The Effects of Argumentation-Based Teaching on Primary School Students' Academic Achievement, Science Attitudes and Argumentative Tendencies

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Abstract

This research aims to analyze the effects of argumentation-based teaching (ABT) on the 4th-grade students' academic achievement, argumentative tendencies and attitude towards science. The universe of the research was 4th-grade students studying in Yığılca district of Düzce province in the 2017-2018 academic year, in Turkey. The sample of the research consists of 37 4th grade students studying in two different classes. The pretest-posttest matched control group design was used which is one of semi-experimental design techniques. While activities related to ABT were administered to the experimental group, the existing curriculum was applied for the control group. The data of the research were collected using three tools: science achievement test (AT), science attitude scale (SAS), and argumentativeness scale (AS). All data collection tools were administered to experiment and control groups as pre-test and post-test to determine if there was a difference after the application. The findings revealed that the academic achievement of the students was significantly influenced by the activities related to ABT. However, there was no significant difference between experimental and control groups in terms of argumentative tendencies and their attitude towards science.

Keywords: argumentation-based teaching, academic achievement, science attitude, argumentative tendencies

1. Introduction

Educational arrangements are in progress today according to technology and scientific developments and many countries are trying to adapt to changes in education and raising standards depending on these scientific and technological developments. As a result of these changes, the society's expectations are increasing. Science teaching is required to satisfy these expectations and to reach the rising standards in education. Appropriate methods and techniques should be determined in science teaching, for improvement in technology and society (Köseoğlu & Kavak, 2001). Progress in science play a major role in the development of countries and provide a basis for scientific and technological developments. Therefore, the importance of science literacy is increasing day by day (Ayas, Çepni, & Akdeniz, 1993).

The Science Curriculum emphasizes that in the fields of education that centers the student, the courses should be carried out with problem-solving, argumentation, and collaborative learning methods. The learning process includes exploring, questioning, and creating an argument. The Turkish national reform efforts have promoted informed citizenship where individuals make evidence-based judgements in their everyday lives including issues that relate to science (Jiménez-Aleixandre & Erduran, 2007; Ministry of National Education, 2018).

When the development of argumentation from past to present is examined, argumentation started 2400 years ago,

when Protagoras, known as the pioneer of the discussion, organized discussions with his students. Examplarily to argumentation application, the first inter-university discussion activities were held in England in 1400 (Billig, 1996). Toulmin defined argumentation in 1958 as verification of claims by stating justifications and supporting them with data. Noting that argument and argumentation are two different and significant concepts, Toulmin defined the argument as the justification of a claim.

The argumentation is described as a process that aims to express an opinion by thinking or writing about a subject individually or as a group, to support the idea with data, to reach a conclusion by criticizing and evaluating, and to persuade the other person (Kuhn, 1992; Driver, Newton & Osborne 2000; Vorobej, 2006). Making an argument or arguments based on claims, data and justification components is a mental process that takes place by associating arguments with each other, verifying and supporting data (Yerrick, 2000; Simon, Erduran & Osborne, 2006; Nussbaum, 2011).

Studies conducted on the the significance of argumentation-based learning on comprehension and application of scientific knowledge and argumentation in science education have gained importance (Driver et al. 2000). With the learning of scientific knowledge and concepts by using ABT, students' academic achievement increases in science course.

ABT supports metacognitive skills, improves communication skills, encourages students to speak and write about science subjects, increases their judgement, enables students to base their thoughts on scientific foundations and create scientific arguments, allows students for defending their opinions against opposite opinions and to participate in large discussion groups (Jiménez-Alexander & Erduran 2007; Michaels, Shouse & Schweingruber, 2008). In addition to these features provided by ABT to students, it also improves students' discussion skills and accordingly, works up into change students' tendency towards the discussion.

The discussion model created by Toulmin provided that the discussion was understandable and evaluable by expressing the discussion in a certain order within the educational activities (Van Eemeren, Grootendorst, Johnson, Plantin & Willard, 2013). The Toulmin argumentation model allows students understanding the science course easier by slowing down the teaching process and allows students for analyzing what they have learned (Leeman, 1987).

Previous researchs have established that the scientific discussion model is very useful for students to acquire high-level cognitive skills such as putting forward a claim by thinking their evidences and reasons, making comments by looking at the events from different perspectives, reaching the basics of the claims by making analyzes, developing the claims and complex thoughts by making synthesis (Jiménez-Aleixandre, Rodriguez, & Duschl, 2000; Duschl & Osborne, 2002; Erduran, Simon, & Osborne, 2004; Kaya & Kılıç, 2005; Von Aufschnaiter, Erduran, Osborne & Simon, 2008). Therefore, various activities using scientific discussion models are needed in the science curriculum. Recent studies were emphasized that students should experience science as argumentation in order to understand scientific thinking (Kuhn, 1992; Driver et al., 2000; Duschl & Osborne, 2002; Jimenez-Aleixandre & Erduran 2007).

Several studies in the field of science education were concluded that ABT increases students' critical thinking skills, questioning skills, their ideation of the nature of science and looking at the events from different perspectives, their ability to form basis their learning and their academic achievement (Yore, 2000; Hickey, Taasoobshirazi & Cross, 2012; Giri & Aily, 2020). Considering all these skills that ABT brings to students, it was deemed appropriate to include ABT activities in this research. In the research, academic achievement, attitudes towards science, and argumentative tendencies were examined as the variables that ABT could affect. Therefore, it is thought that this research will benefit the studies to be carried out on ABT.

1.1 Problem Statement

Is there a statistically significant difference between the experimental group, where ABT is applied in the teaching of the concepts in the 4th-grade Science Course 'Let's Learn About Substances?' chapter, and control group, where the teaching methods applied which the science course curriculum included, in terms of Achievement Test, Science Attitude Scale, and Argumentativeness Scale average scores?

1.2 Sub Problems of the Research

1. Is there a statistically significant difference between the Achievement Test, Science Attitude Scale, and Argumentativeness Scale average scores of the students in the experimental group and control group before the application?

2. Is there a statistically significant difference between the Achievement Test, Science Attitude Scale, and Argumentativeness Scale average scores of the students in the experimental group and control group after the

application?

3. Is there a statistically significant difference between the average scores of the Achievement Test, Science Attitude Scale, and Argumentativeness Scale of the experimental group students before and after the application?

2. Method

The semi-experimental method was used in the research. According to Büyüköztürk (2011), the experimental method is the research design used to discover the cause-effect relationship between variables. The purpose of the semi-experimental method is the same as the experimental method. The semi- experimental method was chosen for this research because when measuring the effect of the method used in different classroom environments and determining the difference between the first and last case on the group, it is appropriate to use the semi-experimental method. In semi-experimental studies, pre-test and post-tests are applied to both groups; but a different method is applied to the experimental group (Creswell, 2011).

Since the effect of the independent variable (ABT) on dependent variables (academic achievement, science attitudes, and argumentative tendencies) was examined in the research, pre-test and post-test were used. For this purpose, two classes were determined as experimental and control groups in the research. While the ABT content was applied in the experimental group, existing activities in the science curriculum were applied in the control group.

Data collection tools were applied as a pre-test before the application in order to determine whether there is any difference between students in the experimental and control groups that may affect the research. With these tests, prior knowledge of students about the chapter “Let’s Learn About Substances?”, attitudes towards science, and the level of their argumentative tendencies were determined. As a result of the analysis of the pre-tests, it was determined that the two groups showed similar characteristics. When the application process was completed, data collection tools were applied as post-tests. Table 1 shows the experimental process.

Table 1. Experimental Process

Groups	Pre-test	Application	Post-test
Experimental Group	AT	Argumentation-Based Teaching Activities	AT
	SAS		SAS
	AS		AS
Control Group	AT	Teaching Activities Predescibed by the Current Curriculum	AT
	SAS		SAS
	AS		AS

AT: Achievement Test, SAS: Science Attitude Scale, AS: Argumentativeness Scale

2.1 The Universe and Sample of the Research

The appropriate sampling method was used to determine the research sample. Appropriate sampling is easier for the groups to be involved in the research process, or more accessible. Due to the limitations in terms of time and workforce, appropriate sampling method was used for the sample to be selected from easily accessible and practicable units. The research was applied in the 2017-2018 academic year at Yığılca district of Düzce province, in Turkey.

The universe of the research was 4th-grade students studying in Yığılca. The researcher was a primary school teacher where he carried out current study. The sample of the research consisted of 37 4th grade students studying in a public school in Yığılca. Two classes were determined as experimental and control groups. The experimental group is consisted of 20 students and the control group is consisted of 17 students. Achievement test, science attitude scale and argumentativeness scale were conducted as a pre-test in order to determine whether the experiment and control groups were equivalent at the beginning of research. It was found that two groups were equal in terms of achievement ($t(36)=0.040$; $p>0.05$), attitude ($t(36)=0.454$; $p>0.05$) and argumentativeness ($t(36)=0.240$; $p>0.05$).

2.2 Data Collection Tools

The data of the research were collected using three tools: science achievement test (AT) designed by the researcher, science attitude scale (SAS) designed by Şener ve Taş (2016), and Argumentativeness Scale (AS) adapted to Turkish by Kaya and Kılıç (2008).

2.2.1 Achievement Test

AT was designed by the researchers to measure students' achievement in the chapter “Let’s Learn About Substances?”

in the science course. At the preparation stage of AT, the goals included in the chapter "Let's Learn about Substances?" were listed. To measure the all goals of the chapter, 30 items were created for AT. Before the pilot study, opinions of three field experts and two linguists were obtained for the test items. After this, to determine the comprehensibility of the questions for the students, the test items were read by 10 students in the 4th grade and it was understood that the test items were comprehenible. After determining the comprehensibility of AT, it was applied to 100 5th grade students to determine the reliability of the achievement test.

To analyze the AT items, the difficulty index (p) and distinguishing index (d) were used. According to the results of the analysis, items were selected between 0.30- 0.72 for difficulty index and 0.30-0.66 for distinguishing index.

After selecting the items, in the last version of the AT there were 25 items to measure the all goals of the chapter "Let's Learn About Substances?". The last version of AT's results of analysis, item difficulty index was 0,46; mean of item distinguishing index was 0.45. The reliability of the instrument was also determined by using the Kuder Richardson formula 21 (KR 21) and the reliability coefficient was found to be 0.76. The reliability coefficient above 0.70 is an indication that AT is reliable (Connolly, 2007; Pallant, 2011; Büyüköztürk, 2011).

2.2.2 Science Attitude Scale

The scale designed by Şener and Taş (2016) was applied to measure the Science Attitudes of the students. SAS consists of 21 items on a 5-point Likert scale. Cronbach Alpha reliability value of the scale was found to be 0.87.

2.2.3 Argumentativeness Scale

In the research, AS, developed by Infante and Rancer (1982) and adapted to Turkish by Kaya and Kılıç (2008), was used to measure the argumentative tendencies of the experimental and control group students. AS consists of 20 items on a 5-point Likert scale. Cronbach Alpha reliability value of the scale was found to be 0.73.

2.3 Creating ABT Activities

In the research, in order to be applied by the researchers in the experimental group in which the argumentation-based teaching was carried out, eight activities were created for the eleven goals in the the unit of "Let's Learn about Substances?" of the Primary School 4th Grade Science Curriculum. The activities were created by among the argumentation techniques such as; table of statements predict-observe-explain, competing theories—story, constructing an argument, concept map and competing theories—cartoons. The appropriateness of the activities in terms of science education field and grammar was evaluated by experts and then, necessary arrangements were made for the activities according to the feedback given by the experts.

2.4 Application Process

The application process has started after the pre-tests (AT, SAS, AS) applied at the beginning of the research process. During the application process, while activities related to ABT were applied in the experimental group, the existing curriculum activities were applied in the control group. The chapter "Let's Learn About Substances?" processed simultaneously in both classes. Post-tests (AT, SAS, AS) were applied to both groups. The application was carried out in 2017-2018 and lasted a total of 8 weeks.

In the experimental group, at the beginning of the application, the mentor teacher was informed about the techniques in the ABT application process and students were informed about the suggestions how they solve the problems when they came across difficulties while practising the ABT activities.

In the experimental group, students were divided into groups including 3-4 students based on their academic achievements and classroom teachers' suggestions, all activities in the experimental group were carried out in a group discussion. In one of the studies conducted in the research, an activity created with the predict-observe-explain technique, one of the argumentation techniques, was applied for the subject of states of matter. The students stated their predictions about the sample situation given in the first stage, in the second stage, they experimented with the materials provided so that they could experiment as a group, and in the third stage, they compared their observations in the previous step with their predictions. The groups specified their thoughts and determinations at the relevant stage through class discussion with other groups. At the end of the application, the teacher summarized the topic. The stages of the application have been completed by this way. In other techniques used in the study, the activities were carried out as a group and the teacher summarized the subject at the end of the activities.

In the control group where the current Science Curriculum was applied, the activities in the workbook were carried out after the subjects had been taught according to the primary school 4th grade science textbook. At the end of the lesson and the application of the activities, a worksheet was given as homework.

2.5 Data Analysis

The data were processed and analyzed using SPSS 21.0 (Statistical Package for the Social Science) software. Statistical significance was analysed using analysis of t-tests as appropriate. Independent Samples t-test was conducted to determine whether there was a significant difference between the pre-test and post-test scores of the experimental and control group students' academic achievement levels, science attitudes, and argumentative tendencies. In addition, the Paired-Samples t-test was performed for dependent groups to determine whether there was a significant difference between the pre-test and post-test scores of the experimental group students' academic achievement levels, science attitudes, and argumentative tendencies.

3. Results

In this research, experimental and control groups were formed in order to determine the effect of ABT on the level of achievement of students' at the chapter "Let's Learn About Substances?", their attitudes towards science lessons, and their argumentative tendencies. The data of the research were obtained before and after the application process with data collection tools.

3.1 Findings Related to the Sub-problem 1

Is there a statistically significant difference between the Achievement Test, Science Attitude Scale, and Argumentativeness Scale average scores of the students in the experimental group and control group before the application?

Table 2. Experimental and Control Groups' AT, SAS, and AS Pre-test Results

Tests	Experimental Group		Control Group			
	X	SS	X	SS	t	p
AT	37	11.7	35.5	9.5	0.419	0.677
SAS	75.3	15.82	73.41	9	0.454	0.653
AS	56.9	10.76	56	11.87	0.240	0.812

As seen in Table 2, AT pre-test mean of the experimental group students was found to be 37, and the control group students' mean was found to be 35.5. Independent Samples t-test was conducted to determine whether there was a significant difference between groups. According to the results of the t-test analysis, there was no significant difference between the groups' AT pre-test mean ($p=0.677$; $p>0.05$).

SAS pre-test mean of the experimental group students was found to be 75.3, and the control group students' mean was found to be 73.41. Independent Samples t-test was conducted to determine whether there was a significant difference between groups. According to the results of the t-test analysis, there was no significant difference between the groups' SAS pre-test mean ($p=0.653$; $p>0.05$).

AS pre-test mean of the experimental group students was found to be 56.9, and the control group students' mean was found to be 56. Independent Samples t-test was conducted to determine whether there was a significant difference between groups. According to the results of the t-test analysis, there was no significant difference between the groups' AS pre-test mean ($p=0.812$; $p>0.05$).

As shown in Table 2, the experimental and control groups were equivalent in terms of academic achievement, science attitudes, and argumentative tendencies before starting the research.

3.2 Findings Related to the Sub-Problem 2

Is there a statistically significant difference between the Achievement Test, Science Attitude Scale, and Argumentativeness Scale average scores of the students in the experimental group and control group after the application?

Table 3. AT Post-Test Results of Experimental and Control Group Students

Test	Experimental Group		Control Group			
AT	X	SS	X	SS	t	p
	88.8	13.3	74.2	9.2	3.904	0.000*

*$p<0.05$

As shown in Table 3, the AT post-test mean of the experimental group students was found to be 88.8, and the control group students' mean was found to be 74.2. Independent Samples t-test was conducted to determine whether there was a significant difference between groups. According to the t value ($p < .05$) found at t-test analysis results, there was a significant difference between the groups' AT post-test mean.

Table 4. SAS Post-Test Results of Experimental and Control Group Students

Test	Experimental Group		Control Group			
SAS	X	SS	X	SS	t	p
	82.65	13.96	75.23	9.24	1.929	0.062

*p<0.05

As can be seen from the table (above), the SAS post-test mean of the experimental group students was found to be 82.65, and the control group students' mean was found to be 75.23. Independent Samples t-test was conducted to determine whether there was a significant difference between groups. According to the results of the t-test analysis, there was no significant difference between the groups' SAS post-test mean ($p=0.06$; $p>0.05$).

Table 5. AS Post-Test Results of Experimental and Control Group Students

Test	Experimental Group		Control Group			
AS	X	SS	X	SS	t	p
	64	12.4	56	12.5	1.894	0.67

As shown in Table 5, the AS post-test mean of the experimental group students was found to be 64, and the control group students' mean was found to be 56. Independent Samples t-test was conducted to determine whether there was a significant difference between groups.

According to the results of the t-test analysis, there was no significant difference between the groups' AS post-test mean ($p=0.06$; $p>0.05$).

3.3 Findings Related to the Sub-problem 3

Is there a statistically significant difference between the average scores of the Achievement Test, Science Attitude Scale, and Argumentativeness Scale of the experimental group students before and after the application?

Table 6. AT Pretest-Posttest Results of Experimental Group Students

	X	SD	t	p
Pre-Test	37	11.7	-10.930	0.00*
Post-Test	88.8	13.3		

*p<0,05

As can be seen from the table (above), the AT pre-test mean of the experimental group students was found to be 37, and the standard deviation was found to be 11.7. The AT post-test mean of the experimental group students was found to be 88.8, and the standard deviation was found to be 13.3. According to the *t* value determined as a result of t-test analysis for dependent groups ($p < .05$), there was a significant difference between the pre-test and post-test scores of the experimental group in terms of academic achievement.

Table 7. SAS Pretest-Posttest Results of Experimental Group Students

	X	SS	t	p
Pre-test	75.3	15,82	-1.593	0.128
Post-test	82.65	13,96		

As seen in Table 7, the SAS pre-test mean of the experimental group students was found to be 75.3, and the standard deviation was found to be 15.82. The SAS post-test mean of the experimental group students was found to be 82.65, and the standard deviation was found to be 13.96. According to the results of the t-test analysis, there was no significant difference between the pre-test and post-test scores of the experimental group in terms of science attitudes.

Table 8. AS Pre-Test Post-Test Results of Experimental Group Students

	X	SS	t	p
Pre-Test	56.9	10.76	-1.673	0.111
Post-test	64	12.4		

As shown in Table 8, the AS pre-test mean of the experimental group students was found to be 56.9, and the standard deviation was found to be 10.76. The AS post-test mean of the experimental group students was found to be 64, and the standard deviation was found to be 12.4. According to the results of the t-test analysis, there was no significant difference between the pre-test and post-test scores of the experimental group in terms of argumentative tendencies.

4. Discussion

The results obtained from the research are given in terms of academic achievement, science attitude, and argumentative tendencies.

Findings reveal that the AT mean of the experimental group, in which ABT was applied, was higher than the control group and that there was a significant difference in favour of the experimental group in the statistical analysis. The activities in which ABT was applied made a more positive contribution to students' academic achievement compared to the activities included in the existing curriculum. When the academic achievement pre-test and post-test results of the experimental group, to which ABT was applied, were examined, it was determined that the academic achievements increased, and there was a significant difference in favour of the post-test in the statistical analysis. The reason for the higher academic achievement of the experimental group students may be explained by the fact that the students are more active in the ABT process. Accordingly, using this approach allows students for expressing themselves comfortably in the discussion environment and questioning what they have learned. In accordance with the present results, previous studies have demonstrated that ABT has contributed positively to academic success, and meaningful learning takes place (Chin & Osborne, 2010; Yeh & She, 2010; Hickey, Taasoobshirazi & Cross, 2012; Hong, Lin, Wang, Chen & Yang, 2013; Kutnick, Fung, Mok, Leung, Lee & Lai, 2017; Kim, 2017; Ho, Chang, Lee, Chou, Hsiao, Chen & Lu, 2019; Giri & Aily, 2020). In these studies, it was stated that the reason for the ABT approach to increase academic achievement is that it offers different opportunities to learners. ABT approach provides students with active learning opportunities by creating a student-centered learning environment, allows students to express themselves, and increases the academic achievement of students by providing more inclusion in the teaching process (Greenbowe, Poock, Burke & Hand, 2007; Pratiwi, Cari, Aminah & Affandy, 2017; Aslan, 2019; Gülen & Yaman, 2019). Schoerning, Hand, Shelley and Therrien (2015) stated in their research that meaningful learning may take place in learning environments where the teacher speaks less and the student talks more. Cross (2009) stated that while using the argumentation method, writing discussion also increases academic achievement. ABT makes it easier for students to learn and to express themselves comfortably, as a result of which their academic achievement increases (Şahin, 2016). Günel, Memiş and Büyükkasap (2010) determined that the application of ABT increases the students' attitude and therefore increases the academic achievement of the students. And also Rosmiati, Lilliasari, Tjasyono & Ramails (2020) have determined that the application of ABT increases the students' reflective thinking capabilities.

In the application process, SAS was applied as a post-test to the students of the experimental group to which ABT was applied and to the students of the control group to which the current curriculum was applied. SAS results indicate that the mean of the experimental group increased from 75.3 to 82.65, and the mean of the control group increased from 73.41 to 75.23. Although the average score increase of the students in the experimental group was higher, there was no significant difference between the experimental and control groups as a result of the statistical analysis ($p=0.06$; $p>0.05$). When the SAS pre-test and post-test results of the experimental group were examined, it was determined that the average science attitude was increased. However, it was found that this increase in the post-test did not create a statistically significant difference.

Several studies have shown similar results in the literature related to the current research (Blosser, 1984; Shrigley, Koballa & Simpson, 1988; Uluçınar-Sağır, 2008; Wendell & Rogers, 2013; Diazibarra, 2016; Ural & Gençoğlan; 2020). Students' attitudes towards science were not changed after the application in the studies where different science levels and subjects (journey to the internal structure of the matter, world, and universe, living things) were applied in primary school science course (Uluçınar-Sağır, 2008; Ceylan, 2014; Diazibarra, 2016).

The reason that there is no difference between the experimental and control groups in terms of science attitudes in this research may be explained by the fact that the activities were not carried out in a long period of time enough to cause a change of the students'attitudes towards science. Long-term applications are needed to change the attitude towards

science. Based on the activities implemented in only one chapter, the attitude change towards science has not occurred. The fact that the application is limited to one chapter is not enough to change the students' attitudes towards science. Diazibarra (2016) stated in his research that teachers must have enough time as more than six weeks for measuring students' ability about putting forward their claims and defending their evidence. Hong, Lin, Wang, Chen & Yang (2013) said that lectures lengthier intervention time affects the elementary school student's attitudes towards science and argumentation. Ural & Gençoğlan (2020) stated that individuals' attitudes towards any subject emerged as a result of various experiences throughout their lives, so it is not possible to change the attitudes in a short time. It was revealed in the studies conducted on student attitudes that student attitudes are formed as a result of long-lived experiences and are not temporary but show relative continuity (Blosser, 1984; Shrigley, Koballa & Simpson, 1988; Bilgin & Karaduman 2005; Balım, Sucuoğlu & Aydın, 2009; Wendell & Rogers, 2013). They also stated that the variables such as gender, age, education level of the family, and family occupation affect the students' attitudes, and this situation increases the resistance of the attitude to change.

In the application process, AS was applied as a post-test to the students of the experimental group to which ABT activities was applied and to the students of the control group to which the current curriculum activities was applied. AS results showed that the mean of the experimental group increased from 56.9 to 64, while the mean of the control group was 56 in both the pretest and the posttest. Although the average score increase of the students in the experimental group was higher, there was no significant difference between the two groups as a result of the statistical analysis ($p = 0.67$; $p > 0.05$). According to the AS pre-test and post-test results of the experimental group to which ABT was applied, the tendency towards the discussion increased. However, it was found that this increase in the post-test did not create a statistically significant difference.

Prior studies that have noted that the laboratory activities that took place for a short time were not enough to change the argumentativeness (Osborne, Erduran & Simon, 2004). Öğreten (2014) determined that there was no significant difference in the willingness to discuss in her research in which examined the effect of the argumentation-based teaching on elementary school 4th-grade students' academic achievement and scientific discussion levels in science courses. Demircioğlu (2011) determined in his study that laboratory education by argumentation-based inquiry method did not cause a change in the tendency towards discussion between experimental and control groups. Uluçınar (2008) found that in terms of AS scores, there was no significant difference between the experimental group in which 8th-grade students' scientific discussion-oriented teaching was applied and the control group in which the existing curriculum was applied. Aktaş and Doğan (2018) determined that students' willingness to participate in the discussion did not change in both methods in their research comparing the argument based inquiry method and the traditional laboratory method.

Contrary to the results obtained from the current research, Rancer, Whitecap, Kosberg and Avtgis (2009) carried out research that included sections in which students participated in argumentation and as a result of these applications, they found that students' tendency towards discussion increased. Kaya and Kılıç (2008) concluded that, as a result of the argumentation practices that continued during a whole semester, the students' tendency towards discussion increased compared to the previous semester. In the research in which scientific discussion focused teaching was applied in the 7th- grade, Uluçınar-Sağır (2008) stated that there was a significant difference between the experimental group and the control group in which the traditional method was applied in terms of AS mean. They also noted that the experimental group students' tendency towards discussion increased. Yeh and She (2010) found that the argumentation-based learning process had a positive effect on students' willingness and skills to participate in the discussion as a result of their study.

The reason for the difference in the argumentative tendencies in different grade levels where ABT is applied may be due to the variables of age, gender, intelligence, and prior knowledge.

The current research was carried out with 4th grade (9-10 years old) students. Students at a young age, usually choose to remain silent because they do not know how to express themselves and defend their opinions, accept everything as it is. Therefore, their argumentative tendencies are low. Previous research has found that there is an increase in the tendency of the students towards the discussion from eight years of age to adulthood, and there is no development from adolescence to adulthood. It was also found that there was no significant difference in gender-related performance. In addition, as the education level of students increases, their argumentative tendencies increase (Kuhn, 1991; Schullery & Schullery, 2003).

According to the results of the current research, no difference was determined between the groups in terms of attitude towards science and tendency towards discussion. This result may explain with short time application; through the students' difficulties of writing scientific explanations at the stage of completion of group activities, expressing

themselves correctly during the discussion stage; due to all these students got anxiety, therefore the attitude towards science and their tendency towards discussion did not change at the end of the research. If argumentation-based teaching (ABT) had been applied in other chapters, in a long-period of time, students would be able to carry out activities easily, because they would get used to it.

According to the results revealed based on the findings obtained from the current research; the types and contents of the activities in the science textbooks might be planned and implemented in accordance with the characteristics of the scientific discussion. In order to increase students' attitudes towards science and to increase their argumentative tendencies, it is recommended to apply ABT for a longer period of time than the current research.

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