THE LABORATORY IMPLICATIONS BASED ON ARGUMENTATION OF PRE-SERVICE SCIENCE TEACHERS

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Abstract: The purpose of current study is to determine the effect of laboratory implications based on argumentation on the pre-service science teachers' logical thinking abilities and critical thinking tendencies. The sample group of the study consists of a total of 64 pre-service teachers (32 for the experimental group, 32 for the control group) who are in their fourth year in the Science Education Program at a state university. The pre-test/ post-test control group experimental design model was used that current research. In the experimental group, the experiments were conducted using worksheets based on argumentation, whereas in the control group the experiments were conducted in the form of a close-ended experiment. In this quasi-experimental designed research, the "Logical Thinking Abilities Test" and "The California Critical Thinking Disposition Inventory" were used as data collection tools. As a result of this study, it was found that the logical thinking ability and critical thinking tendency levels of the experimental group were higher than those of the control group. Accordingly, it can be argued that laboratory activities conducted with argumentation-based worksheets are more effective than laboratory activities conducted with the use of close-ended experiment in terms of developing logical thinking abilities and critical thinking tendencies on the part of pre-service science teachers.

Keywords: Pre-service science teachers, argumentation, science laboratory implications

Introduction

As is known, it is vital to design a learning environment based on research-inquiry in order to provide students with permanent learning. In a leaning environment based on research and inquiry, students ask questions, formulate arguments and structure information by supporting their arguments with proofs (Günel, Kıngır and Geban, 2012). The teacher helps students to develop their high level cognitive skills such as analysis, synthesis and evaluation by providing a suitable environment in which students can make scientific debates (Duschl and Osborne, 2002). In the study they carried out to support the use of argumentation teaching by teachers in a scientific context, Simon, Erduran and Osborne (2006) stated that motivating students for the process and occupational development of the teachers might have an impact on the quality of argumentation. Specifically, scientific debates have recently become a notable practice (Driver, Newton and Osborne, 2000). One of the reasons for this is that students can carry out studies which are similar to those of scientists and have the opportunity to structure information in the way scientists do in the teaching environments in which scientific debate strategies are used (Brown, Collins and Duguid, 1989). In addition, the fact that students think about the link between the argument that is formulated during scientific debates and the proof put forward to support this argument will improve their abilities of critical thinking (Erduran, Ardaç and Güzel, 2006). As a result, the students will have the opportunity not only to learn scientific concepts but also to appreciate the nature of science (Driver et al., 2000). With this in mind, Keys, Hand, Prain and Collins (1999) devised the approach of learning science based on argumentation as a learning and teaching approach based on written and oral argumentation which allows students to experience the processes that scientists go through while solving real-life problems they face and which provides the students with the opportunity to structure information during this process in science classes. There are various definitions as to what an argument means. Toulmin (1958) defines argument as an assertion and demonstrating its validity. Driver et al. (2000), on the other hand, defines argument as an individual or a group activity, a social activity done through thought or writing. While argument defines as claims, data, grounds and the backings contributing to an idea, argumentation signifies compiling these constituents (Simon, Osborne and Erduran, 2003). It is striking that Toulmin model is frequently used in the studies conducted in recent years. Toulmin model is comprised of six elements. While data, claims and grounds are the main elements of an argument, backing, qualifiers and rebuttals are auxiliary elements. In Toulmin's model, grounds verify the course from the data to the result, whereas the backings are assumptions that demonstrate the validity of grounds (Jimenez-Aleixandre and Pereiro-Munoz, 2002). The main structure of this model has been formulated as because (data) is…… in terms of ……. (grounds), then ……. (backing); therefore, ……. (result). Zohar and Nemet (2002) expressed that argumentation plays an

important part in science education in that it encourages scientific thinking and development of a qualified conceptual understanding in students. Teaching argumentation skills in science classes as a way of developing reasoning skills has been a focal point of studies on science education that adopt argumentation (Acar, 2008).

Numerous studies conducted in the field of science education conclude that integration of argumentation into the education and training environments may benefit students in many respects (Berland & Reiser, 2011; Sampson & Clark, 2011). In the study carried out by Çetin, Kutluca and Kaya (2013), it was concluded that, at the end of the process, there is an increase in the quality of the argumentation performed by the students involved in the process of argumentation as compared with the beginning of the process. Also, the researchers stated that students can formulate more quality arguments and can learn science concepts more effectively thanks to the science classes based on argumentation. Especially, the presentation of argumentation in combination with laboratory is invaluable with regard to science education. In this way, students will both have the opportunity to put theoretical knowledge into practice in laboratory environment and find the chance to debate their arguments with their friends in their groups. Laboratory practices based on argumentation are a strategy devised by Sampson, Grooms and Walker (2011). In this practice, students try to explain a problem, a phenomenon or an observation by working in small groups. While doing this, they design their own experiment settings, share their results with other groups in a certain format and get feedback from their peers. Groups reassess their views and try to explain different views in the light of feedbacks they get. The students are asked to write any hypothesis/claim in small groups in a laboratory environment and to design an experiment with regard to this and also they are asked to discuss their own designs with other groups (Osborne, Erduran and Simon, 2004). In addition, the groups are expected to prepare reports while sharing their results. Moreover, the students get the chance to be evaluated by their teachers/instructors or their peers by being observed during the process. During evaluation, how students form arguments such as claim, data, backing (qualifier), grounds (proofs), limiters, rebuttals (exceptions) is of importance. In such practices, there are also some reasoning activities in which students express especially how the proofs and the explanation are connected. When the body of literature is examined, we come across studies with regard to argumentation based laboratory practices (Demircioğlu, 2008). Demircioğlu (2011) carried out a study to examine the effect of laboratory education based on the approach of "Argument Based Inquiry" during "General Physics Laboratory III" classes on the academic success of pre-service science and technology teachers, their tendencies towards discussion, scientific process skills and their level of argumentation. The study concluded that laboratory education based on the approach of "Argument Based Inquiry" increases the academic success and scientific process skills of pre-service science and technology teachers as compared to traditional classes, but it doesn't provide any change as to their tendency towards discussion. During the implementation of the study, the quality of argumentation was seen to increase in the reports of the students in the experimental group, while the quality of argumentation does not change in the reports of the students in the control group.

When the body of literature especially in our country (in Turkey) is examined, we see that the positive effects of argumentation based practices on high level mental skills (such as scientific process skills, critical thinking skills, logical thinking skills etc.) are mentioned and the studies scrutinizing these skills (Aydın and Kaptan, 2014; Çınar, 2013; Demiral, 2014; Gültepe, 2011, Koçak, 2014; Şahin, 2016; Tonus, 2012; Tümay, 2008) stand out. However, a study that deals with the development of critical thinking disposition and logical thinking skills which lead to the development of the skills in students mentioned above through argumentation based learning practices does not exist. With this in mind, we aim to study the effects of argumentation based laboratory practices on the logical thinking skills and critical thinking disposition of pre-service science teachers. To this end, we have formulated two hypotheses and tested these hypotheses. These hypotheses are as such:

1. There is a significant difference between the logical thinking skills of the pre-service teachers in the experimental group to whom argumentation based laboratory practices were applied and that of the pre-service teachers in the control group to whom close-ended experiments were applied and the difference is in favour of the experimental group.
2. There is a significant difference between the critical thinking disposition of the pre-service teachers in the experimental group to whom argumentation based laboratory practices were applied and that of the pre-service teachers in the control group to whom close-ended experiments were applied and the difference is in favour of the experimental group.

Method

In this study, a quasi-experimental design with a pre-test post-test control group was used. The experimental design classified as test model is a quantitative research model "which is directly controlled by the researchers and in which the desired data are produced with the aim of identifying cause-effect relationships" (Karasar, 2011).

In experimental studies, terms such as participants or study group are preferred instead of population and sample because the aim of experimental studies is to demonstrate the circumstances that are studied rather than generalize (Sönmez, 2005). Within this context, the term of study group was preferred in this study rather than population-sample. The study group of this study is comprised of the students who are attending the Department of Science Teaching for Elementary Schools in the Faculty of Education in Afyon Kocatepe University during the spring semester of the 2015-2016 academic year. The study group is made up of 64 pre-service teachers in their senior year (4th year) who are either in experimental group or in control group.

Data Collection Tools:
"Logical Thinking Ability Test (LTAT)" and "California Critical Thinking Disposition Inventory (CCTDI)" have been used in this study as data collection tools.

"Logical Thinking Ability Test (LTAT)" was devised by Tobin and Capie (1981) and was adapted to Turkish by Geban, Aşkar and Özkan (1992). The test consists of 10 questions, 8 of which are multiple-choice questions, which measure the abilities of defining and controlling variables, calculating probability, developing relations and using ratio. The first 8 multiple-choice questions each have one correct answer and an explanation that leads to this correct answer. In order for the answer to be rendered correct, both the answer and the explanation must be correct. The last two questions which are not multiple-choice ones certain probabilities must be stated in full. The highest point one can get on this test is 10. The reliability of the test is 0.81. In this study, it has been found out that the KR-20 coefficient obtained in the pre-test results of LTAT is 0.61.

"California Critical Thinking Disposition Inventory (CCTDI)" was originally formulated by Facione, Facione and Giancarlo in 1998 as a Likert-type scale comprised of 75 items. The validity and reliability studies of the scale in its translated form into Turkish were conducted by Kökdemir (2003). It was noted that the structure of factors that constitute CCTDI which was reduced to 51 items are not very different from its original form, that some items were moved between factors and that two factors were combined into one. The scale is comprised of 51 items and 6 sub-scales in total (Truth-seeking, Open-mindedness, Analyticity, Systematicity, Self-confidence, Inquisitiveness). "Analyticity" of these sub-scales expresses watching out for situations which tend to be problematic, logical thinking in tough problems and using objective evidence. "Open-mindedness" signifies an individual's being tolerant of different approaches, his/her taking others' views and ideas into consideration while making decision and be mindful of his/her own mistakes. "Inquisitiveness" means an individual's disposition to obtain information and to learn new things without expecting any gain from this. "Self-confidence" refers to the confidence a person has in his/her own logical thinking processes. "Truth-seeking" measures the disposition to evaluate different ideas. "Systematicity" refers to the disposition to use a decision-making strategy based on information and that follows a specific method; in other words disposition to making research in an organised, planned and careful manner. This new form of CCTDI has an internal consistency reliability of 0.88 and the total variance that the scale explains is 36,13. The internal consistency coefficient of CCTDI used in this study has been found to be 0.85.

The Implementation Process
The participants in the study group are made up of two groups, one experimental group (n=32) and one control group (n=32). Before the implementation process, "Logical Thinking Ability Test (LTAT)" and "California Critical Thinking Disposition Inventory (CCTDI)" were applied to both groups as a pre-test. During the implementation process, worksheets based on argumentation were used in the laboratory activities of the experimental group, while close-ended experiment techniques were used in the laboratory activities of the control group. While preparing the worksheets based on argumentation, experiments that would attract students' attention were especially chosen. 8 activities were made during the implementation process. When the process was completed, "Logical Thinking Ability Test (LTAT)" and "California Critical Thinking Disposition Inventory (CCTDI)" were applied this time as a post-test.

Analysis of the Data
The data obtained was analysed with the help of statistics packet program in order to compare the results of the pre-test and the post-test. Independent sample t-test was used to determine the differences between the post-test scores of the pre-service teachers which was aimed at identifying the logical thinking abilities of the pre-service teachers in the experimental group and the control group. Similarly, independent sample t-test was used to determine the differences between the post-test scores with regard to the critical thinking disposition of the pre-service teachers in the experimental group and the control group.

Findings

In this section, we have examined whether there are significant differences in the logical thinking ability and critical thinking disposition between the experimental group in which open-end argumentation based laboratory applications were used and the control group in which close-ended experiment technique was used and the results have demonstrated in tables in detail. It has been found out that the data obtained from LTAT and CCTDI scales has a normal distribution. Therefore, unrelated samples t-test and related samples t-test were used in the analysis of the data.

Table 1 shows the independent samples t-test results regarding the pre-test scores that the students in the experimental group and the control group got on LTAT.

Table 1. Independent samples t-test results of the pre-test scores that the students in the experimental group and the control group got on LTAT.

Test	Groups	N	Mean	SD	t	P
LTAT	Experimental (Pre-test)	32	6.59	1.68	-0.483	0.631
	Control (Pre-test)	32	6.84	2.39		

When we examine Table 1, we can note that there isn't a statistically significant difference between the LTAT pre-test scores of the students in the experimental group and the control group.

Table 2 shows the independent samples t-test results regarding the pre-test scores that the students in the experimental group and the control group got on CCTDI.

Table 2. Independent samples t-test results of the pre-test scores that the students in the experimental group and the control group got on CCTDI.

CCTDI sub-scales	Groups	N	Mean	SD	t	P
Analyticity	Experimental (Pre-test)	32	57.84	6.37		
	Control (Pre-test)	32	59.56	6.65	-1.06	0.295
Open-Mindedness	Experimental (Pre-test)	32	46.78	8.55		
	Control (Pre-test)	32	47.71	6.85	-0484	0.630
Inquisitiveness	Experimental (Pre-test)	32	38.75	6.26		
	Control (Pre-test)	32	41.28	4.33	-1.879	0.065
Self-Confidence	Experimental (Pre-test)	32	24.78	4.75		
	Control (Pre-test)	32	26.37	5.24	-1.275	0.207
Truth-Seeking	Experimental (Pre-test)	32	25.43	4.55		
	Control (Pre-test)	32	25.81	4.46	-0.332	0.741
Systematicity	Experimental (Pre-test)	32	26.53	3.12		
	Control (Pre-test)	32	25.68	4.47	-0.875	0.385
CCTDI	Experimental (Pre-test)	32	220.12	20.91		
	Control (Pre-test)	32	226.43	17.27	-1.316	0.193

When we examine Table 2, we can see that there aren't any statistically significant differences between the pre-test scores of the students in the experimental group and the control group with regard to the sub-scales of CCTDI and the overall scale.

Table 3 demonstrates the paired samples t-test results in terms of the pre-test post-test scores on LTAT of the students in the experimental group.

Table 3. Paired samples t-tests results in terms of the pre-test and post-test scores on LTAT of the students in the experimental group.

Test	Groups	N	Mean	SD	t	P
LTAT	Experimental (Pre-test)	32	6.59	1.68	-1.180	0.247
	Experimental (Post-test)	32	7.09	1.51		

When we examine Table 3, we see that there aren't any statistically significant differences between the pre-test and the post-test scores that the students in the experimental group obtained on LTAT.

Table 4 shows the paired samples t-test results with regard to the pre-test scores that the students in the experimental group obtained in CCTDI.

Table 4. Paired samples t-test results with regard to the pre-test scores that the students in the experimental group obtained on CCTDI

CCTDI sub-scales	Groups	N	Mean	SD	t	P
Analyticity	Experimental (Pre-test)	32	57.84	6.37	-1.884	0.069
	Experimental (Post-test)	32	60.28	5.97		
Open-Mindedness	Experimental (Pre-test)	32	46.78	8.55	-0.299	0.767
	Experimental (Post-test)	32	47.25	5.58		
Inquisitiveness	Experimental (Pre-test)	32	38.75	6.26	-3.303	0.002*
	Experimental (Post-test)	32	43.84	5.91		
Self-Confidence	Experimental (Pre-test)	32	24.78	4.75	-2.266	0.031*
	Experimental (Post-test)	32	27.15	3.42		
Truth-Seeking	Experimental (Pre-test)	32	25.43	4.55	-0.422	0.676
	Experimental (Post-test)	32	26.00	5.70		
Systematicity	Experimental (Pre-test)	32	26.53	3.12	-0.918	0.366
	Experimental (Post-test)	32	27.46	3.94		
CCTDI	Experimental (Pre-test)	32	220.12	20.91	-2.868	0.007*
	Experimental (Post-test)	32	232.00	17.81		

*p<0.05

When we examine Table 4, we can see that there are statistically significant differences in favour of the post-tests between the pre-test and post-test scores of the students in the experimental group in the "Inquisitiveness" and the "Self-confidence" sub-scales of CCTDI and in the overall scale.

Table 5 shows the paired samples t-test results regarding the pre-test and post-test scores that the students in the control group got on LTAT.

Table 5. Paired samples t-test results regarding the pre-test and post-test scores that the students in the control group obtained on LTAT

Test	Groups	N	Mean	SD	t	P
LTAT	Control(Pre-test)	32	6.84	2.39	-.158	.876
	Control(Post-test)	32	6.93	1.79		

When we examine Table 5, we can see that there aren't any statistically significant differences between the pre-test and the post-test scores that the control group students obtained on LTAT.

Table 6 exhibits the paired samples t-test results regarding the pre-test and the post-test scores that the control group students obtained on CCTDI.

Table 6. Paired samples t-test results regarding the pre-test and the post-test scores that the control group students obtained on CCTDI

CCTDI sub-scales	Groups	N	Mean	SD	t	P
Analyticity	Control (Pre-test)	32	59.56	6.65	-0.174	0.863
	Control (Post-test)	32	59.71	4.26		
Open-Mindedness	Control (Pre-test)	32	47.71	6.85	-0.575	0.569
	Control (Post-test)	32	48.62	5.64		
Inquisitiveness	Control (Pre-test)	32	41.28	4.33	-0.860	0.396
	Control (Post-test)	32	42.40	6.45		
Self-Confidence	Control (Pre-test)	32	26.37	5.24	-0.173	0.864
	Control (Post-test)	32	26.56	2.92		
Truth-Seeking	Control (Pre-test)	32	25.81	4.46	-0.595	0.556
	Control (Post-test)	32	26.50	5.21		
Systematicity	Control (Pre-test)	32	25.68	4.47	-1.679	0.103
	Control (Post-test)	32	27.59	4.19		
CCTDI	Control (Pre-test)	32	226.43	17.27	-1.926	0.063
	Control (Post-test)	32	231.40	16.82		

When we examine Table 6, we see that there aren't any statistically significant differences between the pre-test and the post-test scores that the students in the control group obtained in the sub-scales of CCTDI and the overall scale.

Table 7 shows the independent samples t-test results regarding the post-test scores that the students in both the experimental group and the test-group obtained on LTAT.

Table 7. Independent samples t-test results regarding the post-test scores that the students in both the experimental group and the test-group obtained on LTAT

Test	Groups	N	Mean	SD	t	P
LTAT	Experimental (Post-test)	32	7.09	1.51	0.377	0.708
	Control (Post-test)	32	6.93	1.79		

When we examine Table 7, we can see that there aren't any statistically significant differences between the scores that the students in the experimental group and the control group obtained on LTAT.

Table 8 shows the independent samples t-test results regarding the post-test scores that the students in the experimental group and the control group obtained on CCTDI.

Table 8. Independent samples t-test results regarding the post-test scores that the students in the experimental group and the control group obtained on CCTDI

CCTDI sub-scales	Groups	N	Mean	SD	t	P
Analyticity	Experimental (Post-test)	32	60.28	5.97	0.433	0.666
	Control (Post-test)	32	59.71	4.26		
Open-Mindedness	Experimental (Post-test)	32	47.25	5.58	-0.979	0.331
	Control (Post-test)	32	48.62	5.64		
Inquisitiveness	Experimental (Post-test)	32	43.84	5.91	0.929	0.357
	Control (Post-test)	32	42.40	6.45		
Self-Confidence	Experimental (Post-test)	32	27.15	3.42	0.745	0.459
	Control (Post-test)	32	26.56	2.92		
Truth-Seeking	Experimental (Post-test)	32	26.00	5.70	-0.366	0.716
	Control (Post-test)	32	26.50	5.21		
Systematicity	Experimental (Post-test)	32	27.46	3.94	-0.123	0.903
	Control (Post-test)	32	27.59	4.19		
CCTDI	Experimental (Post-test)	32	232.00	17.81	0.137	0.891
	Control (Post-test)	32	231.40	16.82		

When we examine Table 8, there aren't any statistically significant differences between the post-test scores that the students in the experimental group and the control group obtained in the sub-scales of CCTDI and on the overall scale.

Conclusion

This study aims to identify the effects of argumentation based laboratory practices on the logical thinking ability and the critical thinking disposition of pre-service science teachers. In parallel with this aim, implementation process was conducted on the 64 pre-service teachers who are attending the Department of Science Teaching in this study in which quasi-experimental design with a pre-test and post-test control group was used. Before the implementation process, "Logical Thinking Ability Test (LTAT)" and "California Critical Thinking Disposition Inventory (CCTDI)" were applied to both groups as a pre-test. As a result of the analyses conducted, it was found out that there wasn't a statistically significant difference in the pre-test scores that the students in the experimental group and the control group obtained on LTAT. Similarly, it was observed that there aren't any statistically significant differences between the pre-test scores that the students in the experimental group and the control group obtained on the sub-scales of CCTDI and the overall scale. In the study which was carried out with 32 pre-service teachers in each of the experimental group and the control group, close endedf experimental techniques were used in the laboratory activities of the control group, while argumentation based worksheets were used in the laboratory activities of the experimental group. At the end of the 8-week long implementation process, measuring tools were used as post-test. It was found out that there isn't a statistically significant difference in the pre-test and pot-test scores that the students in the control group obtained on LTAT, the sub-scales of CCTDI and overall CCTDI. Likewise, it was seen that there isn't a statistically significant difference in the pre-test and the post-test scores that the students in the experimental group obtained on LTAT. On the other hand, it was observed that there are statistically significant differences between the pre-test and post-test scores that the students in the experimental group obtained on the "Inquisitiveness and "Self-Confidence" sub-scales of CCDTI and the overall scale and the differences are in favour of the post-tests. When the post-test scores that the students in the experimental group and the control group obtained on LTAT and the sub-scales of CCDTI and overall CCDTI were compared, it was also observed that there aren't any statistically significant differences between the scores.

A significant difference in logical thinking ability of the students in the experimental group and the control group did not emerge as a result of the argumentation based laboratory activities. It can be assumed that this outcome arose because the 8-week implementation process was not enough. This is because argumentation based laboratory practices are not what students are accustomed to. When we take the fact that close-ended experiments or open-end experiments without argumentation are conducted in laboratory classes into consideration, it is true that it will take pre-service teachers to get used to this new practice. When the body of literature is studied, we can see that logical thinking skills are dealt with rather than logical thinking ability in the studies carried out with regard to argumentation. For instance, the study conducted by Aydın and Kaptan (2010) concludes that while the logical thinking skills of the pre-service teachers aren't significantly affected in classes in which the argumentation is readily presented, the logical thinking skills of the pre-service teachers are significantly affected in the group that had an argumentation based class.

We have concluded that there isn't a statistically significant difference between the post-test scores that the students in the experimental group and the control group obtained on the sub-scales of CCTDI and the overall scale. This conclusion we have made corresponds to the conclusion that there isn't a statistically significant difference in the critical thinking disposition between the post-test scores of the students in the experimental group and the control group which was drawn in a study titled the effects of argumentation based science learning on the success of the pre-service teachers in the subject of solutions and their critical thinking disposition conducted by Koçak (2014). Similarly, the study carried out by Qing, Jing, Yazhuan, Ting and Junping, (2010) demonstrates that a statistically significant difference between the average scores that the experimental and the control group students obtained with regard to their critical thinking disposition does not exist. We can see that, among the studies that deal with the argumentation based learning approach, there are also studies that examine the effects on critical thinking skills apart from critical thinking disposition. One such study is the experimental study that Çınar (2013) carried out argumentation based science teaching for 5th graders. This study also concluded that there isn't s significant difference between the experimental group and the control group students with regard to the development of their critical thinking skills.

Although there isn't a significant difference between the experimental group and the control group in this study, a significant difference in the critical thinking disposition of the students in the experimental group emerged at the end of the process of argumentation based laboratory activities. Especially, the strikingly significant difference in the Inquisitiveness and Self-confidence makes us think that argumentation based laboratory practices attract the attention of the pre-service teachers and that it helps them gain self-confidence over time. When we study the body

of literature, we see that the studies dealing with argumentation practices focus on critical thinking skills rather than critical thinking disposition. Within this context, we can cite the study conducted by Eirexas and Jiménez Aleixandre (2007) as an example to this in that it deals with skills rather than disposition. In the study mentioned above, students were encouraged to put forward their arguments in written and oral debates and its was observed that the critical thinking skills of students improved thanks to these debates at the end of the implementation process. In parallel with this, Tümay (2008) conducted the study in "Chemistry Teaching with a Focus on Argumentation" classes which aimed to examine the growing understanding of argumentation in science and science education that pre-service chemistry teachers have. At the end of the implementation process, it was concluded that teaching with a focus on argumentation is an effective way of improving the thinking skills of pre-service teachers. In a study conducted by Gültepe (2011), it emerged that the teaching approach based on scientific discussion is more effective than traditional teaching approach in improving critical thinking skills of students. Tonus (2012) found out that there is a significant difference between the pre-test and the post-test measuring critical thinking skills of the students after the argumentation process. In the study in which Şahin (2016) examined the effects of Argumentation Based Science Learning approach (ABSL) on the academic success, metacognition and critical thinking skills of gifted students, it was found out that there is a statistically significant difference in favour of the experimental group when the results of critical thinking skills tests were compared. The results obtained from these studies have parallels with each other.

In this study, logical thinking ability test and critical thinking disposition inventory were used with a view to identifying the effects of the argumentation based laboratory activities of pre-service teachers on high level thinking. In other studies to be carried out in the future, logical thinking skills and critical thinking skills tests directly aimed at skills rather than ability or disposition could be used. This study was carried out for a period of 8 weeks. In order to better identify the effects of argumentation based laboratory practices, longer-termed studies spanning a whole academic year could be conducted. Quantitative research method was used in this study. Mixed method studies could be designed in future studies to be conducted by integrating qualitative aspects.

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