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Effect of Argumentation Based Learning on Science Achievement and Argumentation Willingness: The Topic of "Particulate Nature of Matter"

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Abstract

Instead of a science class where students are passive listeners in the learning process and teachers focus only on instruction and evaluate their students' cognitive acquisitions (Driver, Newton& Osborne, 2000: 297), classes that engage students with the construction, evaluation and criticism of arguments and models in the 21st century world are the educational environments targeted by today's world countries (Osborne, 2007; Simon, Erduran & Osborne, 2006: 237; Simon & Johnson, 2008).In the light of this information, the aim of this study is to investigate the effects of the implications carried out according to the argumentation based learning in teaching the topic of "particulate nature of matter" on the science achievement and argumentation willingness of the sixth grade students in Turkey. In the research, quasi-experimental method with pre-test-post-test control group was used as quantitative learning method. In the intervention group, a teaching was made according to the argumentation based learning. As for the control group, a teaching was made according to the learning-teaching environments in the science curriculum of the Ministry of National Education in Turkey. "Particulate Nature of Matter Test [PaNoMaT]" and "Argumentation Willingness Scale [AWS]" were used as data collection tools in the study. The sample of the study consists of 42 sixth grade students (intervention group, N= 20, control group, N= 22) studying in primary education in Turkey. At the end of the research, it was determined that the increase in the success of the intervention group in the relevant chemistry topic was more significant than the increase in the success of the control group. In the study, it was also determined that the argumentation willingness of the intervention group increased significantly at the end of the implications.

Keywords: Argumentation based learning, argumentation willingness, particulate nature of matter, science achievement, primary education, sixth grade

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Introduction

In addition to understanding the universe and trying to get rid of situations that are seen as problems, human beings are also trying to meet many of their basic needs. Therefore, it has to respond to the needs and demands of the age in which it lives. Being at the forefront of science and technology in the 21st century requires individuals with student status to be inquiring, critical thinking, innovative and self-developing individuals. It is thought that by integrating some skills into the learning-teaching environment (learning / renewal skills, technology/information-media skills, professional / life skills), students will use these skills more often and then achieve these skills (Karamustafaoğlu, 2018). In argumentation based learning (ABL) (scientific discussion), we can often encounter environments where these skills are frequently used. In such learning-teaching environments, students can make claims against problems that reflect real-world problems well, and they can engage in more scientific discussion by supporting these claims with data and grounds. The number of studies examining these alternative approaches that encourage critical thinking, reasoning and scientific decision making skills in the scientific discussion process has increased in recent years (Erduran & Msimanga, 2014; Okur & Güngör Seyhan 2021a; Okur& Güngör Seyhan 2021b; Osborne, Erduran& Simon, 2004; Vieira, Tenreiro-Vieira & Martins, 2011).

In the Turkish education system, the science curriculum aims to provide learning-teaching environments where students can present claims about a related problem situation, support these claims with grounds, refute the claims of other friends and develop opposing arguments (MoNE, 2018). When we examine the science textbooks with the renewed program, it is seen that the 3rd, 4th, 5th and 6th grade textbooks include activities to improve argumentation skills (Çapkınoğlu, Metin, Çetin & Leblebicioğlu, 2014; Eyceyurt Türk & Güngör Seyhan, 2022).

Theoretical Framework

Argument and Argumentation

There are many definitions in the literature for the concepts of argument and argumentation. According to Nussbaum (2008), "argument" is a sentence put forward by the individual; "Argumentation" is a social dynamic discussion process involving two or more individuals. Supporting and evaluating this process with scientific claim, experimental or theoretical evidence brings argumentation to an important place in science education (Erduran & Jimenez-Aleixandre, 2008). In addition, this process includes group and individual thinking-writing activities (Osborne, Erduran & Simon, 2004). Toulmin states that there are components of claim, data and justification in a simple argument, while in more complex and high-level arguments, there are supporting, limiting and rebuttal components besides these components (Erduran, Simon & Osborne, 2004, p.918).

Argumentation Based Learning in Science Education

In the argumentation process, students work in groups and try to solve problems collaboratively. At the same time, they try to refute the opposing claims. In a chemistry course taught with the argumentation learning method, students learn to think about alternative explanations with a questioning attitude and to critically evaluate the outcomes of the discussion. Therefore, teaching with argumentation enables students to learn science concepts and also provides them with the habit of thinking like a scientist. Argumentation is an integral part of not only science, but also decision making processes related to sociological issues in which different explanations are put forward in daily life (Demirdöğen, Yeşiloğlu & Köseoğlu, 2015).

It is emphasized that ABL is effective in increasing students' environmental awareness, argument skills and higher-order thinking skills (Fettahoğlu, 2016; Topçu & Atabey, 2017; Yıldırır & Nakiboğlu, 2014). At the same time, it has been reported that these learning environments have a positive effect on students' achievement (Aslan, 2012; Öğreten & Uluçınar, 2014), levels of conceptual understanding (Tezel & Yılmaz, 2017) and metacognitive strategies (Aydın &Kaptan, 2014).

Argumentation Based Learning in Turkish Science Education System

The Ministry of National Education (2018) is making improvements in the science teaching curriculum so that students can easily express their claims, making justifications, refute their classmates' opposing claims, and learn in environments where they can create opposing arguments. In the Turkish education system, especially in science education, argumentation has become important in terms of the development of science literacy (Ministry of National Education [MoNE], 2018).

The main purpose of science education is to provide scientific knowledge and make students learn by understanding this scientific knowledge (National Research Council [NRC], 1996). The constructivist approach differs from the traditional approach as it allows students to make sense of what they have learned and reconstruct them by associating new information with the information they have (Osborne et al., 2004). Scientific discussion environments to be created while using the constructivist approach are also important for obtaining the desired results. When we look at the history of science, it is seen that such discussions occur while the new claims made by scientists are rejected or accepted (Lawson, 2003). The importance of scientific discussions arising from the meeting of ideas is also expressed in international and national organizations (MoNE, 2018). Unfortunately, despite all these, in many courses, especially science class in education, these discussion environments are not provided to students (Cavagnetto, 2010). Thanks to the educators who are aware of the situation, it is observed that the scientific discussion (argumentation) is being used more in science education than before (Duschl& Osborne, 2002; Osborne et al., 2004). Based on these discussion environments, it was pointed out that, while discussing with each other and their teachers, they gain different perspectives and develop their cognitive and reasoning skills (Duschl & Osborne, 2002).

The Importance of the Research

In the science curriculum, there is also ABL among the strategies, methods or techniques that include student-centered learning-teaching environments (MoNE, 2018). Argumentation took its place as a "method" in the Turkish education system Science course curriculum in 2013. In the Turkish education system, changes have been implemented in the science curriculum, which is defined as inquiry and research based learning, which emphasizes the ability to make an explanation and create arguments rather than being purely exploratory and experimental (Tezel, 2018). As the most effective method that can enable the individual to try to learn, the Ministry of National Education (2018) emphasizes the ABL that it envisages to be used frequently in science lessons after 2013 year (Aldağ, 2006). In this process, students try to use alternative perspectives in solving the problems given to them and explore and evaluate many possible solutions. These alternative perspectives reveal cognitive imbalance and dissonance and provide the most important impetus for students to start thinking. When the previous studies on this topic are examined, studies investigating the students' conceptual understanding, argument-making skills, critical and scientific thinking skills of argumentation based learning within the scope of Science lesson at primary level have been encountered, however as the number of studies examining the effect of ABL implications on students' conceptual comprehension and scientific discussion skills at the 6th grade level is limited, and this study is thought to contribute to the literature on the study of students' argumentation willingness.

In the Turkish education system, students first meet the subject of "matter" in the 3rd grade of primary school by learning only its "general characteristics". Afterwards, they learn about their "distinctive properties" and "the interaction of matter with heat". When they reach the 6th grade, students will learn that matter has a "particulate, space and motion nature". The relevant chemistry topic is a difficult subject to learn since it contains many abstract concepts and it is seen that students have misconceptions about this subject (Boz, 2006; Harrison & Treagust, 1996; Kapıcı & Akçay, 2016; Nakhleh & Samarapungavan, 1999; Nakhleh, Samarapungavan & Sağlam, 2005).The findings of this study showed that the activities carried out within the scope of ABL were effective in understanding the macroscopic and microscopic dimensions of the "particle, space and motion nature of matter" and the relationships between these dimensions. It is very important for science teaching to create curricula and course contents (theoretical and applied) for effective primary education, to make abstract concepts concrete, to increase the academic success of students and to be able to be interpreted with daily life. In argumentation based learning environments, especially during the discussion, the kneading of the information with the existing information will provide the basis for the development of the student's ability to both think conceptually and do new researches (Jiménez-Aleixandre & Erduran, 2007; Osborne, 2009; Osborne et al., 2004). In the scope of the study, it was aimed to determine the contribution of ABL to the conceptual learning of students on the subject of "particulate, space and motion nature of matter" and to examine the effectiveness of the method.

Research Objectives

This research aimed to examine how ABL affects students' science achievement and their argumentation willingness in the teaching of student cognitive acquisitions on the particulate nature of matter. Based on this main purpose, answers to the following research questions were sought in this study;

1) Is there a statistically significant difference between the scores of the PaNoMaT pre-test and post-test of the students' in-group and the scores of the PaNoMAT pre- and past-test between-groups?
2) Is there a significant difference between the Argumentation Willingness Scale (AWS) pre-test and post-test scores of the students in the intervention group?
3) Is there a significant relationship between the scores of the PaNoMaT post-test and the Argumentation Willingness Scale (AWS) post-test of the students in the intervention group?

Research Method

Within the scope of the study, in order to investigate the effect of ABL on the science achievement, pre-test-post-test design with unequalized control group was studied with a quasi-experimental model. While the ABL was made to the intervention group after the pre-test, the teaching envisaged by the Ministry of Education in the Curriculum of Science in Turkey was carried out to for control group. Post-test of PaNoMaT was applied to both groups. Implications in the intervention group were carried out with groups of 4-5 people.

Implementation Process in the Intervention and Control Groups

In order to identify the negative situations that may arise during the main implication process and take precautions, pilot implications were carried out before starting the main implications. The pilot implementations of the study were conducted with 117 students in the 6th grade of three schools which were randomly chosen and different from the school where the main implications would be carried out. “Predict-Observe-Explain” and “Competing Theories with a Story” which are among the activities of ABL, one of the learning-teaching environments envisaged to be used in the science classes, and worksheets to be used in these activities were designed by the researchers during the pilot study and necessary modifications were made to use them in the main implications.It was observed that during the pilot studies, all implications were carried out by the lesson teacher. During the pilot implications, it was observed that the students had difficulties in understanding and applying the argument components (such as make a claim, grounds, present a supportive and the ability to use rebuttal). This situation decreased with the increasing number of activities and the main implication was started by considering the opinions of the educators and lesson teachers for the solution of this problems in the main implication.

The main implication process of the research was carried out for 4 weeks (sixteen lesson durations) with 42 students studying in two different classes of a public school in the Fall semester of the 2018-2019 academic years. During the implication process, the lessons in the intervention and control groups were conducted by the researcher. The implications for the intervention group of the study were started with pre-testing, and the students were firstly introduced with the ABL and the stages of the method. In this introductory phase, students learned about argument skills such as making claims, grounds, limitation and rebuttal. In teaching the cognitive domain acquisitions determined by the Ministry of National Education for the topic of "particle nature of matter" in the 6th grade Science lesson, the researchers made an order as follows: (1) Examining the particulate and space nature of the matters, (2) Examining of the motion nature of the matters, (3) Expansion and contraction of the matter, (4) Properties of particle, space and motion nature of the matter and its changes in state changes of matters (solid-liquid-gas). Within the scope of this ranking, worksheets related to the achievements targeted during the lesson plan were distributed respectively and related activities were carried out. Experimental procedures designed according to the ABL and all learning-teaching environments in which students will use their argument skills in practice were provided during these activities. The process was completed with the post-tests after all activities related to the targeted cognitive domain acquisitions. An exemplary POE activity carried out with intervention group is given in Appendix 1. Before starting the implications, PaNoMaT was applied as a pre-test to both the intervention and control group students, and after the implications, it was applied as a post-test.

In the teaching of the topic of the particulate nature of matter, the activities in the "6th grade science lesson curriculum" and the teacher's handbook, which was prescribed by the MoNE, were applied to students in the control group. The curriculum and the teacher's handbook include activities to motivate students to observe, compare, build models, make predictions, and develop their skills to test these predictions. The curriculum and teacher handbook include activities to develop students' scientific knowledge, scientific process skills, awareness of sustainable development, use of other life skills, career awareness and entrepreneurship skills, reasoning ability using socio scientific issues, scientific thinking habits and decision-making skills (MoNE, 2018).

Study Group

The sample of the study was selected with the convenience sampling method from the non-random sampling methods (Creswell, 2008). The study group of the study consists of 6th grade students studying in two different classes of a public school in the Fall semester of the 2018-2019 academic years and consisted of a total of 42 students (intervention group: 20and control group: 22 students). The "Particulate Nature of Matter" unit included in the scope of the study is taught at the 6th grade level of Primary Education (Level 2: Covers grades 5 to 8, and is for students aged 10 to 14) in the Turkish Education System. For this reason, the participants of the study are 6th grade students.

Data Collection Tools

Particulate nature of matter test (PaNoMaT)

PaNoMaT, which will be used within the scope of the research, was prepared by considering two of the cognitive domain acquisition that MoNE determined for the 6th grade Science lesson “Particulate Nature of Matter”:

- Student explain that the particulate, space and motion nature of the matters.

  Regarding the motion nature, the concepts of vibration, translation and rotation are mentioned.

- Compares how the spaces between the particles of matter and the motions of the particles change according to the state change with experiments.

During the preparation process of PaNoMaT, national and international theses and articles, science curriculum, lesson plans and auxiliary resources and online sites were examined by researchers and a question list consisting of 67 questions was created. The test was finalized in line with the analysis of the data obtained from the pilot implications and the opinions of four science educators in teacher training program. PaNoMaT, which was finalized after validity and reliability analyzes, consists of 25 questions, 23 of which are multiple choice and 2 of which are open-ended (Appendix-2, sample questions). The highest score that can be obtained from the test is 50 because two questions are given to each correct answer in PaNoMaT.

In order to determine the scope validity of PaNoMaT, the scientific accuracy of the questions and the level of suitability of each question according to the targeted cognitive domain acquisitions, the table of specifications was prepared. PaNoMaT was examined by four science educators and their opinions were received. In line with the feedback from the educators, the necessary corrections were made for PaNoMaT. In addition, during the pilot implementation, test was applied to one hundred seventeen sixth grade students and item analyzes were conducted in order to test its validity. As a result of the item analysis, among the items of the PaNoMaT consisting of 67 items, those whose discrimination levels were below 0.29 were eliminated. After these items were removed, item analyzes were repeated and it was seen that the discrimination levels of all items were high. The item discrimination parameters for the test ranged between 0.25-0.64, and when the difficulty parameters were examined, it was seen that the difficulty parameters of the items changed between 0.12 and 0.66. Item difficulty parameters are at medium level between 0.30 and 0.60 and high level between 0.6 and 1 (Büyüköztürk, 2012). The average difficulty of the test was found to be 0.44 and the test was of medium difficulty. KR-21=.76 coefficients was calculated to investigate PaNoMa Treliability. Findings show that the reliability of the test is high. When all the findings are considered together, it can be said that the validity and reliability of the test prepared are high.

Argumentation willingness scale

Argumentation Willingness Scale (AWS), developed by Infante and Rancer (1982) was used to determine the changes in the willingness of the intervention group students who participated in the activities to be held for the ABL to create an argumentation environment and to participate in argumentation. Translation and adaptation studies of the relevant scale into Turkish were carried out by Kaya (2005). Kaya (2005) made the adaptation study with middle school students. The scale is 5-point likert type and consists of 20 items. The scale is two-dimensional as "participating in the argumentation" and "avoiding the argumentation". The reliability coefficient of the original of this scale is .91, and the reliability coefficient of the Turkish form was found to be .71 by Kaya (2005). While the highest score that can be obtained from the survey is 100, the lowest score that can be obtained is 20.

Data Analysis

SPSS-22 package program was used in the statistical analysis of the data obtained from the applied PaNoMaT and AWS. PaNoMaT was applied to both intervention and control groups and AWS was applied only to intervention groups as pre-test and post-test. Independent t-test was used when PaNoMaT pre-test and post-test scores showed normal distribution. All statistical analyzes were tested at the significance level of .05.

Findings and Analysis

Findings and Analysis Related to PaNoMaT Pre-test Scores

As a result of the analyzes made for the answer of the 1st research question in the study, since the number of students in the intervention and control groups that make up the working group is less than 30, the use of non-parametric tests in the analysis of the data obtained in the study came to the forefront (Howitt &Cramer, 2011; McKillup, 2011; Tabachnick, Fidell & Ullman, 2007). For this reason, some analyzes were made to determine the statistical method to be applied to the data obtained from PaNoMaT applied to students and it was examined whether the scores showed a normal distribution or not. When all the data on the normality tests carried out within the scope of the study are examined: Pre-test data of the intervention group (Kurtosis= -.62; StdErr.: .99 and Skewness=.44, StdErr.: .51) and post-test data of the intervention group (Kurtosis=-.48, StdErr.: .99) and Skewness= -.29, Std Err.: .51) values were determined to be in the range of ± 2(Büyüköztürk, 2012).Similarly, Kurtosis and Skewness values were examined for the pre- and post-test data of the control group students before the normality tests. Pre-test data of the intervention group (Kurtosis= .31; StdErr.: .95 and Skewness=.68, Std Err.: .49) and post-test data of the intervention group (Kurtosis= -.94, StdErr.: .95) and Skewness= -.01, StdErr.: .49) values were determined to be in the range of ± 2(Büyüköztürk, 2012).

Also, in cases where the group size is less than 30, it is checked whether the normality assumption is met by looking at the value of Shapiro-Wilks (Kul, 2014). When Table 1 is examined, it is determined that both the pre-test and post-test data show normal distribution since the p-pre-test and p-post-test values of the intervention and control groups are greater than .05. Therefore, the data were analyzed with the t-test from parametric tests (Büyüköztürk, 2012).

Table 1
Results of Shapiro-Wilk Test for PaNoMaT Pre- and Post-test

	Group	Shapiro-Wilk		
		Statistics	df	*p*
Pre-test	Intervention	.95	20	.38
	Control	.94	22	.30
Post-test	Intervention	.98	20	.93
	Control	.96	22	.57

*p>.05 value

After the normal distribution of the PaNoMaT pre- and post-test scores obtained from our study was determined, t-test for the independent groups, which is one of the parametric tests, was applied whether there was a significant difference between the data obtained from PaNoMaT pre-tests. These findings were given in Table 2.

Table 2
T-Test Results for Independent Groups

	Group	N	Average	Standard Deviation	Standard Error of Average
Pre-test*	Inv.	20	19.80	5.89	1.32
	Control	22	19.72	8.80	1.87

*Descriptive values

		Levene test		t-test results	
		f	t	df	Level of Significance (*p)
Pre-test	Equal Variance Assumption	2.071	.03	40	.97
	Unequal Variance Assumption		.03	36.88	.97

*p>.05 value

In Table 2, according to the PaNoMaT pre-test data analysis, no significant relationship was observed between the pre-tests of both group students. While the highest score of a student who answers all the questions of PaNoMaT correctly is 50, the average of the scores of the students in the intervention and control groups from the pre-test are 19.80 in the intervention group and 19.72 in the control group. According to this result, it can be said that the students of both groups will carry out implications with a similar level of prior knowledge about the related chemistry topic.

Findings and Analysis Related to the Pre- and Post-Test of the PaNoMaT

In order to answer the first research question of the study, t-test for dependent groups was performed for the data obtained from the PaNoMaT pre- and post-tests, and the results are given in Table 3.

Table 3
Results of T-Test for Dependent Groups

		Average	N	Standard Deviation	Standard Error of Average	t	df	Level of Significance (*p)
Inv. Group	Pre-test	19.80	20	5.89	1.32	-11.77	19	.000
	Post-test	36.35	20	6.84	1.53			
Control Group	Pre-test	19.72	22	8.80	1.87	- 3.55	22	.002
	Post-test	27.72	22	10.75	2.29			

* p<.05

When Table 3 is examined, it was determined that there is a significant difference between the PaNoMaT pre-test and post-test of the both intervention and control groups(p<.05).

Findings and Analysis Related to PaNoMaT Post-test Scores in the both Groups

In order to examine whether there is a statistically significant difference between the achievements of the relevant chemistry topic of the both group students, t-test for independent groups was performed in the analysis of the data obtained from PaNoMaT. The findings obtained as a result of the analyzes are given in Table 4.

Table 4
Results of T-Test for Post-tests of Independent Groups

	Group	N	Average	Standard Deviation	Standard Error of Average
Post-test*	Intervention	20	36.35	6.84	1.53
	Control	22	27.72	10.75	2.30

*Descriptive Values

		Levene test		t-test results	
		f	t	df	Significance level (*p)
Post-test	Equal Variance Assumption	5.433	3.06	40	.004
	In equal Variance Assumption		3.13	36	.003

*p<.05 value

When Table 4is examined, it is observed that there is a significant difference between the averages of the intervention and control groups in favor of the intervention group (p<.05). This result can be interpreted as that argumentation based learning improved the achievement in the relevant chemistry topic more than the learning-teaching activities carried out with control group students.

Findings and Analysis Related to the Argumentation Willingness Scale's Pre-test and Post-test

In order to check whether there is a significant difference in the argumentation willingness of the students in the intervention group, which is the second research question of the study, t-test for dependent groups was performed. The data are given in Table 5.

Table 5
Results of T-Test for Dependent Groups Related to Argumentation Willingness Scale's Pre- and Post-test

		Average	N	Std. Dev.	Stand. Error of Average	t	df	Signif. Level (*p)
Inv. Group	Pre-test	66.50	20	8.07	1.80	-6.03	19	.000
	Post-test	88.45	20	6.38	1.43			

*p<.05 value

When Table 5 is examined, there is a significant relationship between the pre- and post-test of the argumentation willingness of the intervention group ($p<.05$). The highest score that can be obtained from AWS is 100, the lowest score is 20. As the average scores of the students increased according to the pre-test-post-test averages of the intervention group, we can say that students' argumentation willingness increased at the end of the ABL process.

Findings and Analysis Related to the Relationship between PaNoMaT Post-test and Argumentation Willingness Scale's Post-test

In order to examine whether there is a relationship between the PaNoMaT post-test results of the intervention group, which is the third research question of the study, and the data obtained from the AWS post-test, the Pearson correlation coefficient was calculated and the results are given in Table 6.

Table 6

Pearson Correlation Coefficient Results between of the PaNoMaT Post-test and Argumentation Willingness Scale's Post-test

		PaNoMaT-Post-test	AWS-Post-test
PaNoMaT– Post-test	Pearson Correlation	1	.01
	Significance (p)		.65
	N	20	20
AWS- Post-test	Pearson Correlation	.01	1
	Significance Level (p)	.65	
	N	20	20

*p>.05 value

When the results in Table 6 are analyzed, no significant relationship was observed between the results of the PaNoMaT post-test and AWS post-test of the intervention group ($r=.01$, $p>.05$ value).

Results and Discussion

In this study it was aimed at investigating the effects of the ABL in teaching the topic of particulate nature of matter on the science achievement and argumentation willingness of the sixth grade students. When the PaNoMaT pre-test results of students in the both groups were examined, it was determined that there was no statistically significant difference between the pre-test results of both group students. This result gives the result that the two groups of students who will participate in learning-teaching environments with both teaching methods have similar levels of preliminary knowledge on the relevant chemistry topic.

As a result of the statistical analyses made in order to understand whether the both learning-teaching environments created any difference between the PaNoMaT pre-test and post-test results of the intervention and control groups, it was determined a statistically significant difference between the pre-test and post-tests of the both intervention and control groups. Another result obtained at the end of the study is that there was a significant difference in favor of the intervention group between the PaNoMaT post-tests of the students in both groups. According to this results, we can say that the ABL, the effectiveness of which we examined, is more successful in the teaching of the relevant chemistry topic compared to the learning-teaching activities in the MoNE Science curriculum. Students were more active in classroom learning in the ABL process. In addition, during this learning process, students were able to express themselves comfortably and had the opportunity to question their existing knowledge by providing reasons. At the same time, they were in a scientific discussion environment by using their ability to refute the scientific claims of other student groups in case they felt inadequacy/deficiency. With these scientific discussions, learning has become fun. Thus, students were able to learn the targeted information more permanently. This result obtained at the end of the study is similar to many literature findings investigating the effectiveness of ABL in the literature (Aktaş & Doğan, 2018; Küçüköner & Yürük, 2018; Meral, BaşcıNamlı&Kayaalp, 2021; Okumuş&Ünal, 2012; Öğreten&UluçınarSağır, 2014; Özkara, 2011; Türkoğuz & Cin, 2013).In the study titled "States of Matter and Heat" conducted by Okumuş and Ünal (2012), the effect of scientific argumentation method on science achievement, comprehension level and argumentation skills of 8th grade students were investigated. At the end of the study, a statistically significant difference was observed between the science achievement of the students who participated in the ABL activities and the science achievements of the control group students. In his study, Uluay (2012) investigated the effects of the ABLon the science achievement of 7th grade students. It was determined that the achievement of the intervention group in which the ABL was applied resulted in a statistically significant difference before and after the implications. In the study of Türkoğuz and Cin (2013), in which they examined the effects of concept cartoon activities prepared according to ABL on students' conceptual understanding and scientific process skills, it was determined that ABL had a better effect on the intervention group students' conceptual understanding.

Among the results obtained in the research is whether ABL creates a change in students' argumentation willingness in teaching the relevant chemistry topic. As a result of the statistical analysis, a statistically significant difference was found between the pre-test and post-test of the Argumentation Willingness Scale. This can be explained by the students’ efforts to learn all the concepts, facts and events in a discussion environment with their group mates both before and after the implications in the argumentation based learning process. Intervention group students stated to the researchers at the end of the study that they had difficulties in providing justifications for their scientific claims in the ABL process. Some of the other negativities that the students complain about are that the level of anxiety in justifying scientific claims made with their groupmates is sometimes high, the duration of the activity is partially long when entering the scientific discussion environment, the difficulties experienced during long discussions and the limited participation of some other students in the discussions. There are a limited number of studies in the literature examining the relationship between ABL and students' argumentation willingness (Aktaş & Doğan, 2018; Eyceyurt Türk & Kılıç, 2020; Meral et al., 2021; Mercan & İşleyen, 2017; Uluçınar Sağır, 2010). Eyceyurt Türk and Kılıç (2020) used the ABL, the effectiveness of which them examined, with prospective science teachers in the teaching of acid-bases and gases. In their study, them also examined how the method affected the prospective teachers' argumentation willingness. At the end of the study, it was concluded that ABL was effective enough to make a statistically significant difference between argumentation willingness pre-and post-test of prospective science teachers. The results obtained from the studies of Meral et al. (2021) revealed that ABL increased pre-service teachers' argumentation skills and their desire to debate. In the argumentation based learning, which includes discussion in its content, individuals are asked to explain what to do in the face of moral dilemmas (Superka, Ahrens, Hedstrom, Ford & Johnson, 1976), by arguing with each other and making grounds. Thus, it is thought that individuals' argumentation willingness develops (Meral et al., 2021). In the discussion process, students' efforts to make the right decision enable them to think, reason and focus on the relevant topic, thus providing a more qualified learning experience (Chen, Benus & Hernandez, 2019). According to many literatures, it is stated that ABL improves students' argumentation skills and encourages them to debate (Demirci-Celep, 2015; Öztürk, 2013; Simon et al., 2006; Zohar & Nemet, 2002). It is also stated that ABL is effective on students' argumentation willingness (Baydaş, Yeşildağ-Hasancebi & Kilis, 2018).

Conclusions and Recommendation

Teaching can be carried out more efficiently by creating scientific discussion environments in science lessons, making students think about scientific data, and providing these data by using justifications. As in ABL, it is a difficult process to design the stages and student tasks in this learning process and to facilitate argumentation in the classroom for students. Therefore, it is necessary to include the use of implications in the ABL process in teaching the topics in the science curriculum. Therefore, it is important to include ABL in learning-teaching environments, such as science courses, where students can create scientific discussions. Based on the findings at the end of this study, it was possible for students to understand and learn the relevant chemistry topic as targeted, and it was seen that they were able to use many skills that are considered important in this process: such as the ability to interact actively in the learning process, to make claims and justifications, to use the experimental applications made in the process as supportive, to make scientific explanations after observation, to use rebuttal skills for different scientific explanations within the group.

In the light of the quantitative findings obtained at the end of the study, in which the effect of the argumentation based learning on the students' science achievement and argumentation willingness in teaching the relevant chemistry topic was investigated, the suggestions we can offer can be listed as follows:

- Teachers who will use techniques and strategies for the first time within the framework of argumentation based learning in learning-teaching environments should be knowledgeable about all strategies and techniques in order to prevent negative situations that may arise.
- It is important that students have experience about argument components during the implications.
- It is absolutely necessary to conduct preliminary studies with the students before the main implications so that they can demonstrate skills such as "presenting claims and grounds, providing support and/or using rebuttals" in the Toulmin argument model.
- Implications were carried out in a period of only four weeks in order to increase the success of the 6th grade students by using their argumentation skills and to determine their effect on the development of their argumentation willingness.
- Implications of argumentation based learning should be carried out for the teaching of more chemistry topics and for more time, and the results should be examined.
- It can be useful to use these and similar techniques based on discussion in instructional designs based on this approach.
- Process-oriented interviews to be made before, during and after the research can be suggested in order to examine the views of students for argumentation based learning and their experiences in the argument forming process in depth.
- Descriptive studies can be conducted to determine the opinions of teachers carrying out the science lesson about the place and importance of the argumentation based learning in the science teaching.

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