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The Impact of the Argumentation- Flipped Learning Model on the Achievements and Scientific Process Skills of Students

Erol TAŞ
Mathematics and Science Education Department, Ordu University, Ordu, Turkey
ORCID: 0000-0003-4077-7351

Hatice GÜLER
Department of Management and Organization, Giresun University, Giresun, Turkey
ORCID: 0000-0001-7811-6642

Jülide SARIGÖL
Mathematics and Science Education Department, Giresun University, Giresun, Turkey
ORCID: 0000-0002-8456-5046

Banu TEPE [*]
Child Care and Youth Services Department, Giresun University, Giresun, Turkey
ORCID: 0000-0002-3428-8167

Filiz DEMİRCİ
Mathematics and Science Education Department, Ordu University, Turkey
ORCID: 0000-0001-5610-5707

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The current study determined the impact of the Argumentation-Flipped Learning (AFL) Model on the scientific process skills and academic achievement of students by performing a quasi-experimental pretest-posttest and retention control group design. The data were collected by scientific process skills test and concept test from a total of 112 5th grade students randomly selected from a public school in the 2017-2018 academic year. In the curriculum, Experimental group-I and Experimental group-II students were taught the lesson by argumentation-flipped learning model and Flipped Teaching Method (FTM), respectively. The lessons in the control group were taught by the method where the teacher was the narrator. The information and the activities in the curriculum were presented directly. The study was applied in the "Matter and Change" unit. The data of the study were collected by scientific process skills and academic achievement test. SPSS 22.0 package program was used to analyze the data obtained from the study. Shapiro-Wilk Distribution Test and descriptive statistics were used to

[*] Correspondency: banutepe79@gmail.com

determine whether the data showed normal distribution. Furthermore, Analysis of Covariance (ANCOVA) was used. According to the study's results, it was determined that the methods applied to the groups did not make a significant difference in the levels of scientific process or in student's academic success.

Introduction

Rapid improvements in science and technology affect education and instruction processes as well as other fields. In this sense, countries make necessary changes in their education systems to raise individuals who can produce information, be creative, research, read, inquire, defend their ideas with their justifications, think multi-dimensionally and use technology at the same time (Söndür, 2020). Students are expected to conduct research from various sources and use the information obtained by analyzing them for decision-making, and forming new ideas (Silva, 2009; Trilling & Fadel, 2009). Apart from the outcomes of success in the teaching activities, it is expected to provide abilities such as communication, cooperation, and interdisciplinary teamwork (Felder & Brent, 2003). Therefore, abilities such as problem solving, critical thinking, self-management, creativity, communication, and cooperation should be supported by considering the needs of the students (Potts, Schlichting, Pridgen & Hatch, 2010) while the teaching processes is planned (Rotherham & Willingham, 2010). Learning and teaching shift from teacher-centered practices to student-centered flexible learning areas where students can participate more effectively in the learning process (Johnson, Adams, & Cummins, 2012). In the light of the latest changes made in the Science Education Program, in-class and out-of-class learning environments should be created and lessons should be conducted in student-centered learning environments so that students can learn meaningfully and permanently (MoNE, 2018). For this reason, it is suggested that teaching methods compatible with the constructivist learning approach can be used (Felder & Brent, 2003). It is also seen that these methods produce effective results (Hung, Jonassen, & Liu, 2008; Savery, 2006). The aim of the constructivist learning approach is to train students who learn the information by researching, who can interpret the information they have learned in their own way, who can defend their ideas with justifications, and who can use them in case of problems (Driscoll, 2005). Based on the constructivist approach's teaching principles, various methods such as problem and project-based learning, inquiry and cooperative learning have been developed (Taşkın, 2020).

Although it seems possible for students to choose the correct information, evaluate it, think about the solution of the problem, convey what they think, create arguments, defend these arguments and discuss them with their peers, more time is required (Deng, 2001; Huang, Hung, & Cheng, 2012). On the other hand, the limited course time is insufficient for such activities developed within the framework of both theoretical knowledge and constructivist learning approach (Hamdan, McKnight, McKnight, & Arfstrom, 2014). The difficulties experienced during the course brought along the search for different learning models. Iris & Vikas (2011) state that new teaching methods based on the use of technology that students like and want to use are used as a new way to avoid this problem. Students are offered flexible learning opportunities by making use of rich digital learning resources and opportunities provided by communication tools (Wanner & Palmer, 2015) and the opportunity to access information whenever and wherever they want (Johnson et al., 2012).

To solve the difficulties in learning many abstract concepts in the science course, it is crucial and necessary to create technology-supported learning environments that students can benefit from (Oktay & Çakır, 2013). In this context, teachers have started to prefer blended (mixed) learning models instead of using a single traditional teaching method in their classrooms (Singh, 2003).

Blended learning is the use of face-to-face and online learning environments together to benefit from the different opportunities they each have (Graham, 2006). The use of online environments with face-to-face education environments reveals more successful results compared to similar domains (Rovai & Jordan, 2004).

Flipped Learning is a kind of blended learning. It is stated that Flipped Learning is an ideal combination of online and face-to-face teaching, allowing for more in-depth and meaningful learning of knowledge (Bergmann & Sams, 2012; Staker & Horn, 2012).

Flipped learning is a method that integrates technology into the teaching processes and is stated to have positive contributions to teaching in terms of different variables such as academic achievement, scientific process skills, student engagement, and motivation. Researches on this method have become widespread in the last few years (Baepler, Walker & Driessen, 2014; Kong, 2014; Camiling, 2017; Reinoso, Iglasias & Fernandez, 2021).

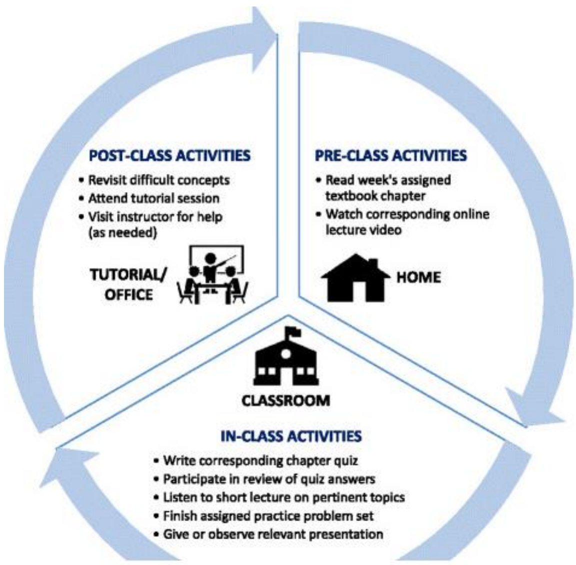

Figure 1. Flipped Learning Process (Moraros et al., 2015).

Flipped classrooms have two components. The first is the performance of the theoretical course content outside the classroom, and the other is the discussions, exercises, and practices carried out in the classroom (Bishop & Verleger, 2013). The FTM allows the teacher to use teaching methods developed within the framework of the constructivist learning approach in classroom activities. Since students interact with their peers and teachers through the materials, they have previously studied using their higher-order thinking skills (critical, creative). It is stated that learning the course content outside of the classroom allows more time to teach active learning techniques in the classroom, as well as creating more in-depth and meaningful learning experiences (Gilboy et al., 2015; Roach, 2014; Roehl et al., 2013).

One of these learning environments is argumentation (MoNE, 2018). The argumentation-based learning process allows students to express their thoughts comfortably, defend them for various reasons, and improve counterarguments to refute other students' claims (MoNE, 2018). The effective science education can take place in a classroom environment where students can express their thoughts without hesitation, justify their ideas and claims with evidence and make contrary arguments to disprove their friends' claims (Kaya & Kılıç, 2010). In the argumentation based learning approach, students ask questions while they reach information, make claims and support these claims with evidence (Demiral & Çepni, 2018). Students gain knowledge through active learning in a social environment because they share their ideas with groups or classmates while building and supporting their claims (Erduran, Simon & Osborne, 2004). This learning path provides students with the opportunity to use their scientific process skills and allows them to work like scientists using scientific methods (Tatar, 2006). In this way, students learn science by doing and living. They work dynamically in the planning, application, and assessment of the process, rather than just manual iteration and verification. This learning method, which enables them to construct new knowledge with previous knowledge and express it meaningfully, is quite suitable for science lessons (Tatar, 2006). In this context, argumentation is an important method in creating the student profile targeted by the constructivist learning approach. The constructivist learning approach emphasizes argumentation as one of the most powerful ways that students learn. Since this method is a time-consuming method in classroom applications, applying it with FTM will also eliminate the disadvantage of time constraints.

It is seen that studies on FTM are predominantly international, while national studies are mainly conducted with undergraduate students (Demirer & Aydın, 2017; Sakar & Uluçınar-Sağır, 2017). Furthermore, studies on FTM mostly measure its effect on students' academic achievement (Clark, 2013; Marlowe, 2012; Findlay-Thomson & Mombourquette, 2014; Sharma et al., 2015; Turan, 2015; Karaca, 2016). However, no study was found in which students' scientific process skills were measured.

Howell (2013) examined the effect of the FL model on academic achievement and carried out activities with FL in the experimental group and with traditional methods in the control group. The analysis presented that the model did not have any effect on success. Çakır (2017) examined the effects of the flipped classroom model on the academic achievement, recall levels, mental risk-taking skills, and computational thinking skills of students through using the model in science lessons with 7th grade students. The study concluded that the flipped learning model increased students' academic achievement and recall levels yet did not show any significant difference in mental risk-taking and computational thinking skills. Güven Demir analyzed the effects of flipped learning model applications on the academic success and planning skills of the 4th grade primary school students. The study concluded that the flipped classroom was more effective on the academic achievement level of Science and Social Studies courses than the traditional classroom. Murat (2018) analyzed the effect of flipped science courses on the 21stcentury skills and scientific epistemological beliefs of 5th grade students and concluded that this model did not show any difference in students. Yurtlu (2018), delved into the effect of the flipped classroom model on the academic success and opinions of teacher candidates in science education and evaluated that this model showed significant positive differences. The study conducted by Kozikoğlu and Camuşcu (2019) aimed to determine the relationship between secondary school students' readiness for flipped learning and their attitudes towards research inquiry. It indicated that secondary school students' readiness for flipped learning and their attitudes towards research inquiry were high. Putri et al. (2019) aimed to determine the effect of the modified flipped classroom approach on the conceptual understanding of 8th grade students, and it was determined that the post-test scores were rather high. Stratton, Chitiyo, Mathende, and Davis (2019) aimed to compare how face-to-face learning and flipped learning differ in terms of student achievement in seventh grade science lessons. The study concluded that the two groups showed no difference.

Demir (2020) conducted a study on 5th grade students and concluded that the applications of the Flipped Classroom in the Science course had positive effects on creating environmental awareness. Söndür (2020) probed into the effects of science lessons supported by flipped classroom model and STEM applications on students' academic achievement, self-learning with technology, and their interest in STEM professions. The study suggested that there was a significant difference in favor of the experimental groups in terms of academic achievement. There was no significant difference between the groups in terms of technology and self-learning. Dixon and Wendt (2021) aimed to determine the effect of the flipped classroom model (FTM on science motivation and achievement of high school students) in their study. They concluded that FTM showed a significant difference in the self-efficacy subscale compared to the traditional classroom model, and there was no significant difference in academic achievement.

This study is believed to be unique in integrating argumentation into the face-to-face teaching process in the classroom, conducting it at the secondary school class level, and investigating its effect on scientific process levels. In this context, the aim of the study is; to investigate the impact of argumentation-flipped learning model on the academic achievement and scientific process skills of students in the "Matter and Change" unit of science course in the 5th grade.

The Aim of the Study

The current study aims to reveal the effect of teaching the 5th grade "Matter and Change" unit subjects with ABFTM on students' academic achievements and scientific process skills. In this study, we tried to find answers to the following questions:

(1) Is there a significant variance among the students' academic achievement in terms of teaching the unit with argumentation-flipped learning model and through the current program in science course?
(2) Is there a significant variance among the scientific process skills of the students in terms of teaching the unit with argumentation based flipped teaching method and through the current program in science course?

Limitations of the Study

This study was limited to 112 students who studied the "Matter and Change" unit in the Science course in 5th grade in a state secondary school in the province of Ordu in the 2017-2018 academic year.

Methods

In this part of the study, information about the research design, research sample, data collection tools, and data analyses are presented.

Research Design

In this study, quantitative research model has been adopted to assess the effect of ABFTM on students' achievements and scientific process skills (SPS). The research design is semi-experimental with pre and post-test with control groups. In the quasi-experimental design, it is aimed to test how different the change seen in one of the groups is from the change in the other groups (Büyüköztürk, 2016). In the study, the random selection principle could not be applied because the control and experimental groups were formed from pre-existing class branches. In the semi-experimental designs non-random assignments are used.

Since individuals cannot be randomly classified, the study is a quasi-experimental design (Creswell, 2017).

In the study, while the subjects were taught with argumentation-flipped learning model, the students in experimental group-I and experiment group-II were taught with FTM. Education was given according to the existing program in the control group.

The processes and the procedures applied to experiment-I, experiment-II and control groups are presented in the Table 1.

Table 1. Processes and the procedures applied in the study

Group	Pre-test	Method	Post-test	Retention Test
Experiment-I	Concept Test SPS Test	Argumentation Based Flipped Teaching Method (ABFTM)	Concept Test SPS Test	Concept Test
Experiment-II	Concept Test SPS Test	Flipped Teaching Method (FTM)	Concept Test SPS Test	Concept Test
Control	Concept Test SPS Test	Teacher-centered Teaching	Concept Test SPS Test	Concept Test

The Study Group

The present study was carried out in the academic year of 2017-2018, in a public secondary school connected to the center of a middle-sized district in the province of Ordu, Turkey. In the study, 112 students were selected randomly from 3 classes of 4 branches which is fifth grade, including the experiment-I group (37 students), experiment-II group (37 students), and control group (38 students).

Data Collection Tools

Concept Test

The 5th grade "Matter and Change" unit concept test developed by Karslı-Baydere was used (2017). The concept test includes 12 questions in two steps, the first step consists of multiple-choice questions, and the second step consists of open-ended questions. Karslı-Baydere (2017) conducted the pilot study with 65 students out of the sample, and the implementation with 50 5th grade students, and the Cronbach Alpha reliability coefficient was found as 0.89 (Karslı-Baydere, 2017). A pilot study was conducted with 32 5th grade students who were not in the sample. The reliability coefficient of the test was determined as 0.81. The tests with reliability coefficient 0.6 and above are accepted to be quite reliable (Can, 2018). Concept test was performed to experiment and control groups as pre and post-test followed by a retention test.

Scientific Process Skills Test

To measure SPS, the "SPS Test" was used, developed originally by Burns, Okey & Wise (1985) and translated into Turkish and adapted by Geban, Aşkar & Özkan (1992). The test mentioned above contains of thirty-six multiple choice questions and the coefficient of reliability (KR-20) was calculated as 0.86 (Burns et al. 1985). Since the original test is suitable for the 8th grade, the study consisted of 15 questions of the test which were rearranged according to the cognitive development level of the 5th. grade and the science curriculum. The validity of the Scientific Process Skill Test was obtained by taking the opinions of three educators and one teacher who are experts in their fields. Necessary arrangements were made in line with the views of field experts and science teacher. A pilot study was performed with total of 28 students in 5th. grade who were not in sample. As a result, the reliability coefficient was determined to be 0.71.

Process of Study

The study is adhered to the time given in the curriculum by Ministry of National Education (MoNE) in the context of 5th grade "Matter and Change" unit. The time devoted to subjects in the study is presented in Table 2.

Table 2. Process of Study

Group	Change of State of Matter	Distinctive properties of Matter	Heat and Temp.	Heat affects matter	Giving info. about the study	Giving info. about FTM	Giving info. about ABFTM	Total
Exp-I	6 lessons	6 lessons	7 lessons	7 lessons	2 lessons	2 lessons	2 lessons	32 lessons
Exp-II	6 lessons	6 lessons	7 lessons	7 lessons	2 lessons	2 lessons		30 lessons
Control	6 lessons	6 lessons	7 lessons	7 lessons				26 lessons

Okulistik Education Portal: There are three contents related to the subject compatible with pc, tablet, and mobile phone in the Okulistik Education Portal, which is supplied for a specific fee and can be used by 112 students during the implementation period:

- Content Interactive Lecturing: (About 10 minutes) It includes animations, illustrated examples, and written explanations with voice narration. At the end of the explanations, interactive questions are asked (True-False-Matching-Putting shape into the right place). If students give a wrong answer, they are warned audibly and visually and activity keeps on till they get the right answer. The achievement percentages are calculated according to the accuracy of the first answers given by the students, and it is ensured that both teacher and the student follow student's success.
- Lecturing with Content Video: (About 12 minutes) Subject is taught by a teacher with the help of an interactive (smart) board with visual support.
- Lecturing with Content Video: (About 5 minutes) Related subject is transferred to the student by combining real images, pictures, animations, and sometimes written explanations with voice narration.

Worksheet: Worksheets are prepared by the researchers using "Toulmin's Argument Model" (Toulmin, 1958 as cited in Okumuş, 2012) and applied experiment-1 group. In the worksheets, an event related to the subject was given to the students and it was expected from the students to form data, claim, justification, supporting, and rebuttal.

Experimental Group-I: All kinds of videos, slides, etc., that students use at home can be prepared by teachers as well as ready contents (Bergmann & Sams, 2012). In this study, Okulistik Education Portal with ready contents was made available for students. So, it was ensured that student entered the system from their computers, tablets, and mobile phones at home to watch the video, animation of the subject content of related content and do the assigned homework. Students are provided to watch contents at school who could not watch at home for various reasons, so all students could access the course content. Students who followed the content of the subject from their houses were provided to make arguments and defend under the teacher guidance in parallel with the worksheets.

Experimental Group-II: The difference of experimental group-II from experimental group-I is that they don't use argumentation in the classroom activities. The students who watched the content of the relevant subject on Okulistik Education Portal, was provided to reinforce the subject by answering the questions asked by the teacher during classroom activities and doing the exercises and examples they gave.

Control Group: The lessons were carried out with the existing classroom activities in line with the current curriculum and homework was given to the students.

Analyses of Data

The statistical analyses of data used in the present were performed by using SPSS 22.0 package program. Since the present study was a semi-experimental design with pre and post-test with control groups, covariance analysis with stable pre-test points was used to remove the first type of bias to determine the difference between academic achievement and SPS. Some conditions must be provided by covariance analysis to give accurate outcomes. Therefore, whether dependent variable points showed normal distribution for each group is primarily examined. Moreover, mode, median, arithmetic mean, skewness, and kurtosis were analyzed in Shapiro-Wilk normality test. Finally, each group shows normal distribution.

Shapiro-Wilk is used in case of the size of the study group is smaller than 50. Otherwise, the Kolmogorow-Smirnow normality distribution test is used (Büyüköztürk, 2016). The Shapiro-Wilk test was used to determine the conformity of the scores to normality as the size of our study group was less than 50 (Exp 1-2, Control group). In addition, the mode, median, arithmetic mean, kurtosis, and skewness coefficients were also calculated. The scores of the dependent variables of the groups have a normal distribution as the kurtosis skewness coefficients are within the normal distribution limits of ± 1.96.

Kurtosis and skewness coefficients and Shapiro-Wilk normality test results according to the pre-test scores of academic achievement and scientific process skills (dependent variables) are presented in Table 3.

Table 3. Summary Results of Normality Pre-Test for Academic Achievement and SPS

		Skewness		**Kurtosis**	**Shapiro-Wilk**		
Test		Statistic	Std error	Statistic	Std error	Statistic	Sig.
Academic Achievement	Exp1	0.846	0.388	1.706	0.0759	0.938	0.040
	Exp2	0.161	0.388	0.238	0.759	0.965	0.295
	Cntrl	-0.231	0.383	-0.145	0.750	0.942	0.048
SPS	Exp1	-0.245	0.388	-0.969	0.759	0.942	0.055
	Exp2	-0.046	0.388	-0.585	0.759	0.972	0.464
	Cntrl	-0.512	0.388	0.359	0.750	0.948	0.076

To examine if there is a linear relationship between data, Scatter Plot scattering diagram was used. The next relevance condition step is the homogeneity of the regression coefficient for groups was examined. One-way variance analysis was used to test if control variable and independent variable are independent from each other. It was observed that data provided all conditions after Levene test which tested the homogeneity of the variance of dependent variable in groups. Finally, findings were obtained by making Covariance analysis (ANCOVA).

Findings

In this part of the study, gathered data was analyzed and presented in tables. The findings about scientific process skills follow the findings about academic achievement during the presentation of findings.

Findings Related with Academic Achievement

The homogeneity of regression coefficient must be provided to gather accurate results from covariance analysis (ANCOVA). Related analysis is presented in Table 4.

Table 4. Slope of Regression Pre-Test –Post-Test and Pre-Test-Retention Test Data

	Source of Variance	Sum of Squares	dv.	Mean of Squares	F	p
Post test	Pre test	12403,812	1	12403,812	33,371	,000
	Group*Pre Test	404,282	2	202,141	,544	,582
	Bias	39399,849	106	371,697		
	Corrected Sum	55396,429	111			
Retention Test	Pre test	13087,569	1	13087,569	32,128	,000
	Group*Pre-Test	150,719	2	75,360	,185	,831
	Bias	43179,694	106	407,356		
	Corrected Sum	57356,250	111			

Table 4 shows the effect of pre-test on achievement does not change according to the post and retention test groups. Thus, there is an insignificant difference in the slope of regression lines of pre-test with control variable according to the groups ($p>.05$). Therefore, the condition of homogeneity of ANCOVA's regression lines is also ensured. The other conditions and the existence of linear relation between data and homogeneity of variances are provided and it is also confirmed that control variable and independent variable are independent of each other. In line with this information, ANCOVA findings are obtained as below. The student achievements of Experiment-I, Experiment-II, and control group were aimed to compare with controlling pre-test points applied to students. The average points of achievement of students according to the groups gathered from ANCOVA and corrected averages of the points are shown below in the table.

Table 5. Distribution of Students' Achievement Points' Means According to Groups

	Group	N	Average	Corrected Average
Post Test	Exp. 1	37	52,1622	50,845
	Exp. 2	37	60,2703	59,120
	Control	38	53,1579	55,560
Retention Test	Exp. 1	37	57,2973	56,021
	Exp. 2	37	54,8649	53,750
	Control	38	51,0526	53,381

According to the corrected achievement average points, the most effective method is the method applied to Experiment-2 group ($\bar{x}$= 59,120). The method applied to experiment-1 group is the least effective method ($\bar{x}$= 50,845). When we look at the retention test, the most permanent method is the method applied to Experiment-I Group ($\bar{x}$= 56,021). The least permanent method is applied to control group ($\bar{x}$= 53,381).

ANCOVA findings which show whether there is a significant difference between corrected average of achievement points among groups are included on Table 6.

Table 6. ANCOVA Findings for the Points of Corrected Post Test and Retention Test According to Groups.

	Source of Variance	um of Squares	dv.	Mean of squares	F	p
Post Test	Pre-Test	4141,246	1	14141,246	38,369	,000
	Group	274,936	2	637,468	1,730	,182
	Bias	9804,131	108	368,557		
	Corrected Sum	5396,429	111			
Retention Test	Pre-Test	3281,536	1	13281,536	33,104	,000
	Group	50,738	2	75,369	,188	,829
	Bias	3330,413	108	401,208		
	Corrected Sum	7356,205	111			

The findings reveal that there is an insignificant difference between the average of post-test achievement points according to groups' corrected pre-test points ($F_{(2-108)}$= 1,730, p<,05). Furthermore, there is an insignificant difference between average retention test points according to the groups' corrected pre- test points ($F_{(2-108)}$= ,188, p<,05).

The Effect of ABFTM on Scientific Process Skills

The homogeneity of the regression coefficient is another important condition for running ANCOVA test. Table 7 shows the findings of the regression coefficient.

Table 7. Slope of Regression of Pre-Test –Post Test Data

	Source of Variance	Sum of squares	dv.	Mean of Squares	F	p
Post Test	Pre-test	136,023	1	136,023	27,313	,000
	Group*Pre-Test	,276	2	,138	,028	,973
	Bias	527,896	106	4,980		
	Corrected Sum	675,857	111			

There is an insignificant difference between the effect of the pre-test on scientific process skills points according to groups as seen in table 7. Therefore, there is an insignificant difference between the slope of regression lines of the pre-test that is the control variable according to groups (p>,05). The condition of homogeneity of regression lines of ANCOVA is also provided. The other conditions, the existence of linear relation between data, the homogeneity of variances, and the independency of control variable and independent variable from each other are also confirmed. In the light of information, findings about ANCOVA are obtained below.

Table 8. Distribution of Average of Students' SPS Points According to Groups

	Group	N	Average	Corrected Average
Post Test	Exp 1	37	8,0811	7,887
	Exp 2	37	8,1892	8,424
	Control	38	7,8421	7,802

The table above shows the average points of scientific process skill test obtained by students and the average points free from the pre-test effect. According to corrected SPS points, the most contributing method was applied to Experiment-II group ($\bar{x}$= 8,424). On the other hand, the least contributing method was applied to control group ($\bar{x}$= 7,802).

Findings of ANCOVA test performed to test the significance difference between corrected SPS post-test points of groups are shown on Table 9.

Table 9. Findings of ANCOVA Test of Corrected SPS Post Test Points According to Groups

	Source of Variance	Sum of squares	dv.	Mean of Squares	F	p
Post Test	Pre test	145,313	1	145,313	29,713	,000
	Group	8,302	2	4,151	,849	,431
	Bias	528,172	108	4,890		
	Corrected Sum	675,857	111			

In terms of findings, there is an insignificant difference between the average of SPS post-test points which is corrected according to the groups' pre-test points ($F_{(2-108)}$= ,849, p<,05). Consequently, the methods used for students were ineffective in their scientific process skills.

Discussion, Conclusion and Recommendations

The effect of argumentation-flipped learning model on students' scientific process and achievements skills were determined in the current study.

In the research, findings of concept test were examined. There is insignificant difference among the average of corrected post-test achievement points according to experiment-I (ABFTM), experiment-II (FTM), and control groups' pre-test points. It means that there is an insignificant difference between the effects of methods applied to the groups and students' academic achievements.

The effect of the method used on learning was usually evaluated with students' academic achievement. Thus, in their study, Demirer & Aydın (2017) focused on flipped class model; examined 29 theses and 61 articles from various databases; and reviewed them with content analyze method. They determined that academic achievement variable was the most handled. They also found out that the variable of academic achievement was measured in 34 studies while there was no change in academic achievement in 12 of them. In the study with high school students, Marlowe (2012) concluded that end-of- term achievement increased, but there is an insignificant difference in academic success. Similarly, in the literature, there are some studies comparing FTM and traditional method showing that there is an insignificant difference between experiment and control groups according to the variable of academic success (Cabı, 2018; Clark, 2013; Findlay-Thompson & Mombourquette, 2014; Fraga & Harmon, 2014; Jensen et al., 2015; Smallhorn, 2017; Yavuz, 2016;). There was no difference in the academic success variable between the experimental and control groups in this study. It might also be due to the different readiness levels of each student when they attend to the classroom. Time spent at home in the flipping process is also important. Students are expected to follow the education portal used in this process at home. Whether the student follows the training portal will also make a difference in participating in classroom activities.

On the other hand, there are some studies showing that FTM increases academic achievement. Some studies carried out with undergraduate students (Göğebakan-Yıldız, Kıyıcı & Altıntaş, 2016; Karaca, 2016; Sharma, Lau, Doherty & Harbutt, 2015; Turan, 2015), high school students (Bhagat, Cheng-Nan & Chun-Yen, 2016; Fulton, 2012) and secondary school students (Akgün, Atıcı, 2017; Çakır & Yaman, 2018; Öztürk & Alper, 2019; Sezer, 2015) present that FTM increases the academic achievement. When we examine the studies offering that FTM increases academic achievement, it's noteworthy that they generally use undergraduate students as a sample. Related studies conducted with content analysis by Demirer & Aydın (2017) and Öztürk (2016) show that the most preferred sample is graduate students and teachers, then high and secondary school students follow in order. In the studies examined, the reasons for the preference of undergraduate students were their being better at using technology than other age groups, their capability to access extra-curricular activities to learn the course content, and their ability to take responsibility for self-learning. Similarly, Sakar & Uluçınar-Sağır (2017) stated that the model could be mostly applied to level of undergraduate students. From this perspective, FTM is more effective for the older age groups who can use the technology easier and fast, can solve the possible problems that are faced, and can fulfill the requirements of flipped classroom model when they come to the classroom and participate classroom activities than children. For this reason, 5th grade students may not be able to fulfill the requirements of the flipped learning process. They may feel alone in solving the problems they encounter in the process. The possible reasons are that students may not be able to focus adequately on classroom activities, use the technology sufficiently, and solve possible problems instantly while following the "Okulistik" Education Portal as well as having inadequate background when they attend the classrooms.

The literature shows that the use of the argumentation-based method increases academic achievement compared to current teaching methods (Akbaş, Şahin & Meral, 2019; Aslan, 2019; Ceylan, 2010; Demirbağ & Günel, 2014; Gülen & Yaman, 2019; Işıker & İrfan, 2021; Karakuş & Yalçın, 2016; Ulu & Bayram, 2015; Yılmaz-Özcan & Tabak, 2019). In contrast, in his study conducted with 35 8th grade students and with activities based on argumentation in the Force and Motion unit, Demirel (2015) found that argumentation did not make a significant difference in students' academic success. Bağ & Çalık (2017) examined 82 studies at the primary education level in their thematic content analysis for argumentation studies. Among these studies, they demonstrated the effectiveness of the intervention in the argumentation process 45 out of 50 studies had positive effects, 3 of them had a neutral and 2 of them had a negative effect.

The highest permanence achieved in our study is from the group within the academic achievement variable, in which the argumentation-based flipped teaching method is used. İnam and Güven (2019) examined 25 theses in their meta-synthesis study in which they analyzed experimental studies using the argumentation method. Only one of these theses reported that the retention test was effective. This may be because determining variables such as academic achievement, attitude, and conceptual understanding are more preferable by researchers.

There was an insignificant difference between the mean scores of the post-test scientific process skills test, which were corrected according to the pre-test scores of the groups. For this reason, the argumentation-flipped learning model applied to the group has no effect on students' SPS.

In the literature, no study has been witnessed examining the effects of FTM on SPS. On the contrary, it is remarkable that many studies have been conducted to find out the effects of argumentation on skills in science education. SPS takes the first place among these skills. Although there is no significant difference among the groups in terms of scientific process skills in our study, it is seen that the Argumentation method is effective in gaining SPS in studies conducted with different groups in the literature (Aslan, 2016; Çetinkaya & Taşar, 2018; Demircioğlu & Uçar, 2015; Işıker & İrfan, 2021; Kabataş-Memiş, 2017; Lin et al., 2018; Ping, Halim, Osman, 2019).

In the classroom argumentation practices, students' participation in the scientific discussion process is influenced by individual characteristics such as their prior knowledge, age, gender, motivation, as well as various environmental factors such as class size and time constraints (Evagorou & Osborne, 2009; Karaer, Karademir & Tezel, 2019; Zohar & Nemet, 2002). It is also stated that although some students have cognitive skills that can form arguments in the classroom, they do not tend to display these skills in the classroom (Perkins, et al., 1993). Students' participation in argumentation-based activities can also be affected by their self-expression skills, that is, their communication skills. By creating a classroom environment where they can express themselves comfortably, students can adapt to the method more easily.

Inverted classes have advantages as well as disadvantages. These disadvantages can be listed as follows: students do not have an equal chance in technological equipment; they need a strong internet connection; home conditions are not the same; there are too many stimulants to distract their attention in the work environment; following the students to watch videos and their level of learning is difficult to control; instant feedback is not taken from students; developing false learning will create a basis for misconceptions; and there are differences in motivation and difficulty of students whose individual learning ability is not developed. Learning in Flipped Classes have some disadvantages as well as advantages. These disadvantages can be listed as follows: not having an equal chance to have technological materials-tools; to need a powerful internet connection as well as computer; the loss of interest because of lack of obligation of attendance to the course; different home conditions and factors that distracting students' attention; the difficulty to control whether students watch the videos and learn the subject; the difficulty in getting an immediate feedback; and differences in each student's motivation and individual learning. It is stated that the basis of FTM is computer technologies and internet network, and the necessary infrastructure should be prepared in homes and classrooms for the student to benefit from this teaching method (Bolat, 2016).

Bishop & Verleger (2013) draw attention to the same point: there must be a careful preparation for the theoretical frame to design the classroom activities correctly. Similarly, in their study held with secondary school students, Lo, Lie & Hew (2017) stated that flipped classes and non-flipped classes are not adequately compared.

Gençer (2015) states the difficulties for integration of Flipped model into the Turkish education system. Difficulties about students can be listed as follow: it is difficult to break his idea for the student who works on the last day of the lessons and only has the idea of passing the lesson; it is difficult for the students to control the attendance of the lessons through the distance learning system; and there are too many factors at home to distract the student.

Many studies about the students' views of FTM show that students liked the method and found it interesting. In their study with primary school 4th grade students, Kahramanoğlu and Şenel (2018) identified that the students found the flipped classroom practices in English class different and fun. Söğüt and Polat (2020) inferred from students' opinions that the flipped classroom model, which they used in teaching the active citizenship learning area in the 5th grade social studies course, was beneficial and increased the interest in the lesson. In their study, Çelik and Soft (2021) stated that they thought that the 10th grade education of the Flipped Classroom Model was generally positive about the model. Besides these positive views, the major negative views that students have can be listed as follows: they are sorry about watching lessons at home prior to lesson; the videos take long time; and they can't get immediate feedback. These opinions of students are an essential issue that needs to be solved (Turan & Göktaş, 2015). These issues that restrict students' learning may affect the student's participation in the process by reducing the operability and effectiveness of argumentation-flipped learning model applied in science lessons in our study.

The sample of our study involves of 5th grade students. FTM requires students to study and learn the course content themselves at home. Situations such as the fact that students in this age group are not aware of their responsibility of watching the course content at home may have caused to the reduce the effectiveness of the Argumentation method. Using the FTM and Argumentation method in younger age groups will make them more conscious about this issue in the upper classes.

In the Science Curriculum, it is foreseen that the courses will be conducted by using of various learning environments such as argumentation-based learning that puts the student at the center in raising students as science literate (MoNE, 2018). For this reason, it is thought that the inclusion of the Argumentation method in the science lesson gradually from an early age will offer a basis for students to learn and internalize the scientific discussion process. It is also thought that more permanent learning experiences will be formed by using them with different methods. Moreover, there may not be a significant difference between the groups because the method applied in the experimental groups is similar to the science curriculum.

Students' prior knowledge is an important cognitive feature that affects their achievements in science and lays the groundwork for scientific reasoning (Chandran et al., 1987; Reynolds & Walberg, 1992). The students' inability to fully grasp the content of the subject they learned at home for the first time and thus participating in classroom practices with insufficient prior knowledge may have weakened the effectiveness of the argumentation method. This situation can be said to be one of the reasons why there was no positive change in students' academic achievements and scientific process skills.

In the light of the research results, the suggestions are listed as follows:

- In flipped learning, games should be added to content interactive lectures and content video lectures in educational portals studies especially for younger age groups. Thus, fun learning environments can be created, and the student can follow courses with pleasure.
- Online education portals and activities with collaborative scenario-based content that can improve children's argumentation skills should be included.
- It is recommended that the duration of the videos to be used especially for younger age groups should be short.
- Therefore, the guidance of parents can make the method more effective and efficient for the process at home especially for little age groups.
- In the education portal the teacher used in the process of FTM, the teacher should be able to keep track of which activities the student has completed.
- Current curricula in Education Faculties should be revised in a way that pre-service teachers have both theoretical and practical skills of Argumentation and Flipped learning methods.
- Teaching faculty members of education faculty using Argumentation and Flipped learning methods while teaching their own lesson and being a role model for prospective teachers in this sense.
- Providing supportive and encouraging in-service courses for teachers to use flipped and argumentation methods in their classrooms.
- Considering students! prior knowledge in classes where argumentation-based inverted method will be applied.
- To make effective learning processes of the FTM, it is necessary to provide technical equipment and infrastructure in a standard way so that teachers and students can access the system without interruption.
- It is recommended to conduct studies on different subjects at different grade levels with ABFTM.

Note

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