ortaya çıkarılması istenildiğinden karma yöntemin nicel boyutu için yarı deneysel desen tercih edilmiştir. Lise 10. sınıfta öğrenim gören iki farklı şubeden biri deney grubu diğeri ise kontrol grubu olarak belirlenmiştir. Bu araştırmada veri toplama aracı olarak; Kimya Her Yerde Başarı Testi, Kimya Dersine Karşı Tutum Ölçeği, Bilimsel Süreç Becerileri Testi, Bilimsel Bilginin Doğası Testi ile argümantasyon etkinlikleri (yazılı-sözlü tartışmalar) kullanılmış ve argüman düzeyleri Argümantasyon Değerlendirme Modeli ile değerlendirilmiştir. Uygulanan yöntemin öğrenci görüşleri açısından değerlendirilmesi amacıyla Yarı Yapılandırılmış Mülakatlar gerçekleştirilmiştir. Nicel verilerin analizinde SPSS 18.0 paket programı, nitel verilerin analizinde ise içerik analizi kullanılmıştır.

Bulgular: Deney ve kontrol grubu öğrencilerinin akademik başarı, kimyaya karşı tutum, bilimsel süreç becerileri ve bilimsel bilginin doğası testlerine yönelik ön test puan ortalamaları arasında istatistiksel olarak anlamlı bir farklılığın olmadığı, ancak grupların son test puan ortalamaları arasında ise istatistiksel olarak anlamlı bir farklılığın olduğu görülmüştür. Benzer şekilde deney grubu öğrencilerinin tartışma istekliliklerini ortaya koymayı amaçlayan tartışmacı anketi ön test ve son test puanları arasında da istatiksel olarak anlamlı bir farklılık bulunmuştur. Öğrencilerin argümantasyon seviyelerinin Seviye 3'e kadar çıktığı fakat kullanılan öğeler bakımından yüzdelik dilimin Seviye 2'de en fazla olduğu görülmüştür. Mülakatlar sonucunda öğrencilerin argümantasyon yönteminin etkinliğine yönelik görüşleri; yöntemden memnun kalma, kalıcı öğrenmeyi artırma, özgüven sağlama, tartışma istekliliklerini artırma, derse karşı ilgiyi artırma ve diğer derslerde kullanılmasını önerme, başlıkları altında kategorize edilmiştir.

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INTRODUCTION

The teacher-centered traditional method, which is widely used in our country, reduces students' sense of curiosity by getting the students used to memorizing and laziness. Therefore, it causes individuals who do not question and can not produce solutions to problems. In order for learning to take place effectively, the traditional classroom environment that students listen to what teacher says and obey the instructions is not sufficient. However, raising individuals who reach and effectively use knowledge and at the same time question the knowledge acquired occupies an important place in the world of today. Knowledge that does not have an application area is not appreciated.

In recent years, emphasis has been placed on studies emphasizing the importance of discussion in the process of learning, applying and evaluating scientific knowledge in science education. (Akdöner, 2019; Aktaş, 2017; Ceylan, 2012; Demirel, 2017; Doyğun, 2019; Gültepe, 2011; Öztürk, 2013; Yalçınkaya, 2018). These studies have shown that during the scientific discussion process, questioning and evaluating many different perspectives can help students learn science concepts in a meaningful way.

It is possible for students to acquire scientific thinking skills through their comprehension of the nature of scientific knowledge and the role of scientific inquiry and discussion. Students can reach this comprehension only by including them in the culture of science. For this, they should be enabled to experience scientific discussion, which is an indispensable component of science culture (Jiménez-Aleixandre & Erduran, 2007).

Creating an educational environment that takes into account learning based on research and scientific inquiry and realizing the idea of raising scientifically literate individuals bring out the concept of argumentation, which is among the learning processes based on scientific inquiry (Walker, Sampson, Grooms & Zimmerman, 2011). Because in the argumentation process, while students are comparing alternative theories or ideas, they put forward their claims through effective discussions and support their claims with justifications. The argumentation process provides individuals with the opportunity to express and defend their ideas comfortably in the classroom environment, it helps individuals to make decisions using data, to question their decisions, and to refute opposing claims by analyzing them.

According to Toulmin (1958), argumentation is defined, by putting forward the reasons, as the process of supporting a particular idea or a claim put forward on a subject with data, or refuting it with counter-claims. Kuhn (1992) defines argumentation as a process of proposing, supporting, criticizing and evaluating an idea about a scientific topic. According to Van Eemeren and Grootendorst (2004), argumentation can be defined as the ability to persuade the audience. According to Simon, Erduran and Osborne (2006), argumentation is defined as the process of bringing together components such as claim, data, warrant, and backing. With the implementation of argumentation models, researchers have started to develop different evaluation methods in order to analyze the arguments created. In order to determine the levels and quality of argumentations by students, an analytical framework used for assesing the quality of argumentation by Erduran, Simon and Osborne (2004) according to Toulmin's Argument Model was preferred (Table 1).

Table 1. Analytical framework used for Assesing the Quality of Argumentation (Erduran et al., 2004)

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

Some frameworks have been developed for the argumentation-based learning method used in science classes (Osborne et al., 2004a). Among these frameworks, *Competing Theories–Cartoons*, *Competing Theories–Story, Competing Theories–Ideas and Evidence* and *Constructing an Argument* were used in this study. Small group scientific argumentation contributes to the creation of new ideas for students as a result of that students make suggestions to each other and evaluate the suggestions they receive. Various techniques can be used to create small groups and to make knowledge acquired permanent by increasing classroom interaction (Osborne et al., 2004b). In this study, beside class discussion, the techniques of "*work in pairs*", "*pairs to fours*" and "*envoy*" are included.

It has been determined that researches on argumentation method, have focused especially on science education in recent years. Some studies on argumentation including variables examined and the results obtained are presented in below.

Koçak (2014) investigated the effects of argumentation on academic successs and critical thinking of teacher candidates, related to their solution concepts. It has been shown that the argumentation method makes a significant difference on the academic achievement of students, but does not make a significant difference on critical thinking dispositions.

Demirel (2017) conducted a research aimed to find out the effects of argumentation and PBL on students' success and various skills about mixtures. It has been shown that argumentation and PBL method is effective on students' academic achievement and scientific process skills compared to the traditional method. In addition, it was determined that the argumentation method

increased the scientific reasoning skills of the students and was more effective in increasing the scientific process skills compared to the PBL approach.

Öğreten (2014) tried to show how argumentation effects academic achievement and argument skill of students about matter. It was observed that the academic achievement of the experimental group students was higher than the academic success of the control group students, the discussion skills of the experimental group students were positively affected, and the use levels of the items in the Toulmin model in discussions increased.

Polat (2014) had a research aiming to display argumentation effects on students' achievement pertain to structure of atom. It was observed that the achievement scores of the experimental group students were higher than the success scores of the control group students.

Balcı (2015) reported a research in which argumentation was investigated in terms of its effect on achievement scores and various skills of students. It has been shown that the argumentation method has a positive effect on students' conceptual understanding, scientific process skills, self-efficacy and attitudes towards the lesson, but not on their argument-forming skills.

Doğru (2016) investigated how argumentation-based classroom activities effected pupils' academic skills. It has been shown that argumentation-based classroom activities are more effective in increasing students' academic achievement, logical thinking skills and questioning thinking perceptions.

Tola (2016) published a paper pertain to matter and heat in which the effects of argumentation was investigated. It was observed that there was no significant difference between the experimental and control groups in terms of conceptual understanding after the application, and the conceptual understanding level of both groups increased during the application. After the application, the experimental group students' scientific thinking skills and understanding of the nature of science were higher than the control group students; while it was observed that the experimental group students' scientific thinking skills and their understanding of the nature of science improved during the application, no increase was observed in the control group students.

Temiz Çınar (2016) studied the effects of argumentation on academic achievement and some skills of students about electricity. Results showed that the argumentation method has a significant effect on students' academic achievement, conceptual understanding and willingness to discuss, but it had no significant effect on critical thinking skills. In terms of argument components, it was observed that they formed arguments at the level 1 and level 2 at the highest level, and they could not create any argument at the level 5.

Aktaş (2017) had a paper aimed to show how argumentation changed students' success and their skills about force and energy concepts. It was determined that argument-based inquiry method had a positive effect on students' academic achievement and argument formation levels, but did not have a positive effect on their willingness to discuss.

Işıker (2017), in his paper investigating the effects of argumentation on some students' skills about matter, found that In the post-test averages obtained from the experimental and control groups, it was observed that there was a difference in favor of the experimental group in terms of academic achievement, attitude towards science lesson and scientific process skills.

In this study, it was aimed to examine the effect of scientific argumentation-based learning method on students' academic achievement and argumentation skills in teaching the unit of "Chemistry is everywhere" and compare it with the existing teaching method. In addition, students' attitudes towards chemistry, their understanding of the nature of scientific knowledge, scientific process skills and their willingness to participate in the discussion were also examined.

METHOD

Research Design

In this study, embedded mixed method design in the classification made by Creswell and Plano-Clark (2011) was used. In this study, as it was desired to reveal the effect of argumentation-based learning method on various variables, a quasi-experimental design was preferred for the quantitative dimension of the mixed method. The research design is given in Table 2.

Table 2. Research Pattern

Groups	Data Collection Tools Used Before Treatment	Treatment	Data Collection Tools Used After Treatment
Experimental	• CEAT* • ASTC • SPST • NSKT • AS	Argumentation-based learning method	• CEAT • ASTC • SPST • NSKT • AS • Interview

Control	• CEAT • ASTC • SPST • NSKT	Existing teaching approach	• CEAT • ASTC • SPST • NSKT

*CEAT: "Chemistry is Everywhere" Unit Achievement Test
ASTC: Attitude Scale towards Chemistry
SPST: Scientific Process Skills Test
NSKT: Nature of Scientific Knowledge Test
AS: Argumentativeness Scale

Sample

The sample of the research consists of 66 students from the two classes of of 10th grade in a state high school in Erzurum, in Turkey. One class was randomly assigned to the experimental group while the other formed the control group. Each of experimental and control groups consisted of 33 students by the chance. During a nine-week period, each group received an equal amount of instructional time and was provided with the same materials and assignments, apart from the argumentation-oriented activities in the experimental group. Duration of the lessons was two 50-min per week.

Research Instrument and Procedure

"Chemistry is everywhere" Achievement Test (CEAT)

By examining the chemistry course curriculum recommended by the Ministry of National Education, the learning objectives in the unit "Chemistry is everywhere" were determined. The unit consists of thirteen gains. A question bank was created with a total of 52 multiple choice items (with five options), including at least two questions for each learning objective. The created question bank was submitted to opinion of six people, two of whom were chemistry teachers and four of whom were academicians, for evaluation. Based on the feedback received, 16 of the questions were decided to be excluded from the test. The remaining 36 questions were again revised in line with expert opinions, and the necessary adjustments were made in the options or question statements. In addition, the items of CEAT was also grouped according to the levels of cognitive skills in Bloom's taxonomy. The distribution of test questions according to Bloom's taxonomy is given in Table 3.

Table 3. The distribution of test questions according to Bloom's taxonomy

Cognitive Skills	Number of Questions
Remember	3, 6, 9, 10, 15, 16, 17, 20, 22, 28, 31, 32
Understand	1, 2, 4, 7, 8, 13, 14, 19, 21, 23, 24, 25, 26, 27, 29, 33, 34, 35
Apply	12
Analyze	5, 11, 18, 30, 36
Evaluate	-
Create	-

CEAT was applied as a pilot study to a total of 68 10th and 11th grade students who had previously succeed the unit of "Chemistry is Everywhere". After the pilot application, difficulty indices and discrimination indices were calculated for the test items (0.47 and 0.49 respectively). The Cronbach alpha (α) reliability coefficient of the test was found to be 0.81. The validity of the test was ensured by a teacher and two academic staffs. The distribution of the items of CEAT according to learning objectives is shown in Table 4.

Table 4. Achievement Test Items with Learning Objectives

Item Number	Learning Objectives
1-2	Gains awareness about the limitations of available water resources in the world.
3-4-5-6	Explains the conditions in which utility water should be treated.
7-8	Discovers the main stages of the water treatment process.
9-10-11	Behaves consciously while choosing and consuming foods.
12-13-14-15	Associates the correct use of cleaning agents with their properties and functions.
16-17-18-21	Examples of usage areas of common polymers are given.
19-20	Gains awareness about the usage and recycling process of polymer materials.
22-23-24	Establishes a relationship between the main components of cosmetic materials and their functions.
25	Recognizes the terms related to drug forms in the market.

26-27	Gains awareness of the structure and correct use of stationery materials.
28-29-30	Examines the composition, functions and environmental effects of fertilizers.
31-32-33-34	Establishes a relationship between the composition of building materials and their functions.
35-36	Explains the reasons of air, soil and water pollution.

Scientific Process Skills Test (SPST)

The original of SPST was developed by Burn, Okey, and Wise (1985). It was translated and adapted into Turkish by Geban, Aşkar, and Özkan (1992). This test consists of 36 multiple-choice (with four options) questions. The five subsections that construct the test aim to test different perspectives of scientific process skills. In this test, there are questions that measure the ability to identify variables (12 questions), to define operationally (6 questions), to graph and interpret data (6 questions), to identify and state hypotheses (9 questions) and to design investigations (3 questions). The reliability coefficient of SPST was calculated by Geban, Aşkar and Özkan (1992) as α=0.81. In this study, the reliability coefficient of the scale was found to be α=0.67. The validity of the test was ensured by a teacher and two academic staffs.

Argumentativeness Scale (AS)

The AS was developed by Infante and Ranger (1982) in order to determine students' tendency to approach or to avoid arguments in the activities based on argumentation-based learning method. It was translated and adapted into Turkish by Kaya (2005). The scale consists of 20 Likert-type questions with 5 alternatives. The reliability coefficient (α) of the original of this test was 0.91, and the reliability coefficient of its translated form was α=0.71 by Kaya (2005). In this study, the reliability coefficient of the scale was found to be α=0.77. The validity of the test was ensured by a teacher and two academic staffs.

Attitude Scale towards Chemistry (ASTC)

The ASTC was prepared to measure students' attitudes towards chemistry by Geban et al. (1992). The scale consists of 15 Likert-type items including 5 alternatives "fully agree", "agree", "undecided", "disagree" and "fully disagree". The reliability coefficient of the test was found to be α =0.82 by Geban et al. (1992) and α = 0.70 in this study. The validity of the test was ensured by a teacher and two academic staffs.

Nature of Scientific Knowledge Test (NSKT)

The NSKT was developed by Rubba and Andersen (1978) to determine students' understanding of the nature of scientific knowledge. The test, which was developed to improve understanding of the students in the 12-15 age group about the Nature of Science, was translated and adapted into Turkish by Taşar (2006). The reliability coefficient of the test was found as α=0.71 by Taşar (2006). In this study, the reliability coefficient of the test used was found to be α=0.81. The validity of the test was ensured by a teacher and two academic staffs.

Verbal and Written Discussions

In each activity in which the argumentation-based learning method was implemented, the experimental group students participated in in-group and inter-groups discussions, formed their own arguments and listened to the arguments of their peers. The verbal discussions of the students in the experimental group were recorded with a tape recorder and camera during each activity. These records were later transcribed and analyzed. Written discussions are the arguments that the students stated in writing for each of the thirteen activities prepared for the experimental group students.

Interviews

At the end of the treatment, a face-to-face semi-structured interviews were carried out with a total of six students with scores of low (2), medium (2), and high (2) according to the CEAT post-test results. Prior to the interviews, students' permission to audiotape was obtained. Each interview took approximately 15 minutes.

Worksheets

At this stage, the activities to be included in the worksheets in accordance with the learning goals of the unit and the working group were determined. The activities are designed to include Toulmin's argument components (claim, data, warrant, backing and rebuttal) in line with the strategies proposed by Osborne et al. (2004a) for the argumentation-based learning method. While designing the activities, care has been taken to ensure that the relevant unit is suitable for the objectives and the students' levels. The activities were tried to be developed for students to gain different perspectives, to construct and defend their own ideas, to produce alternative thoughts, to use their high-level thinking skills and their ability to make effective discussions. As a result of expert opinions, necessary arrangements (simplicity of spelling, choice of cartoons and stories appropriate to the class level, etc.) were made and a total of thirteen worksheets were prepared, including a worksheet for each learning objective. Before moving on to the activities within the scope of the unit, an introductory activity was applied at the beginning of the treatment so that the students could better understand the argumentation-based learning method and thus be prepared for the argumentation process.

Procedure

In order to evaluate the applicability of thirteen activities prepared based on the learning goals of "Chemistry is everywhere" unit and to make the necessary improvements, a plot study was carried out with a total of 34 students consisting of 10th grade students of a high school. Teaching was carried out through classroom activities carried out with the help of worksheets in the experimental group. Worksheets were distributed to the students approximately three days before the course day so that the students could make preparations and come prepared for the lesson. Until the treatment day, the students were asked to fill in the relevant sections as a result of their research by following the instructions on the worksheet. During the application, students were asked to defend these arguments that they developed individually using different group techniques. In the following process, the students tried to defend their claims or refute the counter claims by providing scientific justifications. After the students formed their individual arguments in this way, the students who had a change of opinion as a result of the discussions were asked to express the change of opinion on the worksheets with their reasons. Thus, students' individual argumentation levels were tried to be determined by using worksheets where they formed their own arguments. In order to determine the levels and quality of argumentations by students, an analytical framework used for assesing the quality of argumentation by Erduran, Simon and Osborne (2004) according to Toulmin's Argument Model was preferred (see Table 1).

In the control group, lessons were generally started with repeating the content covered in the previous lesson and continued by giving examples of current and remarkable events and news that would attract the attention of the students about the subject to be told. Then the appropriate course materials such as audio-visual contents with the help of smart board were presented. The instructor assured students to get notes in their notebooks by emphasizing the important concepts during the lecture. At the final stage of the course, the questions in the textbook and in other sources were solved together with the students. In cases where the concepts that students have difficulty in understanding were determined, the content was repeated as a summary and the lesson was concluded.

Data Analysis

Considering the positive contributions of using different data collection tools together in terms of validity and reliability of the research, as a data collection tool in this research the followings are used; i) in the quantitative dimension of the research, CEAT was used to determine the effect of the argumentation-based learning method on students' academic achievement, ii) AS was used to determine students' willingness to argue, iii) ASTC used to determine their attitudes towards the chemistry course, and iv) SPST and NSKT were used to determine the relationship between science concepts. Also argumentation activities (written-oral discussions) were used to determine argument formation skill levels and argument levels were evaluated with the Argumentation Evaluation Model. In the qualitative dimension of the research, Semi-Structured Interview Form was used to evaluate the applied method in terms of student opinions.

The basic assumptions of this research are as follows:

• It was assumed that the students in the experimental and control groups participating in the research answered the questions in the tests, surveys, scales and interviews simultaneously and sincerely.

• It was assumed that no variables (familial, personal, environmental, etc.) other than the argumentation-based learning method and the current teaching method affected the changes in the dependent variables of the students in the experimental and control groups.

• It was assumed that the experimental group and control group students participating in the research did not interact with each other.

• It is assumed that the practitioner approaches both groups impartially throughout the study.

• During the treatment, it was assumed that the experimental group students wrote down all their thoughts while expressing oral and written discussions.

• It was assumed that all scales applied during the research process were applied under standard conditions in both groups.

Analysis of the quantitative data was carried out by SPSS 18.0 package program, and content analysis was used in the analysis of qualitative data. Independent t-test was used in cases where the pre-test and post-test scores of CEAT, ASTC, SPST and NSKT applied to the experimental and control group students showed normal distribution and otherwise, The Mann-Whitney U test was used. AS pre-test and post-test scores did not follow a normal distribution and so the Wilcoxon Signed-Ranks test was used. Significance level was taken as 0.05 in the analysis of all test results. The verbal discussions and the written discussions in the worksheets were divided into items according to the Toulmin model, and the argumentation levels (Level 1 to 5) according to the analytical framework used for assesing the quality of argumentation, by Erduran et al. (2004) were determined. Content analysis was carried out in the analysis of semi-structured interview data.

FINDINGS

CEAT

Table 5. Independent Groups t-Test Results of CEAT Pre-Test and Post-Test Scores

	Group	N	X	S	sd	t	p	η 2
Pre-test	Experimental	33	13.0	2.384	64	1.283	.204	.68
	Control	33	12.33	1.796				
Post-test	Experimental	33	20.96	4.311	64	7.449	.000	
	Control	33	14.72	2.139				

Independent groups t-test was conducted due to the normal distribution of CEAT pre-test and post-test scores. t test results for the CEAT are given in Table 5. It is seen that there is no statistically significant difference between the CEAT pre-test mean scores of the experimental and control groups (t (64) = 1,283; p> .05), but there is a statistically significant difference between the CEAT post-test mean scores of the groups. (t (64) = 7.449; p <.05). Accordingly, the fact that the CEAT post-test mean score ($\bar{X}_E$ =20.97) of the students in the experimental group is higher than the mean score (X_C=14.73) of the students in the control group show that this difference is in favor of experimental group. The effect size was found to be η^2 = 0.68 (large effect).

ASTC

Table 6. Mann-Whitney U Test Results of ASTC-Test and Post-Test Scores

	Group	N	Mean Rank	Sum of Ranks	U	p	r
Pre-test	Experimental	33	34.65	1143.50	506.500	.624	.06
	Control	33	32.35	1067.50			
Post-test	Experimental	33	38.83	1281.500	368.500	.023	.27
	Control	33	28.17	929.000			

Since the experimental and control group ASTC pre-test and post-test scores did not show normal distribution, the Mann-Whitney U test was used. Mann-Whitney U test results are given in Table 6. It is understood that there is no statistically significant difference between the experimental and control group ASTC pre-test mean scores (U = 506,500; p> .05). The effect size for the pretest scores were found as r = 0.06. Between the ASTC post-test scores there is a statistically significant difference, in favor of the experimental group (U = 368.500; p <.05). The effect size was found r = 0.27 (medium effect).

SPST

Table 7. Independent t-Test Results of SPST Pre-Test and Post-Test Scores

	Group	N	X	S	sd	t	p	η 2
Pre-test	Experimental	33	14.75	3,816	64	1.322	.191	.31
	Control	33	13.57	3.437				
Post-test	Experimental	33	17.87	3.689	64	2.763	.007	
	Control	33	15.36	3.606				

Since the SPST pre-test and post-test scores of the experimental and control groups showed normal distribution, independent groups t-test was conducted. t-test results of SPST are given in Table 7. It is seen that there is no statistically significant difference between the experimental and control group SPST pre-test mean scores (t (64) = 1.322; p> .05). However, there is a statistically significant difference between the SPST post-test mean scores of the groups (t (64) = 2.763; p <.05). This indicates that the difference is in favor of the experimental group. The effect size was found to be η^2 = .31 (small effect).

NSKT

Table 8. Independent t-Test Results of NSKT Pre-Test and Post-Test Scores

	Group	N	X	S	sd	t	p	η2
Pre-test	Experimental	33	133.363	12.584	64	.288	.774	.62
	Control	33	132.606	8.336				
Post-test	Experimental	33	175.909	19.794	64	6.371	.000	
	Control	33	150.697	11.176				

Independent groups t-test was performed because the NSKT pre-test and post-test scores of the experimental and control groups showed normal distribution. t-test results of NSKT are given in Table 8. There is no statistically significant difference between the experimental and control group NKST pretest mean scores (t (64) =. 288; p> .05), but a statistically significant

difference between the NKST posttest mean scores (t (64) = 6.371; p <.05) in favor of the experimental group. The effect size was found as η^2=.62 (large effect).

AS

Table 9. Wilcoxon Test Result of AS Pre-Test and Post-Test Scores in Experimental Group

Pretest-Posttest	N	Mean Rank	Sum of Ranks	z	p	r
Negative ranks	1[a]	3.00	3.00	-4.882 *	.	0.84
Positive ranks	31[b]	16.94	525.00		.	
Equations	1[c]					

a. Experimental group AS posttest <Experimental group AS pretest ** Based on negative ranks*

b. Experimental group AS posttest> Experimental group AS pre-test

c. Experimental group AS posttest = Experimental group AS posttest

Since the experimental group AS pre-test and post-test scores did not show normal distribution, Wilcoxon test was used and the results are given in Table 9. It is seen that there is a statistically significant difference between the experimental group AS pre-test and post-test scores (z = -4.882, p <.05). Considering the mean ranks and the sum of ranks, it is understood that this observed difference is in favor of the positive ranks, namely the AS posttest score. The effect size was r = 0.84 (large effect).

Written - Verbal Discussion

Each written discussion activity completed with an individual or group is scored with either one (1) point or zero (0) point, depending on whether the claim is scientifically feasible. The rates of 10th grade students to give correct answers to the claims in the written discussion activities individually and in groups are 75.7% and 78.3%, respectively. These values show that the percentage of correct answers in group discussions is slightly higher than in individual discussions. Table 10 below gives the total distribution of the percentage of students corresponding to the argumentation levels reached by students.

Table 10. Percentage of Students with Individual Argumentation Levels Based on Activities

	Argumentation Levels					
Activity No	**Level 1 %**	**Level 2 %**	**Level 3 %**	**Level 4 %**	**Level 5 %**	**Total %**
Activity 1	30	61	9	—	—	100
Activity 2	21.3	45.6	30.0	3.1	—	100
Activity 3	15.1	72.7	9.1	3.1	—	100
Activity 4	22.7	62.1	10.6	3.1	1.5	100
Activity 5	15.15	45.45	30.3	7.6	1.5	100
Activity 6	30.3	45.45	18.2	6.05	—	100
Activity 7	6.03	42.5	30.3	15.14	6.03	100
Activity 8	36.37	51.52	9.01	3.1	—	100
Activity 9	33.34	45.45	21.21	—	—	100
Activity 10	3.1	45.40	39.3	9.1	3.1	100
Activity 11	24.26	51.52	21.22	3.1	—	100
Activity 12	20.2	60.6	12.12	5.05	2.03	100
Activity 13	17.17	70.7	10.1	2.03	—	100

Level 2 discussions have a wide variety of items consisting of different combinations of claims, data, warrants, backings and qualifiers elements. Therefore, the percentage of this level can be expected to be high. The rebuttal plays an important role in determining the quality of the discussion, so the quality of the discussions involving the rebuttal is expected to be higher. The argumentation levels of the students remained at level 3 in the first activity, and as the activities progressed, their argumentation levels reached level 4 and 5. In this case, it can be said that the students started to use the scientific language within the activities more effectively as time progressed and so they made better quality contributions to scientific discussions by understanding the argumentation-based learning method better.

Students' views

In order to address the question of "What are students' opinions about the argumentation-based learning method?", one-on-one interviews were held with six randomly selected students from the experimental group. The interview recordings, which were made with camera footage and lasted approximately 15 minutes, were later transcribed. Within the scope of the interview, a total

of 8 questions were asked, aiming to reveal the students' feelings and thoughts about the method used. The students' answers to the questions were evaluated respectively. Codes were first created by means of content analysis, and the created codes were collected under appropriate categories. The findings obtained are presented and interpreted in detail in table 11 below. Students are numbered 1 to 6 according to the order in which the interviews were conducted.

Table 11. Students' View about Argumentation from the Interviews

Categories	Students	Sample Statements
Satisfied	*S1* *S2* *S3* *S4* *S5* *S6*	***S1:*** *I am very pleased, teacher. Because the chemistry topics of grade 10 were mostly verbal, I felt them boring. But the lessons with this method were more enjoyable.* ***S3:*** *Yes, my teacher, I am very pleased. Because in this method, I started to get my self-confident. I saw that I could state my ideas to my friends with opposite ideas.*
Retention of Knowledge	*S1* *S2* *S3* *S4* *S5* *S6*	***S1:*** *… It was so effective on retention of knowledge. Teachers mostly conducted lessons by being took notes. This forced me to should memorize the content. But with this method I realized that there is an increase in retention time of my learning by logically discussing our ideas each other.* ***S5:*** *…this method showed that permanent and effective learning can be achieved in lessons.* ***S6:*** *...a method kept me awake. I did not immediately forget what I learned.*
Self-Confidence	*S3* *S4* *S6*	***S3:*** *…as I learned and discussed, my self- confidence increased.* ***S6:*** *…I was hesitant, I would not talk. With this method, I have confidence in myself within the group and I saw I acquired much knowledge.*
Willingness to Discussion	*S1* *S2* *S3* *S4* *S5* *S6*	***S1:*** *…as a result of my research on a topic, while I was speaking my opinion another friend's defense of the opposite was making me attack. I can argue for hours to find common ground on the subject.* ***S4:*** *… helped me enjoy the lessons. I saw that I was generating new ideas in the discussion. It made me very happy to do research and to discuss a topic with my friends.*
Be interested	*S1* *S2* *S3*	***S1:*** *It increased my interest in a lesson that I find boring.* ***S2:*** *I think all lessons and even all subjects can be taught with this method. In this way, our interest and desire to study increases.* ***S3:*** *…I saw that I could enjoy even a boring lesson.*
Recommending for other Courses	*S1* *S2* *S3* *S4* *S5* *S6*	***S2:*** *I think all lessons and even all subjects can be taught with this method. In this way, our interest and desire to study increases.* ***S3:*** *I think it can be used in other subjects. It seems more appropriate to use in verbal lessons. Retention of knowledge is increasing where there is discussion.* ***S4:*** *It should be used especially in verbal lessons... thanks to this method, we can learn something from the lessons we spent slumbering.* .

DISCUSSION and CONCLUSION

CEAT post-test results showed that there is a statistically significant difference between the mean scores of the experimental and control groups (t (64) = 7,449; p <.05). This difference is possibly due to argumentation method that enabled them to be very active, that allowed them to express themselves easily, that enabled them to learn by questioning information, and that made discussion environment for them fun. The data obtained from the interviews with the students in the experimental group also support this result. In the interviews, students stated that the method facilitated their learning, increased their interest in the lesson and, provide their knowledge to be retentive, accordingly increased their success. Similarly, the findings obtained from many studies investigating the effect of this method on different subjects and concepts support this result (Akkaş, 2017; Aktaş, 2017; Aslan, 2018; Balcı, 2015; Chen & She, 2012; Demircioğlu & Uçar, 2015; Yalçınkaya, 2018).

ASTC post-test scores revealed a statistically significant difference in favor of the experimental group (U = 368.500; p < .05). It is reported that students resist the change of attitude and that longer-term practices are required to change the attitude towards the course (Gençoğlan, 2017; Kaya, 2018; Uluçınar Sağır, 2008). However, for this study, a positive effect on the students' attitudes was obtained, possibly due to: the content of this study was related to daily life, the treatment was carried out in a relatively long period of nine weeks, and the course is made more attractive by being applied different activities. This result obtained in the presented research is in accordance with the researches in the literature which states that discussion activities are effective in improving students' attitudes towards the course (Akkuş et al., 2007; Balcı, 2015; Çınar, 2013; Günel et al., 2010; Işıker, 2017; Kaya, Doğan & Kılıç, 2005; Özer, 2009; Yalçın Çelik, 2010).

The fact that there is a statistically significant difference between the groups' mean scores in the SPST post-test (t (64) = 2.763; p <.05) can be interpreted in terms of that argumentation requires students to be active, develops a sense of responsibility in their

own learning, increases retention of knowledge and contributes to the development of basic skills of scientific thinking. The results of this study are in accordance with the findings of some studies in the literature, in which the positive effect of the argumentation method on students' scientific process skills was reported (Aslan, 2018; Ceylan, 2010; Cin, 2013; Demircioğlu, 2011; Ulu, 2011; Şekerci, 2013; Demirel, 2017).

There was a statistically significant difference between the groups' NKST post-test mean scores ($t(64) = 6.371$; $p < .05$). This result can be interpreted as an indicator of an increase in their self-confidence in scientific thinking by gaining experiences so that students who participate in scientific argumentation discussions have the chance to see many aspects of science in this process. When the mean scores of the experimental and control group students regarding the sub-dimensions of NKST are examined, it can be said that the students in the experimental group developed more accurate understandings of amoral, creative, developmental, parsimonious, testable, and unified characteristics of the scientific knowledge compared to the students in the control group. Studies have shown that the argumentation helps students learn scientific content (Bell & Linn, 2000; Zohar & Nemet, 2002), develop high-level reasoning, critical thinking and decision-making skills (Yeşiloğlu, 2007), understand how scientific knowledge is structured and evaluated (Dawson & Venville, 2009; Jiménez-Aleixandre & Erduran, 2008) and improve their social skills (Kuhn & Udell, 2003). There are similar studies in the literature regarding that the scientific argumentation-based learning method positively affects students' understanding of the nature of scientific knowledge (Altun, 2010; Boran, 2014; Kaya, 2005; Özer, 2009; Tekeli, 2009; Tümay, 2008; Tümay & Köseoğlu, 2010; Uluçınar Sağır, 2008).

There is a statistically significant difference ($z = -4.882$ $p < .05$) between the pre-test and post-test scores of the AS. This difference is in favor of the positive ranks, namely the AS posttest score. During the treatment in the classroom, it was tried to create a democratic environment in which students can express their thoughts and opinions clearly. The fact that the development of the sense of belonging of the students within the group, their struggle to understand the knowledge in a social structure, the increase in their desire of the students who are not interested in the course to participate in the lesson activities, and the positive change that the students showed in the discussions, especially in the last weeks, can be regarded as some of possible factors which increased their willingness to discussion. The students' statements from the interviews support this notion. The mean scores of the experimental and control group students regarding the AS sub-dimensions show that the students tried to avoid participating in the classroom discussion process before the treatment. However, the increase in the mean score after the application shows that the level of avoidance of students from participating in the discussion process has decreased and therefore they can express their opinions more easily. As a result, it can be said that there is a significant and positive effect on students' inclination to participate in the discussion. The result is similar to the results of some studies in the literature (Kaya, 2005; Şekerci, 2013; Demircioğlu et al., 2015; Uluçınar Sağır, 2008; Tekeli, 2009, Erdoğan, 2010; Yalçın-Çelik, 2010; Çınar, 2013).

When the written discussion activities of the experimental group students were examined, it was observed that students reached third level in all activities and only two students reached level 5 in the 4, 5, 7, 10 and 12th activities. In addition, it is seen that the percentage of students in terms of the items they use is the highest in Level 2. It can be stated that the reason for this is that students used expressions containing claims, data and warrants more frequently in activities, but they could not use expressions containing rebuttals. In fact, it is not considered possible for students to use refutation in every subject. Because the students reached a consensus in most of the activities (related to current issues), they could not use the expressions containing rebuttal. On the other hand, the fact that more groups reached the upper levels (level 4 and 5) in group discussions due to the use of refutational statements indicates that students can use scientific language better at in-group discussion and create better quality arguments in joint decision-making. In addition, as a result of the students' detailed feedback during group work, developing many alternatives and more solutions for problem solving can make the process more effective. It can be said that factors such as students' influencing each other in this process, generating more rational ideas with associations, changing perspectives towards each other, and multi-faceted thinking on the subject may affect this result. In studies by Aktaş (2017), Demircioğlu (2011), Osborne et al. (2004a), Şekerci (2013), Yalçın- Çelik (2010) and Yalçınkaya (2018), it is reported that students' argumentation levels are mostly Level 2. The results obtained in this study are in line with the findings of the literature in this respect.

Based on the results of this study, some suggestions for future research and applications are presented below;

- The effect of the argumentation method on the learning process can be compared with other teaching methods (such as demonstration and problem solving) in addition to the method in the existing program.
- A guideline determining the roles of students and teachers in argumentation activities can be prepared and used. These guidelines will contribute to the effective and efficient use of time in the argumentation-based learning process.
- In the studies to be done, the effects of argumentation-based learning method on different variables such as the permanence of students 'success, students' argumentative attitude, self-efficacy perception in chemistry course, argument quality, creative and critical thinking skills can be examined.
- In the studies to be carried out on the argumentation-based learning method, topics related to daily life that will attract the attention of the students and increase their curiosity can be applied as preparatory activities.
- In order to increase the quality of the arguments, teachers should direct and encourage students to scientific thinking and active participation in the classroom.

• In argumentation-based learning method applications, it can be aimed to increase the effectiveness of the method used by including more than one different type of activities.

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