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THE EFFECT OF "ARGUMENT-BASED SCIENCE INQUIRY" APPROACH ON SCIENCE TEACHER CANDIDATES' ACADEMIC ACHIEVEMENTS

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Abstract

Science education, when it is dealt with in terms of subject, activities and target behaviours, is an open area to inquiry and development. However, this case is interpreted from a different point of view in a lot of educational institutions in our country (Turkey). The aim of this study is to evaluate the effect of "Argument-Based Science Inquiry (ABSI)" approach on the academic achievements of 3rd grade Science Education teacher candidates by applying this approach to the activities and establishing a suitable educational environment, and to reveal their thoughts about it. Mixed methods research has been used in this paper. In the quantitative dimension of the research, a pre-test post-test control group experimental design has been used. At the end of the implementation process, an achievement test has been applied to both groups, and results have been analyzed statistically. The results have shown that there is a statistically significant difference between the pre-test and post-test results of experimental group, and ABSI approach has a positive effect on student success. In the qualitative dimension of the study, semi-structured interviews have been used with the experimental group's teacher candidates. Data have been analyzed through content analysis method. In accordance with all findings, it is deduced that the ABSI activities affect the academic achievement of teacher candidates more positively than the classical laboratory practices in Laboratory Practices II class.

Keywords: argument-based science inquiry, science laboratory activities, science education, academic success.

1. Introduction

Today, the world order constantly changes and evolves, and this status brings an adaptation process along with it. As a result, the idea of bringing up individuals, who adapt to this process, gains importance. Also, in today's technological era, there is an increase in the number of innovations in many areas of our life, and there is a boost in scientific data. In line with this change, the contents of countries' targets and expectations also differ. Today, the target of education system is not to have individuals memorizing the knowledge, but to raise characters that have thinking skills and that can produce, construct, search and criticize the knowledge. Current education policies are prepared in line with these objectives (Brad, 1994). At this point, the effect of science and technology makes itself apparent, and the effort to increase the quality of science and technology gains importance day by day. Therefore, if the education programs of countries are investigated, it can be seen that in many, science education centered systems that are closely related to the technology, society and environment are preferred.

To be able to understand the progress of this change, we have to investigate the process briefly through time. In that perspective, we can see that the factors, which are like researchers' evaluation of the concept of learning with different perspectives, and their having different previous experiences, have caused different learning theories to emerge (Philips & Soltis, 2004). To research on the topics such as the use of scientific knowledge to solve problems, the investigation of the effect of science on human life, and the effort on what needs to be taught to students to make this knowledge useful in life, has formed the focal point of curriculum changes that have been implemented recently (Brickman, Gormally, Armstrong, & Hallar, 2009; Crawford, 2000). In addition, this has brought forward the subject of the necessity of including student centered approaches as a means of realizing learning in the most successful way (Brickman et al., 2009).

However, in schools, where classical method has been used, the duty of teacher was to give the knowledge directly (Demirel, 2006). In this point of view, science was restricted to the scientific practices and the use of data. In the construction process of knowledge, the importance of students' views was not taken into consideration (Driver, Newton, & Osborne, 2000).

Therefore, in this study, it is claimed that considering the situation, students need some activities, which can eliminate those drawbacks, to let them overcome this. It is also believed that an argument-based Science Education may help to improve this status. In addition, in previous studies, the importance of scientific argumentation has been clearly dwelled on to obtain and systematize scientific knowledge and to develop students' mental activities.

1.1. Scientific Argumentation (Argument-Based Science Inquiry Approach)

Instead of a program that transfers the information directly to the students, a program, which targets to raise individuals that can search, question, transfer what they learn to their life and use scientific method to solve the problems they encounter, is preferred. That is the situation in our country's (Turkey) National Education System, as well. It is believed that the only way to make this happen is with research-inquiry based lessons. In addition, to make a student's cognitive activities emerge and to help his/her capacity develop, it becomes evident that the teacher, environment and curriculum need to be in a supportive position (Grandy & Duschl, 2007). Students interested in solving the real scientific problems become active in research-inquiry based science classes (Polman & Pea, 2001). Laboratory practices, which allow students to develop their problem solving, researching and exchanging information skills, make the concept that will be acquired and relations between concepts more effective and consistent (Hofstein & Lunetta, 2004). The main aim of science education includes not only giving scientific concepts but also learning how the way of dealing with "the scientific discourse" should be (Kuhn, 2010). Therefore, it is necessary to emphasize the importance of argument in science education. Argument in science has a significant role in investigating new thoughts to make an idea valid and reliable. In science schools, argument is used as a tool to develop students' understanding of new science contents (Cavagnetto, 2010).

The original name of Argument-Based Science Inquiry, "The Science Writing Heuristic" (SWH) has been adapted into Turkish as "Yaparak Yazarak Bilim Ogrenme Yaklasimi" (YYBO) (Gunel, 2006; Hand & Keys, 1999; Keys, Hand, Prain, & Collins, 1999). Researcher that developed this approach has changed its name as "Argument-Based Science Inquiry" recently (Hand, 2008; Kingir, Geban, & Gunel, 2011). Hand and Keys (1999) have seen ABSI approach as the framework of scientific argument in science classes and have developed it as a tool to take this forward.

This approach takes its roots from constructivism, and it is based on the processes, which give importance to research-inquiry strategies and thinking. Argument-Based Science Inquiry approach has a function of establishing a connection between formal and informal knowledge in science education (Akkus, Gunel, & Hand, 2007). ABSI approach allows students give various explanations and test their hypotheses by giving them the starting questions. In addition, since it establishes a ground for them within the evidences to do discussions against small or big groups, it helps students to understand and interpret science concepts better.

Toulmin, who has analysed argumentation process, addresses argument as backed claims. (Toulmin, 2003). In Toulmin's model, *data*, *claim*, *warrants* and *backing* establish the basic argument structure, however, in more complex arguments, *qualifiers* and *rebuttals* can also be seen (Driver, Newton & Osborne, 2000). While data, claim and warrants are listed as the basic elements to establish an argument, backing, qualifiers and rebuttals are the elements that contribute to the validity of the argument (Kaya & Kilic, 2008).

Studies have shown that in science classes, the applications of Argument-Based Science Inquiry approach were limited (Jimenez-Aleixandre, Rodriguez, & Duschl, 2000; Newton, Driver & Osborne, 1999). When both science education and scientific argument are considered, the factors of scientific research and scientific inquiry can be seen in both structures. This close relationship between the two structures make scientific argument an important and necessary part of science education. As it is mentioned before, studies have shown that scientific argument practices have not been given enough importance in science classes; and when the reasons for that are evaluated, it is seen that there are factors like teachers' not knowing the approach very well, cannot providing a discussion setting, and having difficulties to carry on the discussion, behind it (Driver et al. 2000). Teachers' disciplined rules in the classroom and their approach to students in terms of these rules make it difficult for students to use their reasoning skills, and make it more complicated for them to become active about the topic (Yerrick, 2000).

1.2. The Aim of the Study

In this paper, the main aims are applying the Argument-Based Science Inquiry approach to Science Education Laboratory Practices II class and identifying teacher candidates' views about their success in science laboratory and about the approach at the end of the process. In addition, it is also planned to let them experience a model learning environment, which will serve to the overall objectives of science education. With this study, it is also aimed at promoting a positive attraction for teachers especially on argument method.

1.3. Problem Statement

The problem statement of this study is as follows:

Is there an effect of "Argument-Based Science Inquiry" approach used in Science Education Laboratory Practices II class on Science Education teacher candidates' academic achievements?

With this question in mind, it has been investigated whether there is a statistically significant difference between the means of experimental and control groups' pre-test and post-test scores in terms of using ABSI or traditional method, and also experimental group's participants' views about ABSI have been reviewed.

2. Method

2.1. Design of the Study

In this study, a mixed methods research has been used to identify the effect of ABSI based Science Education on the 3rd grade teacher candidates' academic achievements in the subject of "Electricity" and to define their thoughts about the approach at the end of the process. Mixed methods research is a method that allows data collection, analysis and integration by hypothesizing research problems, which cannot be understood using only quantitative or qualitative research methods but facilitating both of them together (Creswell & Plano-Clark, 2007). Therefore, mixed methods researches can be defined as the combination of quantitative and qualitative methods, approaches and concepts. Researcher may achieve this integration in a single work or in a series of works (Creswell, 2003; Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 1998).

In the research, quantitative methods have formed the base design, and with the inclusion of qualitative dimension, the research has been transformed into an embedded design research. At first, the quantitative data collection phase has been processed and then the qualitative data collection phase has been completed.

Through the process, lessons in both groups have been carried out by the researcher. Researcher has been used ABSI approach in the experimental group and traditional method in the control group. In both groups, at the beginning of the lesson, teacher candidates have been asked some short-answer questions, which have been prepared by the researcher, consisting of the achievements of subject of the lesson to define their readiness levels. The study has been planned as a 16-week process, and in the first eight-week period, the subject "Electricity" has been presented. At the end of the process, teacher candidates' academic achievements in this subject have been evaluated.

A semi-experimental method has been used to collect the quantitative data of the research. Results related to the quantitative data are shown by tabulating the scores. Experimental and control groups have been formed for the experimental design:

Experimental Group: Participants in the experimental group have realized the stages of this study with groups of 5. Activities based on scientific argument have been prepared by the researcher. Toulmin's Argument Model has been used in the base of the preparation process of lesson materials. In the study, experiment report, creating an argument, guess-observe-explain activities have been facilitated from the scientific argument model applications. In addition to these techniques, higher order cognitive skills and critical thinking skills like positing a hypothesis, designing an experiment, controlling, defining the variables, using the data, interpreting, developing a counter-view, evaluating, being aware of assumptions have been given place in the study.

Control Group: Participants in the experimental group have been divided into groups of 5. Classes have been carried out by using the classical or in another term, traditional method. In this approach, subjects have been taught under the authority of teacher and students were merely audience. Throughout the process, direct instruction method, question-answer techniques and demonstration experiments have been used. As for the lesson materials, course book and some animations prepared in terms of computer presentation technique have been utilized.

For the qualitative part of the study, semi-structured interview questions have been used, and data containing the details and depths of information have been collected from a small sub-sample. Some examples and explanations, which are related to the generalizations reached at the end of the study through the analyses of these interviews, are also presented.

2.2. The Universe and Sample of the Study

The universe of the study was the students of a university in Antalya, Turkey, and the sample consisted of 106 Science Education teacher candidates, who were studying in the 3rd grade of the Department of Science Education of this university in the spring semester of 2013-2014.

2.3. Identification of the Study Groups

The study has consisted of 106 teacher candidates. 52 of them have taken place in the control group, and 54 of them have taken place in the experimental group. With the aim of deciding the group equality, previous semester's GPA's of teacher candidates, who were planned to take part in the study, have been evaluated, and it has been seen that groups were equal before the experimental process. That means there was no statistically significant difference between the experimental group (X=5.46; p>.05) and the control group (X=6.31; p>.05) before the study.

This equality between groups is shown in the table below.

Table 1. *Means of academic achievement pre-test scores related to group equality*

Group	*N*	*X*	*S*	*df*	*t*	*p*
Experimental	54	5.46	2.313	103.8	1.958	.053*
Control	52	6.31	2.129	104	1.955	.053*

*p> .05

2.4. Techniques of Data Collection and Measurement Tools

Data of the research consist of the results obtained through "Academic Achievement Test" (AAT) to define to what extent achievements and objectives were reached, and the answers gathered via interview questions that were prepared to identify teacher candidates' thoughts about the ABSI approach.

In the quantitative dimension of the study, a 30-item test has been evaluated by 2 experts and 2 teachers to strengthen the validity. In a pilot study, to define the comprehensibility level and the time length of the test, the achievement test has been applied, apart from the actual sample group, to 115 Science Education teacher candidates, who were studying in the 2nd grade of the same department in the university. After the pilot application, necessary adjustments have been made and the time length has been decided as 40 minutes (one class hour). In the pilot study, to figure out the reliability of the test, the Cronbach's Alpha score of 115 students' answers to 30 questions has been calculated. As a result of item difficulty index, item discrimination index and reliability analyses, it has been concluded that 15 items in the achievement test could not meet the conditions of the study. By eliminating these 15 items, the reliability of the test has been improved.

In the qualitative dimension of the study, a semi-structured interview technique has been utilized to identify teacher candidates' thoughts about the ABSI approach in details. Interview questions intended to define the thoughts of teacher candidates about the approach and the learning process have been prepared with the help of 2 experts, and they have been given their final shapes after an evaluation. As a result, 7 open ended questions have been used in the interview.

2.5. Data Analysis

Both quantitative and qualitative research techniques have been used to analyze the data obtained from the study. In the analysis of the quantitative data, results gathered from the

sample have been evaluated at the ".05 significance level", by using SPSS 23.0 program, to define the effect of ABSI approach on the academic achievements of teacher candidates. In the study, a Paired Samples T-test for the first and second sub-problems, and an Independent Samples T-test for the third sub-problem have been applied. On the other hand, in the qualitative dimension of the study, teacher candidates have been interviewed to identify reflections on argument based practices, and data have been analyzed by using content analysis method. Recordings gathered in the first step of data collection have been transcribed for a few times and have been divided into themes. For each theme, a code list has been created. Researcher's recurrent work on the codes that s/he has organized by reading the collected data has formed the data coding process (Yildirim & Simsek, 2013). Data have been described systematically, in terms of the codes and themes created, and interpreted after tabulating the results. Answers that each student has given to the questions are presented by giving direct quotations from students' speeches in the Findings Section of the study.

3. Findings

3.1. Findings of Academic Achievement Test

3.1.1. Findings related to the comparison of academic achievement pre-test post test scores of teacher candidates in the experimental group

To define the effect of current education program (classical learning approach) and ABSI approach on academic achievement, the achievement test's results have been specified by comparing pre-test and post-test scores in Table 2.

Table 2. *Paired samples t-test results related to the difference between pre-test and post-test achievement scores of experimental group students*

Experimental G.	*N*	*X*	*S*	*df*	*t*	*P*
Pre-test	54	5.46	2.313	53	-15.66	.000*
Post-test	54	9.70	2.015			

*p< .05

In Table 2, results obtained from pre-test and post-test scores of experimental group students have been analyzed. The mean of pre-test scores has been found as 5.46, and the mean of post-test scores has been found as 9.8. This result shows that there is a significant difference at .05 significance level between the pre-test and post-test scores of experimental group students, in favour of the post-test.

3.1.2. Findings related to the comparison of academic achievement pre-test post test scores of teacher candidates in the control group

Table 3. *Paired samples t-test results related to the difference between pre-test and post-test achievement scores of experimental group students*

Control G.	*N*	*X*	*S*	*df*	*t*	*p*
Pre-test	52	6.31	2.129	51	-3.622	.001*
Post-test	52	7.88	2.981			

*p< .05

In Table 3, results gathered from pre-test and post-test scores of control group students have been analyzed. The mean of pre-test scores has been found as 6.31, and the mean of post-test scores has been found as 7.88. This result shows that there is a significant difference at .05 significance level between the pre-test and post-test scores of control group students, in favour of the post-test. In other words, science and technology program applied to the control group have increased students' achievements, as well.

3.1.3. Findings related to the comparison of the difference between academic achievement post-test scores of teacher candidates in experimental and control groups

Table 4. *Independent samples t-test results related to the difference between post-test achievement scores of experimental and control group students*

Post-test	*N*	*X*	*S*	*df*	*t*	*p*
Experimental	54	9.70	2.015	89.147	-3.667	.000*
Control	52	7.88	2.981	104	-3.693	.000*

*p< .05

In Table 4, the results obtained from post-test scores of experimental and control group students have been analyzed, and it is seen that experimental group students' arithmetic mean of post-test scores (X=9.70) is higher than control group students' arithmetic mean of post-test scores (X=7.88). In addition, this implies that there is a statistically significant difference between the two groups' post-test scores in favour of experimental group (p=.00<.05).

3.1.4. Findings related to the thoughts of teacher candidates in experimental group about Argument-Based Science Inquiry Approach

In the interview, there are 7 open ended questions related to the thoughts of teacher candidates about the application of ABSI approach in Science Education Laboratory Practices II class. After the implementation of the study, 4 different themes, which are student outcomes, skills that asserting a claim and data use in ABSI approach make the teacher candidates acquire, negative thoughts that students have about ABSI and advantages of ABSI, have been identified from the interviews with teacher candidates. These are listed and described as follows:

Table 5. *Theme and code lists of the interviews*

Themes	Codes
Student outcomes after the application of approach	Meaningful learning Sense of discovery Permanent learning Sense of wonder Cause and effect related learning Pedagogical outcomes
Skills that asserting a claim and data use in ABSI approach make the teacher candidates acquire	Thinking skills Research-inquiry skills Scientific process skills Scientific thinking skills Scientist like thinking skills Scientific thought
Negative thoughts that students have about ABSI	Noise in crowded classroom environment applications Withdrawn attitudes of some teacher candidates Not having a division of labour in some groups
Advantages of Argument-Based Science Inquiry approach	Making lesson efficient Developing a different perspective Saving the lesson from monotony

Examples of teacher candidates' thoughts in relation with these themes have been given below.

Table 6. *Teacher candidates' thoughts about student outcomes related to the ABSI Approach*

Student Outcomes	*f*	*%*
Meaningful Learning	13	25
Sense of Discovery	10	19
Permanent Learning	9	17
Sense of Wonder	8	15
Cause and Effect Related Learning	7	13
Pedagogical Outcomes	5	10

In Table 6, teacher candidates' thoughts on learning outcomes related to ABSI have been presented. It can be seen that 25% of the teacher candidates in the experimental group have stated that they have achieved meaningful learning in the first place as an important outcome of ABSI approach. 19% of them have mentioned that sense of discovery is the second most important outcome of the ABSI approach. In the third place, permanent learning has been referred by 17% of teacher candidates as another important outcome. The rest of the outcomes are lined up as in the fourth place sense of wonder with 15%, in the fifth place cause and effect related learning with 13%, and in the last place pedagogical outcomes with 10%.

Below, some teacher candidates' statements supporting these findings have been presented:

S1: "*By writing my own questions, I have passed from theory to practice. In the old system, all questions were given ready and almost everything I would do was fixed. My creativity have been improved with this approach, and I had the opportunity to reach what I wondered.*"

S2: "*We have participated into the process very deeply. I acquired permanent learning with this approach and thus my learning realized more enduringly and motivated.*"

S4: "*I had the opportunity to think with this approach. Instead of doing the experiments directly, I decided what is right or wrong by thinking, designing and using claims and rebuttals. And this made me learn more permanently.*"

S5: "*Instead of remaining in one framework, with discovery, I had the chance to discover unattained and never wondered points. So, I can say that it broadened my horizon.*"

S3: "*The base of learning is to answers to our questions. With the help of this, I found an answer to my will of knowing, understanding and wondering.*"

S3: "*By preparing questions myself, my sense of wonder was motivated. While designing an experiment to find answers to those questions, I acted with suspicion towards the events around me.*"

S1: "*I learned how permanent learning could be developed with this approach. I rediscovered the main objective of laboratory practices. I certainly want to use this approach in the classes throughout my teaching life.*"

S5: "*This approach improved me a lot in terms of perspective. At the same time, it made laboratory classes entertaining. I certainly want to use this approach in the classroom during my professional teaching.*"

S3: "*This class, which was carried out with classical method, became much more enjoyable, and the lesson was saved from monotony. In my teaching profession, I will definitely prefer this approach.*"

S6: "*ABSI made me learn meaningfully. It developed my sense of wonder.*"

S7: "*I think it is the ABSI, because it is more contemporary. There was an active participation in the process. It was motivating for the class. Meaningful and permanent learning were realized.*"

S8: "*It is certainly the ABSI. I will also use this approach when I become a teacher. I think it makes learning permanent for the learner. It reveals the sense of discovery.*"

Table 7. *Thoughts of teacher candidates related to the skills that asserting a claim and data use in ABSI Approach make them acquire*

Skills Acquired by Asserting a Claim and Data Use	*F*	*%*
Thinking Skills	10	26
Research-Inquiry Skills	7	18
Scientist Like Thinking Skills	7	18
Scientific Process Skills	6	16
Scientific Thinking Skills	5	13
Scientific Thought	5	13

In Table 7, the results about teacher candidates' thoughts related to the skills, which have been acquired by them via asserting a claim and data use, have been shown. The first group of skills they have mentioned that they have acquired are thinking skills with 26% of the experimental group. With 18% research-inquiry skills are the second group of skills that teacher candidates have stated. In addition, scientist-like thinking skills are sharing the second place again with 18%. They are followed by scientific process skills with 16%, scientific thinking skills with 13%, and scientific thought again with 13%.

Below, some teacher candidates' statements supporting these findings have been presented:

S1: "*I had a chance to see false facts. I spotted my mistakes. I leaned towards thinking like a scientist.*"

S2: "*Showing evidence is important in making one gain scientific method and scientific thinking skills. Positing hypotheses in line with the claims made me use the scientific method. On the other hand, it made me acquire skills like critical thinking and reflective thinking. Like a scientist, I realized the importance of reasoning by knowing the cause instead of believing the facts blindly.*"

S3: "*It made me think like a scientist.*"

S4: "*My thought system evolved. It made me live the processes of hypothesizing, doing experiments and observations, improving claims with evidences or positing new hypotheses via rebuttals, and also made me act with a scientist's thought system.*"

S5: "*I think, we acquired scientific thinking skills. With the scientific process skills, we had the opportunity to think like a scientist. We did a lot of inquiries.*"

S6: "*In my opinion, we worked like a scientist in the process. We concentrated on scientific thoughts and acquired various thinking skills.*"

S7: "*We did research and inquiry. We gained important achievements at the end of the process.*"

Table 8. *Negative thoughts of teacher candidates related to ABSI Approach*

Negative Thoughts Related to ABSI Approach	*f*	*%*
Noise in Crowded Classroom Environment Applications	5	41
Withdrawn Attitudes of Some Teacher Candidates	4	33
Not Having a Division of Labour in Some Groups	3	25

In Table 8, teacher candidates' negative thoughts about ABSI have been shown. It is seen that almost half of the participants, 41% of them, in the experimental group have stated that ABSI approach has caused noise when applied in crowded classroom situations. In addition, 33% of them have complained about attitudes of shy classmates, and 25% of them have mentioned unfair labour division problems in some groups.

Below, some teacher candidates' statements supporting these findings have been presented:

S1: "*There were some friends, who were hesitating to ask questions in the classroom. So, their participations into the lesson were low.*"

S2: "*There should not be a leader in small group works. Having a specific leader makes other students stand in the background.*"

S3: "*The classroom's being crowded caused some noise from time to time, so it sometimes lowered the level of comprehension of the discussions.*"

S4: "*In fact, because of classroom's being crowded, sometimes there could be some noise in some lessons.*"

S5: "*Some of my friends did not participate in to the lesson, so they did not contribute to the division of labour. Because of this, we occasionally had problems.*"

S6: "*Our class was crowded. Sometimes disturbances were occurring, since there was no division of labour among some of my friends in the group. We could be facing some noise.*"

S7: "*In my opinion, group discussions should not be used in crowded classrooms. We faced some difficulties in the periods, when we had difficulty in the division of labour.*"

S8: "*In fact, I did not experience many troubles in the process. But sometimes some of my friends were having difficulty to listen to each other. And that was causing some noise on a small scale.*"

Table 9. *Thoughts of teacher candidates about the advantages of ABSI Approach*

Thoughts Related to the Advantages of ABSI Approach	*f*	*%*
Making Lesson Efficient	7	39
Developing A Different Perspective	6	33
Saving the Lesson from Monotony	5	28

In Table 9, teacher candidates' thoughts about the advantages of ABSI approach are given. It can be understood from the table that 39% of the participants in the experimental group have mentioned that the approach has made the lesson more efficient. As another advantage, developing a different perspective has been stated by 33% of them. In addition, 28% of the teacher candidates have suggested that the approach has broken up the monotony in the classroom.

Below, some teacher candidates' statements supporting these findings have been presented:

S3: "*This class, which was carried out with classical method, became much more enjoyable, and the lesson was saved from monotony. In this way, it transformed into both an entertaining and an efficient lesson.*"

S4: "*The classes, which were monotone, became entertaining. I had a chance to apply my knowledge that was generally stayed in theory, so my interest to this lesson increased.*"

S2: "*With this approach, I think my thoughts developed a lot in terms of perspective, at the same time, laboratory classes turned into more entertaining lessons. I spent a productive term.*"

S1: "*I caught the chance of looking into the events from different frameworks with this approach. Classes, which were mainly monotone, became entertaining. It was a fruitful year for me.*"

S5: "*It made me gain a different perspective. Classes were mainly enjoyable. We did not see the traces of classical method.*"

S6: "*I spent a productive year. Classes were entertaining. We got rid of monotony. We learned to look at from different frameworks.*"

S7: "*Monotonous classes ended.*"

S8: "*With a different perspective, all my prejudices about the lesson got lost. Lesson was saved from monotony quite a lot.*"

4. Conclusion and Discussion

In this part, the results, which have been reached based on the findings from the analyses have been interpreted.

4.1. Results Related to the Comparison of Academic Achievement Pre-test Post-test Scores of Teacher Candidates in the Experimental Group

Laboratory activities prepared with Argument-Based Science Inquiry approach have positively affected the academic achievements of teacher candidates. In the literature, there are works that support the results related to the aforementioned sub-problem of the study (Kaya, 2005; Zohar & Nemet, 2002)

4.2. Results Related to the Comparison of Academic Achievement Pre-test Post-test Scores of Teacher Candidates in the Control Group

An increase has been seen in the academic achievements of teacher candidates learning with the classical approach (in which classical experiment reports are prepared, the decision of what experiment will be done is given by the teacher, the tools of experiment are provided by the teacher) in the control group. However, it has been concluded that the increase in the academic achievements of teacher candidates in the experimental group, where ABSI approach has been used, is higher than as it is in the control group.

When the studies have been evaluated, it has been seen that science educationists meet on the view that the success in the traditional science education will rise with the use of laboratory. According to them, laboratory use in science education makes the concept development and learning easier (Fix & Renner, 1979; Freedman, 1997). In the traditional teaching, laboratory education is based on the principle of reaching knowledge by doing concrete experiments. However, in the practices conducted in this framework, it has been seen that comprehension is not at the sufficient level because of recipe like experiments,

some basic concepts are not properly created in the mind of a student, and knowledge is not constructed, therefore, meaningful learning do not happen (Novak, 1988; Singer, Hilton & Schweingruber, 2005). In addition, it has been emphasized by various researchers that students tend to fake the findings they need to get from the experiment in line with the information in the experiment or in the course book (Roth & Roychoudhurg, 1994; Watson, Prieto & Dillon, 1995). As a result, in our study, it has been seen that traditional laboratory education has developed teacher candidates' academic achievements at a lower level.

On the other hand, it is exactly vice versa in the Argument-Based Science Inquiry approach. Thus, teacher candidates' pre-test and post-test means being higher in the experimental group than in the control group is an inevitable consequence that has been reached. This shows us the effectiveness of Argument-Based Science Inquiry approach.

4.3. Results Related to the Views about the ABSI Approach of Teacher Candidates in the Experimental Group

In accordance with the results gathered from the interviews, teacher candidates have stated that teaching/learning with ABSI has made classes entertaining, and given them a chance to live the process like a scientist. In addition, they have expressed that in the practices they participated in actively, they have had the opportunity to live many experiences like critical thinking, research-inquiry and rediscovery of the knowledge via their self-expression skills, and they have been extremely pleased with this approach. However, they have decided that they have had problems at some points such as non-collaborative work of some of their friends and occurrence of a noisy environment in the classroom from time to time. When the literature has been examined, it has been seen that there are study results that show parallelism with the factors, which teacher candidates have underlined in this study about the ABSI approach (Ceylan, 2010; Jimenez-Aleixandre, Rodriguez & Duschl, 2000; Ozer, 2009; Richmond & Striley, 1996; Tekeli, 2009; Ulucinar Sagir, 2008).

5. Suggestions

In our country, classical laboratory practices are still being used in many schools, and with this approach, knowledge is presented directly and unilaterally by the teacher. With the classical laboratory practices, students' reasoning, research-inquiry, associating a cause and effect relation, and as a result, meaningful learning activities cannot achieve a total success. Argument-Based Science Inquiry approach lets students use many skills such as in-depth learning, thinking, questioning, positing a hypothesis and refuting if necessary. Therefore, in-service training activities, which introduce and suggest the use of this approach, may be organized, and in that way, the use frequency of this approach can be increased.

This research has been done in a limited time. Thus, it might be possible to do a science education with longitudinal works or projects based on the ABSI, and its effect on other variables besides academic success can be investigated. In addition, the effect of using the ABSI approach with other models, methods and techniques on students' acquisition of various skills with the help of their achievements might be investigated. Considering the positive effects of arguments on the comprehension of science concepts, development of science, investigation of knowledge by the students, and constitution of permanent knowledge, it is believed that giving arguments a place in course books can make enormous contributions to the students.

Argument-Based Science Inquiry approach, whose effectiveness has been proved with many studies abroad, should be taught to teacher candidates studying in universities, and teacher candidates' discussion skills should be developed in the framework of this approach. This study has been carried out with 3rd grade Science Education teacher candidates studying

at the university. It may be suggested that the ABSI approach should be used in several classes of primary education, in elementary education, and in other classes of universities. In other words, this research has been done with a restricted sample. Therefore, in case the research is carried out with a wider sample or it includes samples from different universes, it might be possible to generalize the effect of ABSI to a wider universe.

References

Akkuş, R., Gunel, M., & Hand, B. (2007). Comparing an inquiry-based approach known as the science writing heuristic to traditional science teaching practices: Are there differences? *International Journal of Science Education, 29*(14), 1745-1765.

Brad, R. (1994). Teaching critical thinking skills [Eleştirel düşünme becerilerini öğretme]. (G. Buyukkurt, Trans.). *Eğitim ve Bilim, 18*(91), 45-49. Originally published in 1984.

Brickman, P., Gormally, C., Armstrong, N., & Hallar, B. (2009). Effects of inquiry-based learning on students' science literacy skills and confidence. *International Journal for the Scholarship of Teaching and Learning, 3*(2), 1-24.

Cavagnetto, A. (2010). Argument to foster scientific literacy: A review of argument interventions in k-12 science contexts. *Review of Educational Research*, *80*(3), 336-371.

Ceylan, Ç. (2010). *Fen laboratuvar etkinliklerinde Argümantasyon Tabanlı Bilim Öğrenme-ATBÖ yaklaşımının kullanımı,* (Master's thesis), Gazi Üniversitesi, Ankara.

Crawford, B. A. (2000). Embracing the esence of inquiry: New roles for science teachers. *Journal of Research in Science Teaching, 37*(9), 916-937.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Creswell, J. W., & Plano-Clark, V. L. (2007). *Designing and conducting mixed methods research.* Thousand Oaks, CA: SAGE Publications.

Demirel, Ö. (2006). *Öğretimde planlama ve değerlendirme öğretme sanatı.* (Extended 10th ed.). Ankara: Pegem A Yayıncılık.

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education, 84*(3), 287–312.

Fix, W. T., & Renner, J. W. (1979). Chemistry and the experiment in the secondary schools. *Journal of Chemical Education, 56*(11), 737-740.

Freedman, M. P. (1997). Relationship among laboratory instruction, attitude toward science, and achievement in science knowledge. *Journal of Research in Science Teaching, 34,* 343-357.

Grandy, R., & Duschl, R. A. (2007). Reconsidering the character and role of inquiry in school science: Analysis of a conference. *Science Education, 16,* 141-166.

Gunel, M. (2006). *Investigating the impact of teachers' implementation practices on academic achievement in science during a long-term professional development program on the Science Writing Heuristic*. Unpublished doctoral dissertation, Iowa State University, Ames, Iowa.

Hand, B., & Keys, C. (1999). Inquiry investigation: A new approach to laboratory reports. *The Science Teacher, 66*(4)*,* 27-29.

Hand, B. (2008). *Science inquiry, argument and language: A case for the science writing heuristic*. Rotterdam, the Netherlands: Sense Publishers.

Hofstein, A., & Lunetta. V. N. (2004). The Laboratory in Science Education: Foundations for the Twenty- first Century. *Science Education, 88,* 28-54.

Jimenez-Aleixandre, M. P., Rodriguez, A. B., & Duschl, R. A. (2000). "Doing the lesson" or "doing science": Argument in high school genetics. *Science Education, 84*(6), 757-792.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). "Mixed methods research: A research paradigm whose time has come". *Educational Researcher, 33*(7), 14-26.

Kaya, O. N. (2005). T*artışma teorisine dayalı öğretim yaklaşımının öğrencilerin maddenin tanecikli yapısı konusundaki başarılarına ve bilimin doğası hakkındaki kavramalarına etkisi*. Unpublished doctoral dissertation, Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Kaya, O. N., & Kılıç, Z. (2008). Etkin bir fen eğitimi için tartışmacı söylev. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi, 9*(3), 89-100.

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

Kıngır, S., Geban, Ö., & Günel, M. (2010, Eylül). Öğrencilerin kimya derslerinde argümantasyon tabanlı bilim öğrenme (ATBÖ) yaklaşımının uygulanmasına ilişkin görüşleri. *Selçuk Üniversitesi Ahmet Keleşoğlu Eğitim Fakültesi Dergisi Sayı, 32,* 15-28, (Originally published in 2011.).

Kuhn, D. (2010). Teaching and learning science as argument. *Science Education,* 810-824.

Newton, P., Driver, R., & Osborne, J. (1999). The place of argumentation in the pedagogy of school science. *International Journal of Science Education, 21,* 553–576.

Novak, J. D. (1988). Learning science and science of learning. *Studies in Science Education, 15*(1), 77-101.

Özer, G. (2009). *Bilimsel tartışmaya dayalı öğretim yaklaşımının öğrencilerin mol kavramı konusundaki kavramsal değişimlerine ve başarılarına etkisinin incelenmesi*, (Master's dissertation), Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Philips, D. C., & Soltis, J. F. (2004). *Perspectives on learning* [Öğrenme: perspektifler]. (4th ed.) (S. Durmuş, Trans.), Ankara: Nobel Yayınevi.

Polman J. L., & Pea R. D. (2001). Transformative communication as a cultural tool for guiding inquiry science. *International Journal of Science Education, 85*(2), 23–238.

Roth, W. M., & Roychoudhury, A. (1994). Physics students' epistemologies and views about knowing and learning. *Journal of Research in Science Teaching, 31,* 5-30.

Richmond, G., & Striley, J. (1996). Making meaning in classrooms: social processes in small-group discourse and scientific knowledge building. *Journal of Research in Science Teaching, 33*(8), 839-858.

Singer, S., Hilton, M., & Schweingruber, H. (Eds.). (2005). *America's lab. Report: Investigations in high school science. Committee on High School Science Laboratories: Role and Vision, Board on Science Education, Center for Education, Division of Behavioral and Social Sciences and Education, National Research Council.* Washington, DC: The National Academies Press.

Tashakkori, A., & Teddlie, C. (1998). *Mixed methodology: Combining qualitative and quantitative approaches*. Applied social research methods series (Vol. 46). Thousand Oaks, CA: Sage.

Tekeli, A. (2009). *Argumantasyon odaklı sınıf ortamının öğrencilerin asit-baz konusundaki kavramsal değişimlerine ve bilimin doğasını kavramalarına etkisi*. Unpublished master's thesis, Gazi Üniversitesi, Ankara.

Toulmin, S. (2003). *The uses of argument*. Cambridge: Cambridge University Press.

Uluçınar, S. Ş. (2008). *Fen bilgisi dersinde bilimsel tartışma odaklı öğretimin etkililiğinin incelenmesi.* Published doctoral dissertation, Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Watson, J. R., Prieto, T., & Dillon, J. S. (1995). The effect of practical work on students' understanding of combustion. *Journal of Research in Science Teaching, 32*(5), 487-505.

Yerrick, K. R. (2000). Lower track science students' argumentation and open inquiry instruction. *Journal of Research in Science Teaching, 37*(8), 807-838.

Yıldırım, A., & Şimşek, H. (2013). *Sosyal bilimlerde nitel araştırma yöntemleri* (9th ed.). Ankara, Seçkin Yayıncılık.

Zohar, A., & Nemet, F. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching, 25,* 689–725.