JOURNAL OF BALTIC SCIENCE EDUCATION
ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

THE IMPACT OF ARGUMENTATION-BASED TEACHING AND SCENARIO-BASED LEARNING METHOD ON THE STUDENTS' ACADEMIC ACHIEVEMENT

Serkan Aslan

Abstract. *Teaching programs based on contemporary learning-teaching approaches have been regulated since the 2005-2006 academic year in Turkey. Nevertheless, the researches conducted in Turkey suggested that teachers mostly use traditional teaching-learning approaches in their classroom activities. Therefore, this research aimed at enhancing the students' academic achievement through the use of argumentation and scenario based learning approaches among the contemporary teaching-learning approaches in order to guide teachers. Experimental design with pre-test and post-test control group was used in the present research. This research was conducted with 45 fourth grade primary school students. The research was conducted with two experimental groups and one control group. Activities related to argumentation-based teaching were administered to the experimental group 1, activities with scenario-based learning method for the experimental group 2, and those of the existing curriculum for the control group. The research deployed an academic achievement test based on the unit of "Let's Solve the Riddle of Our Body". Independent samples t-test, one-way analysis of variance (ANOVA) and covariance analysis (ANCOVA) were used during data analysis. Research results revealed that the academic achievement of the students was significantly influenced by the activities related to argumentation-based teaching and scenario-based learning method.*
Keywords: *argumentation based teaching, constructivism approach, science teaching, scenario-based learning.*

Serkan Aslan
Suleyman Demirel University, Turkey

Introduction

Countries advancing in the fields of science and technology today are characterized as developed countries where the transition from the industrial society to the information society is experienced, and where this change is immersed in all areas of the society. Science plays a major role in the progress and development of countries as it is at the centre of these developments. This reveals how much importance we must attach to science and science education in our developing country.

With an effective science education, it is expected to raise science literate individuals who use what they learn better, who think critically, who argue and produce solutions. Developed and developing countries have made various alterations in their curricula regarding science education with a view to educating these individuals. Amendments have been made in primary school program in Turkey since 2005-2006 academic year, and several recommendations on the implementation of methods, techniques and activities have been presented (Ministry of National Education [MNE, 2017]. Argumentation-based teaching and scenario-based learning method are among these activities. Kuhn (1993) defined argument as an assertion, argument, or thesis that is put forward together with a justification. Argumentation is the establishment of an argument or arguments, the combination of arguments, and the logical justification of the data (Fettahlioglu, 2013). To put it another way, argumentation is a dynamic process by which individuals with different ideas about a topic or a problem assert their claims, present solution proposals to solve the problems and use refutations and limitations (Kuhn & Udell, 2003).

Simon, Erduran and Osborne (2006) stated that argument is an assertion or proposition; while argumentation is a debate process by which different claims are hold together. Nussbaum (2011) described argumentation as a process through which individuals create arguments and criticize the arguments generated by using rebuttal. Argumentation can be considered as a process by which individuals having different point of views towards a topic or a problem express their ideas through evidence, and they discuss and refute a claim or assertion with the help of some evidence. The main goal

https://doi.org/10.33225/jbse/19.18.171

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

in the argumentation-based teaching is to provide learners with knowledge in a learning environment based on research and inquiry, by asking questions, making claims and supporting their arguments with evidence (Keys, Hand, Prain, & Collins, 1999). There are numerous argumentation models in the relevant literature. One of which is Toulmin's argument model signifying that a simple argument includes claims, data and justification components. In more complicated and high-level arguments, backing, qualifiers and rebuttals are included along with these components (Erduran, Simon, & Osborne, 2004).

Toulmin emphasizes that an argument must include claims, data and warrants which are significant in terms of the quality of an argument. There are also researches regarding evidence (data) as the most basic component of the argumentation process. Having pointed out that evidence is the most important component of the argumentation process, Thielemier (2013) stated that students are much more active in the argumentation process when supporting their claims with evidence and data. The researcher also indicated that it is vital for the students to have this skill so that they can create the capacity needed for large structural argumentation functions, thus they must be taught how to use different evidence (written, verbal, explicit, closed ...). One of the approaches developed within the framework of the new education understanding is the scenario-based learning method in which students solve the problems by taking the role of the performer in the scenario (Veznedaroglu, 2005). During this process, students start learning through their own knowledge, develop and use the communication skills and knowledge management required for long-term learning by presenting their results in group (Waterman, 1998). Scenario-based learning is a highly significant method which is used for putting thoughts into action and observing behaviours being passed on to life (Cautreels, 2003). In scenario-based learning, different scenarios are designed to provide meaningful learning by integrating them with a constructivist approach in the classroom environment. By using scenario based learning method, learning becomes meaningful and pleasurable (Cubukcu, 2011).

With the increasing significance of constructivist learning approach in education, student-centred teaching approaches in science education have become prominent. In parallel to these; science education aims to raise individuals who do research, inquiry, propose solutions to the social and economic problems and who have advanced communication skills. Argumentation-based learning settings also contribute to the students' conceptual understanding, scientific thinking and understanding of science as well as other skills (Tola, 2016). Besides, students endeavour for learning scientific concepts by discussing and confirming them with the argumentation-based teaching in science education, (Yesiloglu, 2007). It also supports the development of students' scientific thinking skills. In the process of argumentation, students consider science as a process by which thoughts are constantly revealed, interrogated and often developed or changed (Kariper, Akarsu, Slisko, Corona, & Radovanovic, 2014). On this subject, argumentation-based teaching plays a significant role in science education. The use of scenario-based learning, especially in science education, is essential and necessary for students so that they can establish a connection with real life. The level of the students' ability to relate their knowledge to everyday life is an indicator of their levels of comprehending science concepts (Pinarbasi, Doymus, Canpolat, & Bayrakceken, 1998).

In recent years, the number of the studies conducted on the argumentation process (Antiliou, 2012; Butt, 2010; Erduran & Jiménez-Aleixandre, 2007; Hudson, 2010; Martin-Gamez & Erduran, 2018; Yildirim & Turk, 2018; Zohar & Nemet, 2002) and scenario-based teaching (Lou, Hart, & Amparo, 2014; Lucas & Roth, 1996; Peplow, 1996; Razzauk, 2011; Taneri, 2018), especially in the field of science have dramatically increased. Upon analyzing the relevant literature in Turkey, there are various studies related to argumentation-based teaching in science education (Arik, 2016; Dogru, 2016; Sahin, 2016) and scenario-based learning method (Kemiksiz, 2016; Kocadag, 2010). However, no research has been conducted with primary school students regarding argumentation-based teaching and scenario-based learning method. This has been considered as a shortcoming by the researcher and it is expected that such a research would be beneficial for the purpose of filling this gap. The main objective of the primary school fourth grade science curriculum is to educate science literate individuals (MNE, 2017). It is of upmost importance for these individuals to be trained with the use of active methods, techniques and approaches in their teaching-learning environment. In this regard, the implementation of methods such as argumentation-based teaching and scenario-based learning that ensure the active participation of the students will facilitate to raise science-literate individuals. By the same token, the argumentation-based teaching and the scenario based learning method increase the academic achievement of the students (Ceylan, 2017; Gulen, 2016; Kemiksiz, 2016). This research was expected to provide guidance to the classroom teachers and program development specialists in the context of how to implement scenario and argumentation-based activities in science education, and to light the ways of the similar researches in the future. Thus, such a research was carried out. This research was expected to make a contribution to the relevant literature.

https://doi.org/10.33225/jbse/19.18.171

Aim of the Research

This research aimed to explore the effect of scenario-based teaching and argument-based learning method on the academic achievement of the 4th grade students of primary school in science lesson. In service of this aim, answers to the research questions were sought:

1. Does the mean of pre-test achievement test scores significantly differ across experimental group 1, experimental group 2 and control group?
2. Do pre-test and post-test achievement test scores vary across experimental group 1?
3. Do pre-test and post-test achievement test scores vary across experimental group 2?
4. Is there a significant difference between the mean of the control group's pre-test and post-test academic achievement test scores?
5. Is there a significant difference between the post-test scores when the pre-test scores of experimental group 1, experimental group 2 and control group are controlled?
6. Is there a significant difference between the mean of the post-test achievement test scores of the experimental group 1, experimental group 2 and control group in terms of gender?

Research Methodology

Research Model

This research used an experimental research model. Experimental studies made it easier to interpret the causal relations between causes and results since it allowed the researcher to compare the changes on the independent variable by controlling the independent variables (Gurbuz & Sahin, 2015). Experimental design with pre-test-post-test control group was used in the present research. Johnson and Christensen (2012) addressed pre-test-post-test control-group design in which both groups which are randomly assigned are exposed to a post-test after pre-test is administered to both groups and one or more experimental groups are exposed to a treatment. The research was conducted with two experimental groups and one control group. In primary school fourth grade science course "Let's Solve the Riddle of Our Body" unit, activities related to the argumentation-based teaching were administered to the experimental group 1, activities with scenario-based learning method for the experimental group 2, and those of the existing curriculum for the control group. The research was conducted during the 2017 and 2018 academic year. Table 1 depicts the experimental design of the research.

Table 1. The experimental design of the research.

Groups	Pre-test	Experimental process	Processing time	Post-test
Experimental 1	Achievement test	Argumentation-based teaching activities	7 weeks (21 course hours)	Achievement test
Experimental 2		Scenario-based learning activities		
Control		Activities based on current curriculum		

Study Group

This research was conducted with 45 primary school fourth grade students who research at a state school in Elazig during the academic year of 2017 and 2018. The reason for the inclusion of 45 is that three classes consist of fifteen students each. Before the experimental process, students' third year grade point averages and their science lesson scores were examined. One-way analysis of variance identified no significant difference between experimental group 1, experimental group 2 and control groups' third year grade point averages (F=1.336, p>.05) and their science lesson scores (F=.264, p>.05). The groups were equalized in this way. The students in 4/B were randomly determined as experimental group 1 in which argumentation-based teaching methods were used, 4/A as experimental group 2 with scenario based learning method and 4/C as control group with the current teaching program. Eight of the 15 students in experimental group 1 were female and 7 were male. In experimental 2, eight of the 15 students were female and 7 were male, while 11 were female and 4 were male in the control group. While students' mother education level varies across primary and high school, father education varies between primary

https://doi.org/10.33225/jbse/19.18.171

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

and university. The socio-economic status of the students is low and medium. Most of the students' mothers are housewives, and their fathers are tradesmen. Official permits were obtained before starting the research. Written permission was also obtained from the parents. The students' content was also obtained to participate in the research within the framework of the principle of volunteerism. Ethical principles were taken into consideration in this research (Karagoz, 2018).

Data Collection Tool

The research deployed academic achievement test developed by Yildirim (2015) based on the unit of "Let's Solve the Riddle of Our Body" referring to the fourth grade science course of primary school. During the development process of the test, the acquisitions of the relevant curriculum were examined and a table of specifications was prepared. The relevant literature was then searched and the items were prepared (Yildirim, 2015). The materials were formed as quad multiple-choice questions, followed by a test of the fifth grade 186 students. As a result of the analyzes, the item difficulty indices vary between .32 and .63 and the item discrimination indices differ across .32 and .68. The KR 20 reliability of the test was calculated. The KR 20 reliability coefficient was determined as .89 after the completion of the test by 186 students (Yildirim, 2015). The KR 20 reliability coefficient of the achievement test was identified to be .73 in the present research. Fraenkel, Wallen and Hyun (2014) noted that the reliability of KR 20 is satisfactory at the level of .70 and above.

The Experimental Process

The experimental procedures related to the research lasted seven weeks in total. The activities were carried out and completed simultaneously in three groups.

Activities in Experimental Group 1: In Experimental group 1, the lessons were carried out within the framework of activities prepared by taking Toulmin's argumentation model into account. Activities were designed to stimulate students' research both individually and in teams. The students were divided into small groups consisting of five while doing the argumentation activities. The groups were heterogeneously created. Worksheets were distributed for each student in the group. Students firstly performed activities on their worksheets individually. Subsequently, each group made in-group discussions. Student discussions were encouraged with the help of data on the worksheets. Group clerks took notes about their arguments and discussion results on common group papers. At the end of the discussion period, each group's announcers present their claims with reasons and data. In the classroom presentations, the students were also encouraged by the teacher to refute the arguments. In addition, different groups were created in each activity, which allows students to communicate with individuals from different groups. It was also aimed at making it easier for students to express themselves in different settings. The teacher served as a counsellor throughout the discussions. The teacher acted in an approach that manages the debates and solves the problem in the event that the debate is blocked. The teacher asked the students to contribute to the small group discussions during the discussion process and to reveal why the claims they do not support are wrong. S/He also encouraged groups to make counter-claims. The teacher also posed the following questions in order to improve the quality of in-group argumentation: *"What are the reasons for suggesting this claim? What data do you make use of while generating the claim? Do you have any other data to strengthen your claim? Do you have any ideas against your group friends' allegations? How can you refute this counter-claim? What are the data that will refute this counter-claim? Has your claim differed at the end of the discussion period? Why?".* At the end of each lesson, a general evaluation related to the activities and discussion process was made by the teacher. Students were also posed various questions. In this way, attempts were made to prevent incomplete and incorrect learning. Argumentation activities prepared by the researcher were presented to four faculty members and two science teachers and the activities got their definite forms. An example of an argumentation activity was presented below:

Argumentation Activity: The Strategy of *Expressions Table* was used in this activity (Osborne, Erduran & Simon, 2004). Four different expressions were presented in the form of a table containing various events related to the significance of correct breathing. Students were asked to write out whether these statements are true, why they think so, and the evidence that supports them.

Activities in Experimental Group 2: Appropriate scenarios were prepared for each of the eight acquisitions depending upon the scenario-based learning method. Several factors were noted while preparing the scenarios. Scenarios were created in the academic year of 2017-2018, by means of the Ministry of National Education's science

https://doi.org/10.33225/jbse/19.18.171

course resource books, teaching books about the field, worksheets, journals and articles. The researchers paid great attention to ensure that these scenarios are true, that the aim is clear, impartial and objective, that the content is appropriate for the level of the children, that they motivate the students to think (Acikgoz, 2007, Veznedaroglu, 2005). Afterwards, these scenarios were presented to four faculty members, two science teachers, two Turkish Education teachers, and the definite version of the scenarios were prepared. For instance, the researcher named the scenario as "Obese Ali" in order to lead the students to gain the acquisition of "S/he recognizes the importance of doing exercise for body health". In this scenario, Ali eats greedily and does not do exercise at all. For this reason, he is gaining weight. His friends are also making fun of him. Ali feels very sad, and goes to a dietician. The dietician told Ali about the importance of doing body exercises and that if he exercises at least 30 minutes every day, he will lose weight. Ali starts to lose weight by exercising every day for 30 minutes and not eating the junk food. The students act out the scenario after the reading it. Each group selected one of the four problems prepared for the scenario depending on their requests and analyzed it in group. Groups solved the problems by discussing them among themselves. Discussions were held on each group's opposing views and it was requested that all these views be reported. Scenarios were prepared by the researcher for eight acquisitions in a curriculum similar to this scenario and implemented for seven weeks.

Activities in the Control Group: Following the application of the pre-test, the activities in the "Primary School 4th Grade Science Lesson Curriculum" and the teacher's guidebook distributed to the schools by the Ministry of National Education were implemented. The program and teachers' guide include the activities on motivating students to observe, compare, create a model, make various estimates, and develop their ability to test these predictions. After applying the activities based on the curriculum, the achievement test was administered to the students in the control group as post-test.

Data Analysis

First, the research confirmed whether data provided the general requirements of the parametric tests. The normal distribution of data in scientific researches was paramount in determining which analysis technique is to be chosen (Secer, 2015, p. 25). It is recommended to examine the tests of "*Skewness and Kurtosis, Kolmogorov-Smirnov, Shapiro Wilks, Histogram, Q-Q Graph, P-P Graph*" tests in order to examine the single variant normal distribution (Cicek, 2014; Guris & Astar, 2014; Pallant, 2010; Secer, 2015). The Shapiro-Wilks test was used to determine whether the distribution was normally distributed. Buyukozturk (2011) and Secer (2015) suggested that the sample be no more than 50 for the Shapiro-Wilks test. Based on these references, the Shapiro-Wilks test was used to determine whether the data demonstrated normal distribution, as experimental group 1, experimental group 2, and control group had fewer than 50 students. Shapiro-Wilks test was determined to be insignificant in the achievement test used as pre-test and post-tests in experimental group 1, experimental group 2 and control group ($p > .05$). As a result of the analyzes, the tests showed normal distribution. Parametric tests are used when the data demonstrate normal distribution. Independent samples t-test, one-way analysis of variance (ANOVA) and covariance analysis (ANCOVA) were used during data analysis. Can (2014) noted the need for giving the effect size in t-test and one way variance analyses. Hence, the effect size was calculated and presented in the relevant tables. Green and Salkind (2013) reported that the effect size in *t*-test could be determined by dividing the difference between the averages of the measurements by the standard deviation of the difference scores, while in ANOVA, by dividing the inter-group variance by the total variance. Based on this reference, effect sizes were calculated and depicted on the tables. The measures of effect size were proposed by Green and Salkind (2013). A value of 1 means that there is a perfect effect (*d*), .8 large effect, .5 medium effect and .2 small effect for t-test. The effect size (η^2) for ANOVA is measured as .01 small, .06 medium and .14 large.

Research Results

Results Related to the Pre-test Academic Achievement Scores of the Experimental Group 1, Experimental Group 2 and Control Group

The first question of the research was that "*Does the mean of pre-test achievement test scores significantly differ across experimental group 1, experimental group 2 and control group?*" Table 2 depicts the results of one-way analysis of variance (ANOVA).

https://doi.org/10.33225/jbse/19.18.171

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Table 2. ANOVA results of pre-test scores of experimental 1, experimental 2 and control group.

Test	Group	N	$\overline{X}$	SD	df	F	p	η2
Achievement test	Experimental 1	15	19.33	2.43	2-42	.682	.51	.03
	Experimental 2	15	19.33	2.87				
	Control	15	18.40	2.22				
Levene Test: .583	*p=.56*							

Table 2 presents that the mean of Experimental 1 group's pre-test achievement scores is $\overline{X}$ =19.33, while that of the Experimental group 2 is $\overline{X}$ =19.33, and the mean of the pre-test scores of the control group is $\overline{X}$ =18.40. ANOVA test results (F=.682, p>.05) identified no significant difference among the averages. This result indicated that the academic achievement of students in experimental 1, experimental 2 and control groups are close to each other. The effect size (η^2=.03) showed that this difference is at a low level.

Results Related to the Pre-test and Post-test Academic Achievement Scores of the Experimental Group 1

The second question of the research has been determined as "*Do pre-test-post-test achievement test scores vary across experimental group 1?*" Therefore, this research aimed to reveal the mean of the pre-test-post-test achievement scores varied across the students in experimental group 1. Table 3 presents the t-test results of the dependent samples t-test.

Table 3. t-Test results regarding the pre-test and post-test scores of experimental group 1.

Experimental Group1	N	$\overline{X}$	SD	t	p	d
Pre-test	15	19.33	2.43	-8.144	.0001*	2.10
Post-test	15	24.06	2.46			

**p< .05*

As is seen in Table 3, the mean of the pre-test achievement scores of the experimental group 1 is $\overline{X}$ = 19.33, while the mean of the post-test scores is to be $\overline{X}$ = 24.06. t-test was conducted with the aim of determining whether there was a statistically significant difference between pre-test and post-test achievement scores of the experimental group 1. A significant difference was noted between the mean of pre-test and post-test scores of the experimental group 1 in favour of post-test.

This difference was determined to have a large effect size (d=2.10). Thus, it may be wise to mention that the activities based on the argument-based teaching increase the academic achievement of the students.

Results Related to the Pre-test and Post-test Academic Achievement Scores of the Experimental Group 2

The third question of the research was that "*Do pre-test and post-test achievement test scores vary across experimental group 2?*" For this purpose, no significant difference was determined between the pre-test-post-test achievement test scores of the students in the experimental group 2. The dependent samples t-test results are presented in Table 4.

Table 4. t-Test results regarding the pre-test and post-test scores of Experimental group 2.

Experimental group 2	N	$\overline{X}$	SD	t	p	d
Pre-test	15	19.33	2.87	-6.546	.0001*	1.69
Post-test	15	23.46	2.69			

**p < .05*

https://doi.org/10.33225/jbse/19.18.171

Table 4 displays that the mean of the pre-test achievement scores of the experimental group 2 is $\overline{X}$ = 19.33, while the mean of the post-test scores is t $\overline{X}$ = 23.46. As a result of the t-test analysis conducted in order to determine if there is a statistically significant difference between pre-test and post test achievement scores of the experimental group 2 (t=-6.546, p<.05), a significant difference was identified between the mean of pre-test and post-test scores of the experimental group 2 in favour of post-test.

This difference was determined to have a large effect size (d=1.69). Thus, it is likely that the activities based on the scenario-based teaching increase the academic achievement of the students.

Results Related to the Pre-test and Post-test Academic Achievement Scores of the Control Group

The fourth question of the research was determined as "*Is there a significant difference between the mean of the control group's pre-test and post-test academic achievement scores?*" Hence, the research analyzed whether there was a significant difference between the pre-test and post-test achievement test scores of the control group. The dependent samples t-test results are given in Table 5.

Table 5. t-Test results regarding the pre-test and post-test scores of the control group.

Control group	*N*	$\overline{X}$	*SD*	*t*	*p*	*d*
Pre-test	15	18.40	2.22	-4.712	.0001*	1.21
Post-test	15	21.46	2.69			

**p < .05*

Upon examining Table 5, the mean of the pre-test achievement scores of the control group was found to be $\overline{X}$ = 18.40, and the mean of the post-test scores is t $\overline{X}$ = 21.46. As a result of the t-test analysis conducted in order to explore whether there was a statistically significant difference between pre-test and post-test achievement test scores of the control group (t=-4.712, p<.05), a significant difference was determined between the mean of pre-test and post test scores of the control group in favour of post-test.

This difference was found to have a large effect size (d=1.21). Thus, the activities based on the current teaching program may be indicated to increase the academic achievement of the students.

Results Related to the Post-test Scores of the Experimental Group 1, Experimental Group 2 and Control Group When Their Pre-test Scores are Controlled

The fifth question of the research was determined as "*Is there a significant difference between the post-test scores when the pre-test scores of Experimental group 1, Experimental group 2 and control group are controlled?*" The assumptions were examined for the covariance analysis was examined. First, it was determined whether pre-test and post-test scores of the groups demonstrated normal distribution. The pre-test and post-test scores of the groups demonstrated normal distribution as a result of the analyzes. Accordingly, the first hypothesis for covariance analysis was met. Another assumption that must be met for covariance analysis is that there must be a linear relationship between the covariance variable and the dependent variable in all groups. Therefore, the linear relationship between the covariance and dependent variables in each group must be examined through scatter plot. Scatter plots regarding pre-test post-test scores of Experimental 1, Experimental 2 and control groups were checked.

https://doi.org/10.33225/jbse/19.18.171

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

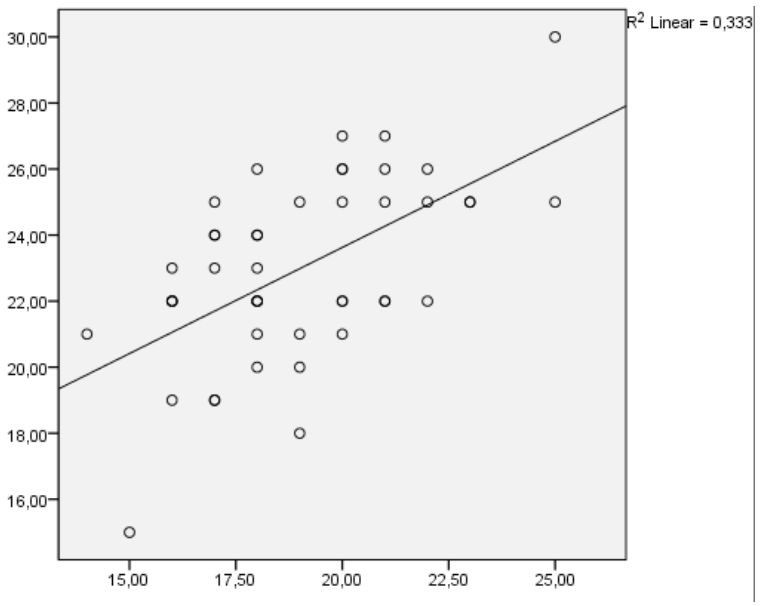

Figure 1. Scatter plot of the groups' pre-test and post test scores.

Figure 1 shows the scatter plot of pre-test and post-test total scores of Experimental group 1, Experimental group 2 and control group. When the graph was examined, it was found that the slopes of the regression lines of experimental group 1, experimental group 2 and control group were close to each other; that there is a medium level and positive relation between the pre-test and post-test scores (r=.577), and thus pre-test and post-test scores were appropriate for covariance analysis. The next assumption was whether the variances for post-test scores were equal. Table 6 depicts the Levene test results conducted to prove this.

Table 6. Levene test results regarding the post-gtest scores of the groups.

	Levene	df_1	df_2	p
Post-test results of the achievement test	.251	2	42	.77

Table 6 suggests that the variances are equal (F=.251, p>.05) and the post-test scores of the groups fit into another hypothesis for covariance analysis. Table 7 displays the mean of the post-test academic achievement scores and winsorized post-test mean depending on pre-test results.

Table 7. t-Test results regarding the post-test scores of experimental group 1, experimental group 2 and control group.

Groups	*N*	*M*	*Winsorized Mean*
Experimental 1	15	24.06	23.88
Experimental 2	15	23.46	23.28
Control	15	21.46	21.83

The mean of post-test total scores of the students and the post-test scores winsorized according to the pre-test scores are presented in Table 7. Thusly, the winsorized mean of the experimental group 1 is $\overline{X}$=23.88; $\overline{X}$=23.28 for the experimental 2; the winsorized post test mean of the control group is $\overline{X}$=21.83.

It is noteworthy that the highest score belongs to experimental group 1 in which the argumentation-based teaching is realized. The ANCOVA results for determining whether the difference between these scores led to a statistical difference are presented in Table 8.

https://doi.org/10.33225/jbse/19.18.171

Table 8. ANCOVA and Bonferroni test results on winsorized post-test results depending on the pre-test scores of the groups.

The Source of the Variance	The sum of the squares	df	The mean of the squares	*F*	*p*	η^2	*LSD*
Pre-test	91.337	1	91.337	19.003	.0001*	.31	
Group	32.545	2	16.273	3.386	.04*	.14	Experimental 1>Control
Error	197.063	41	4.806				
Total	24149.000	45					

**p<.05*

Table 8 shows the covariance analysis results of the students' post test scores. Pre-test total scores were analyzed as a control variable, and the significant difference between the post-test total scores were tested. Correspondingly, a significant difference was found between the post-test total scores when the pre-test total scores are taken under control (F=3.386; p<.05). When the eta square value was examined, being in different groups was determined to affect the post-test scores with a difference of 14% regardless of pre-test scores. According to the results of the Bonferroni test conducted in order to show the difference between the groups, this difference was found to be between the scores of the students in the experimental group 1 and the control group. In other words, the covariance analysis illustrated that the post-test scores of the group in which the argumentation-based instruction was applied were significantly higher compared to the others.

Results Related to the Post-test Academic Achievement Scores of the Experimental Group 1, Experimental Group 2 and Control Group in terms of Gender

The sixth question of the research was determined as "*Is there a significant difference between the mean of the post-test achievement test scores of the experimental group 1, experimental group 2 and control group in terms of gender?*" In accordance with question, it was examined whether there was a significant difference between the post-test achievement scores of the experimental group 1, experimental group 2 and control group. Independent samples t-test results are given in Table 9.

Table 9. t-Test Results on whether the post-test scores of the experimental group 1, experimental group 2, control group differed across gender.

Groups		*N*	$\overline{X}$	*SD*	*t*	*p*	*d*
Experimental 1	Female	8	24.00	1.41	-.103	.91	.05
	Male	7	24.14	3.43			
Experimental 2	Female	8	23.50	2.72	.049	.96	.02
	Male	7	23.42	2.87			
Control	Female	11	21.81	1.77	.828	.42	.48
	Male	4	20.50	4.65			

**p < .05*

As is seen in Table 9, the mean of the post test scores of the female students in the experimental group 1 is $\overline{X}$ = 24.00, and that of the male students is $\overline{X}$ = 24.14. No significant difference has been identified in post-test achievement test scores of the experimental group 1 in terms of gender (t=-.103, p>.05). When it comes to the experimental group 2, the mean of the post test scores of the female students has been determined as $\overline{X}$ = 23.50, and $\overline{X}$ = 23.42 for the male students. The results of the t-test analysis suggested no significant difference between the post-test achievement test scores of the students in Experimental group 2 depending on their gender (t=.049, p>.05). In addition, the mean of the post-test scores of the female students in the control group is $\overline{X}$ = 21.81, while it is $\overline{X}$ = 20.50 for the males. As result of the t-test analysis conducted in order to determine whether post-test

https://doi.org/10.33225/jbse/19.18.171

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

achievement scores of the control group differed across their gender, no significant difference has been determined (t=.049, p>.05).

The effect sizes for the experimental group 1, experimental group 2 and control group were calculated as d=.05, d=.02, d=.48, respectively. The difference was found to be low. The results showed that the activities administered to the groups had a low effect on the academic achievement of the students in terms of their gender.

Discussion

This research aimed to explore the effect of scenario-based learning and argument-based learning on the academic achievement of the primary senior students in science classes. No significant difference was identified between the mean of the academic test pre-test scores of the experimental group 1, experimental group 2 and control group. This result indicated that the academic achievement of the students in experimental group 1, experimental group 2 and control group are close to one another. The research also examined whether there was a significant difference between academic achievement pre-test and post-test mean of the students in experimental group 1, experimental group 2 and control group and a significant difference has been found in favour of post-test. For the Experimental group 1, argumentation-based teaching activities were prepared in order to lead students to discuss the arguments and present evidence for ensuring the refutation of them. These activities were found to have a significant impact on the academic achievement of the students. In this respect, the implementation of argumentation based teaching activities in the fourth grade science course of primary school may increase the academic achievement of the students. There are numerous studies examining the effectiveness of argumentation-based teaching on increasing the academic achievement of students (Aymen-Peker, Apaydin & Tas, 2012; Turkoguz & Cin, 2013; Yesildag-Hasancebi & Gunel, 2013).

Scenario-based learning methodology has a structure that is remarkable, that ensures active participation of the students, that provides learners with self-control, that provides first-hand concrete experiences and that houses students' life-related problems (Yildiz, 2010). All these cases may lead to the emergence of a significant difference between the pre and post test scores of the students in experimental group 1, experimental group 2 and control group in favour of post-test scores. The relevant national and international literature include a large number of studies that reveal the effectiveness of the scenario based learning method on increasing academic achievement of the students (Cakir, 2017; Ceylan, 2017; Kocayusuf, 2014; Kemiksiz, 2016; Razaauk, 2011; Siddiqui, Khan & Akhtar, 2008; Yeniceli, 2016; Yildiz, 2010). Moreover, activities based on the current teaching program were administered to the control group and a significant difference was found between the averages of pre-test and post-test scores in favour of the post-test. Primary education programs have been revised based on the constructivist approach in Turkey since the 2005-2006 academic year. The primary school fourth grade science teaching program was also structured based on constructivist approach (MNE, 2017). The constructivist approach requires that knowledge is understood and structured depending on individuals' minds and characteristics. In this approach, students are active in the teaching-learning process and construct the knowledge they have learned according to their prior knowledge. The constructivist approach is a student-centred approach (Kutluca, 2013). Thus, it can be said that activities that are student-centred and that structured the learners who are active in the teaching-learning process and learned based on the preliminary knowledge are significantly effective on the academic achievement of the students. Similar results have emerged in the studies conducted by Biyikli and Yagci (2015), Johson (2008) and Zengin (2016). All these results also support the results of this research.

This research analyzed whether there existed a significant difference between post-test scores when pre-test results of the experimental group 1, experimental group 2 and control group are controlled. A significant difference was found in favour of experimental group 1. This indicated that the students in the experimental group 1 are more successful than the control group at the end of the teaching period. Moreover, the high level of eta-square value calculated for the achievement test supports this result. Thus, the activities on the argumentation based teaching are more effective in increasing students' achievement than those conducted on the basis of the fourth grade science lesson teaching program. In an argument-based learning process, students are not passive and actively participate in the learning process through discussions. In this process, students make claims about the given topic, justify their claims and try to refute the counter-claims. Besides, students are also provided to develop socially by creating effective scientific discussion environments with small group activities (Demirci, 2008; Iordanou; 2008, Sampson & Clark, 2008). In the present research, it can be considered that the students in experimental group 1 group are effective in learning the scientific discussions among themselves, in the class,

https://doi.org/10.33225/jbse/19.18.171

with their teachers and in small groups and that permanent and meaningful learning can be created by providing the students with argumentation based activities instead of presenting the knowledge. The research results also revealed that there is no significant difference between post-test scores of the students in experimental group 1, experimental group 2 and control group in terms of gender. Along these lines, the activities based on the argumentation-based, scenario-based and the current teaching program do not vary across gender.

Conclusions

A change was made in the 2005 academic year, the curriculum in Turkey. Student-centered approaches are suggested in new curricula. Nevertheless, the researches conducted in Turkey suggested that teachers mostly use traditional teaching-learning approaches in their classroom activities. Therefore, this research aimed at enhancing the students' academic achievement through the use of argumentation and scenario based learning approaches among the contemporary teaching-learning approaches in order to guide teachers. This research examined the effect of argumentation based teaching and scenario based learning method on students' academic achievement in the fourth grade science course of primary school. There was a significant difference between the pre-test and post-test of the students in the experimental group 1 in which the argumantation based teaching was applied. There was a significant difference between the pre-test and post-test of the students in the experimental group 2 in which the scenario based learning method was applied. As a result of the research, it was noted that argumentation-based teaching and scenario-based learning significantly increased the students' academic achievement. This result shows that student-centered approaches increase students' academic achievement. The research results also revealed that there is no significant difference between post-test scores of the students in experimental group 1, experimental group 2 and control group in terms of gender. The results of this research are expected to contribute to classroom teachers in Turkey. At the end of the research, it was determined that the student-centered approach on the students' academic achievement was based on the argumentation-based teaching and scenario-based learning method. In this respect, while teaching-learning environment is organized by classroom teachers, it can be said that the application of argumentation-based teaching and scenario-based learning method which is one of the modern learning-teaching approaches in the science course will increase the academic success of the students.

Recommendations

Based upon the research results, the following recommendations are provided:

1. Research results suggested that the activities related to argument-based teaching, the scenario-based learning method and the existing teaching program are effective on the academic achievement of the students. Given these results, students-centred activities must be conducted by teachers during the teaching-learning process. The academic achievement of the students will undoubtfully increase.
2. The inclusion of more scenario-based and argumentation-based activities in the fourth grade science course of primary school will contribute to increase in the academic achievement of the students.
3. Experimental researches may be conducted in science or other lessons at different levels of classes about argumentation-based teaching and scenario-based learning method.
4. The examination of argumentation-based teaching and scenario-based learning method via different methods such as mixed research, case study, action research will have a great contribution to the related literature.

References

Acikgoz, K. Ü. (2007). *Active learning*. Izmir: Bilis Publishing.

Antiliou, A. (2012). *The effect of an argumentation diagram on the self-evaluation of a creative solution*. (Unpublished doctoral dissertation). The Pennsylvania State University, USA.

Arik, M. (2016). *Effectiveness of argumentation based learning on seventh grade students' awareness about demarcation of science.* (Unpublished master's thesis). Istanbul University, Istanbul.

Aymen-Peker, E., Apaydin, Z., & Tas, E. (2012). Understanding of heat insulation with argumentation: Case study with primary 6th grade students. *Journal of Institute of Social Sciences of Dicle University, 4*(8), 79-100.

https://doi.org/10.33225/jbse/19.18.171

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Biyikli, C., & Yağci, E. (2015). The effect of learning experiences designed according to 5E learning model on level of learning and attitude. *Journal of Abant Izzet Baysal University Faculty of Education, 15*(1), 302-325.

Butt, N. (2010). *Argument construction, argument evaluation, and decision-making: A content analysis of argumentation and debate textbooks.* (Unpublished doctoral dissertation). Wayne State University, Michigan.

Buyukozturk, Ş. (2011). *Social sciences for data analysis handbook.* Ankara: Pegem.

Cautreels, P. (2003). A personal reflection on scenario writing as a powerful tool to become a more professional teacher educator. *European Journal of Teacher Education, 26*(1), 175-180.

Ceylan, T. (2017). *The effect of conceptual teaching through scenario-based learning in the course of social studies to the achievement, attitude and retention on the students*. (Unpublished master's thesis). Recep Tayyip Erdogan University, Rize.

Cakir, U. (2017). *The effects of scenario based training on disaster related information and attitude levels of secondary school students*. (Unpublished master's thesis). Gazi University, Ankara.

Cicek, E. (2014). Descriptive statistics. In Ş. Kalayci (Eds). *SPSS applied multivariate statistical analysis techniques.* Ankara: Asil Publishing.

Cubukcu, Z. (2011). Scenario-based learning. In B. Oral (Eds) *Teaching learning theory and approaches.* Ankara: Pegem.

Demirci, N. (2008). *The effect of the teaching focused on toulmin's scientific argumentation model upon the understanding of the chemistry teacher candidates on general chemistry topics' and levels of argumentation.* (Unpublished master's thesis). Gazi University, Ankara.

Dogru, S. (2016). *The influence of argumentation–based classroom activities on fifth grade students' academic success, logical thinking skills, and willingness to discuss*. (Unpublished master's thesis). Mustafa Kemal University, Hatay.

Erduran, S., Simon, S., & Osborne, J. (2004). TAPping into argumentation: Developments in the application of Toulmin's argument pattern for studying science discourse. *Science Education, 88*(6), 915-933.

Erduran, S., & Jiménez-Aleixandre, M. P. (2007). *Argumentation in science education perspectives from classroom-based research*. Springer Science: Business Media B.V.

Fettahlioglu, P. (2013). Argumentation based on teaching learning approaches. In G. Ekici & M. Güven (Eds.) *Teaching learning approaches and application examples.* Ankara: Pegem.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. (2014). *How to design and evaluate research in education.* New York: McGraw-Hill Education.

Green, S.B., & Salkind, N.J. (2013).*Using SPSS for windows and macintosh: Analyzing and understanding data*. New Jersey: Pearson.

Gulen, S. (2016). *Argumentation science learning approach based on the science-technology-engineering and mathematics disciplines impacts of student learning products.* (Unpublished doctoral dissertation). Ondokuz Mayis University, Samsun.

Gurbuz, S., & Sahin, F. (2015). *Social sciences research methods: Philosophy -method- analysis*. Ankara: Seckin.

Guris, S., & Astar, M. (2014). *Scientific researches SPSS and statistic.* Istanbul: Der Publishing.

Hudson, R. A. (2010). *Statistical argumentatıon in project-based learning environments*. (Unpublished doctoral dissertation). Indiana University, USA.

Iordanou, K. A. (2008). *Developing argument skills across scientific and social domains*. (Unpublished doctoral disseration). Columbia University, USA.

Johnson, D. P. (2008). *A mixed methods study of effects of constructivist and traditional teaching on students in an after-school mathematics program*. (Unpublished doctoral disseration). Fielding Graduate University, Kaliforniya.

Johnson, R. B., & Christensen, L. B. (2012). *Educational research: Quantitative, qualitative, and mixed approaches*. California: SAGE Publication.

Karagoz, Y. (2018). *SPSS and AMOS applied scientific research methods and publication ethics*. Ankara: Nobel Publishing.

Kariper, I. A., Akarsu, B., Slisko, J. Corona, A., & Radovanovic, J. (2014). Prospective science teachers' argumentation-based science learning skills. *Erciyes University Journal of Institute of Science and Technology 30*(3), 174-179.

Kemiksiz, C. (2016). *Effects of using scenario-based learning method in 6th grade science classes on academic achievement, attitudes and permanence*. (Unpublished master's thesis). Abant Izzet Baysal University, Bolu.

Keys, C. W., Hand, B., Prain, V., & Collins, S. (1999). Using the sicence writing heuristic as a tool for leraning from laboratory investigations in secondary science. *Journal of Research in Science Teaching, 36*(10), 1065-1084.

Kocadag, Y. (2010). *The effects of cased-based learning approach on the elimination of misconceptions about the subject of genetic*. (Unpublished master's thesis). Karadeniz Technical University, Trabzon.

Kocayusuf, A. (2014). *The effects of learning products of context based scenario accompanied mastery learning strategy*. (Unpublished master's thesis). Akdeniz University, Antalya.

Kuhn, D. (1993). Science as argument: Implications for teaching and learning scientific thinking. *Science Education, 77*(3), 319-337.

Kuhn, D., & Udell, W. (2003). The development of argument skills. *Child Development*, *74*(5), 1245-1260.

Kutluca, T. (2013). Constructivist teaching learning approaches. In G. Ekici & M. Güven (Eds.), *Teaching learning approaches and application examples.* Ankara: Pegem.

Lou, Y., Hart, J., & Amparo, A. (2014). *The efficacy of scenario-based simulations for middle and high school science and engineering*. Paper presented at World Conference on Educational Multimedia, Hypermedia and Telecommunications, University of South Florida, United States.

Lucas, K. B., & Roth, W.M. (1996). The nature of scientific knowledge and student learning: Two longitudinal case studies. *Research in Science Education, 26*(1), 103-127.

Martin-Gamez, C., & Erduran, S. (2018). Understanding argumentation about socio-scientific ıssues on energy: A quantitative study with primary pre-service teachers in spain. *Research in Science & Technological Education, 36*(4), 463-483.

MNE. (2017). *Sciences curriculum (Primary & secondary school 3, 4, 5, 6, 7 and 8th grades).* Ankara: State Books Press.

https://doi.org/10.33225/jbse/19.18.171

Nussbaum, E. M. (2011). Argumentation, dialogue theory, and probability modeling: Alternative frameworks for argumentation research in education. *Educational Psychologist, 46*(2), 84–106.

Osborne J., Erduran S., & Simon S. (2004). *Ideas, evidence and argument in science (Inservice training pack, resource pack and video)*. London: Nuffield Foundation.

Pallant, J. (2010). *SPSS survival manual: A step by step guide to data analysis using SPSS*. New York: McGraw-Hill Education.

Peplow, P. (1996). Videoconferencing for small-group discussion sessions of a case-based learning programme in anatomy. *Medical Teacher, 18*(4), 309-317.

Pinarbasi, T., Doymus, K., Canpolat, N., & Bayrakceken, S. (1998). *The level of pre-science student teachers of relating their chemistry knowledge in daily life.* Paper presented at 3th National Sciences Education Symposium. Karadeniz Technical University, Trabzon.

Razzouk, R. (2011). *The effects of case studies on individual learning outcomes, attitudes toward instruction, and team shared mental models in a team-based learning environment in an undergraduate educational psychology course*. (Unpublishd doctoral disseration). Florida State University, Florida.

Sampson, V., & Clark, D.B. (2008). Assessment of the ways students generate arguments in science education: Current perspectives and recommendations for future directions. *Science Education, 92*, 447-472.

Secer, I. (2015). *SPSS & LISREL pratical data analysis.* Ankara: Anı.

Siddiqui, A., Khan, M., & Akhtar,S. (2008). Supply chain simulator: A scenario-based educational tool to enhance student learning. *Computers & Education, 51*, 252-261.

Simon, S., Erduran, S., & Osborne, J. (2006). Learning to teach argumentation: research and development in the science classroom. *International Journal of Science Education, 28*(2-3), 235-260.

Sahin, E. (2016). *The effect of argumentation based science learning approach (ABSL) on academic success, metacognition and critical thinking skills of gifted students*. (Unpublished doctoral disseration). Gazi University, Ankara.

Taneri, A. (2018). Scenario-based case study method and the functionality of the section called "from production to consumption" from the perspective of primary school students. *Asian Journal of Education and Training, 4*(1), 56-61.

Thielemier, B. T. (2013). *Developing emerging argumentation: Using disparate forms of evidence to create instructional inroads*. (Unpublished master's thesis). Colorado State University, Colorado.

Tola, Z. (2016). *The effect of argumentation instruction on 6th grade students' conceptual knowledge, scientific reasoning and nature of science understanding*. (Unpublished master's thesis). Kocaeli University, Kocaeli.

Turkoguz, S., & Cin, M. (2013). Effects of argumentatıon based concept cartoon actıvıtıes on students' conceptual understandıng levels. *Journal of Buca Faculty of Educaiton, 35*, 155-173.

Waterman, M. A. (1998). Investigative case study approach for biology learning. *Bioscene, 24*(1), 3-10.

Veznedaroglu, H. M. (2005). *The effects of scenario based learning on attitudes and self efficacy beliefs of teacher candidates' towards teacher proficiency.* (Unpublished master's thesis). Ankara University, Ankara.

Yeniceli, E. (2016). *The effect of teaching based on scenario to success of phsyical sciences class and attitude towards the class*. (Unpublished master's thesis). Gazi University, Ankara.

Yesildag-Hasancebi, F., & Gunel, M. (2013). Effects of Argumentation Based Inquiry Approach on Disadvantaged Students' Science Achivement. *Primary Online, 12*(4), 1056-1073. Retrieved from http://ilkogretim-online.org.tr.

Yesiloglu, S. N. (2007). *Teaching gases topic to high school students trough argumentation*. (Unpublished master's thesis). Gazi University, Ankara.

Yildirim, G. (2015). *Applications of context-based learning in primary 4th class science and technology course.* (Unpublished master's thesis). Anadolu University, Eskisehir.

Yildirim, B., & Turk, C. (2018). The effectiveness of argumentation-assisted STEM practices. *Cypriot Journal of Educational Science, 13*(3), 259–274.

Yildiz, N. (2010). *The effect of experiment applications on the success, attitude and scientific process abilities of the students in the solution of the learning scenarıos based on problems in science education.* (Unpublished master's thesis). Marmara University, Istanbul.

Zengin, E. (2016). *The effects of teaching with the 5 E learning model on the academic success of middle school, 8th grades in the subject of cell divisions*. (Unpublished master's thesis). Atatürk University, Erzurum.

Zohar, A., & Nemet, F. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching,39*(1), 35-62.

Received: *October 22, 2018* Accepted: *March 15, 2019*

Serkan Aslan PhD, Assistant Professor, Suleyman Demirel University, Isparta, Turkey.
E-mail: serkanaslan@sdu.edu.tr
Website: https://avesis.sdu.edu.tr/serkanaslan

https://doi.org/10.33225/jbse/19.18.171