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The Effects of Socioscientific Issues Based Instruction on Middle School Students' Argumentation Quality

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Abstract
The aim of this research is to examine how socioscientific issues (SSI) based instruction affects middle school students' argumentation quality. In this research, we worked with 25 seventh grade students. A simple experimental design was used in this research. An SSI based unit was designed and these unit activities were applied for 8 weeks. The data of the research is obtained through written argumentation forms. Descriptive analysis, Wilcoxon signed rank test, and effect size values were used to analyze the argumentation components. As a result of the research, it was shown that students improved their argumentation quality significantly. The results obtained from this research demonstrate that SSI based instruction is an effective approach to improve the students' argumentation quality. Therefore, SSI based instruction can be used to improve the argumentation quality of the students in science lessons.
Keywords: argumentation quality, middle school students, socioscientific issues based instruction

1. Introduction

In the 21st century, we are faced with many scientific and technological developments. Some of these developments, despite their advantages, cause disputes in society with their risks and disadvantages. For example, genetically modified organisms (GMO) might be evaluated in different ways in the society. Some people support GMO in terms of meeting the food need of increasing population and producing crops that are resistant to different climatic conditions. Meanwhile, some are anxious to produce these products due to the possibility of causing health problems in humans and the depletion of natural agricultural products. Issues like producing GMO that might be evaluated with different perspectives and cause discussions in the society are called as socioscientific issues (SSI) (Eastwood et al., 2012).

Confronting with SSI in science education process will be effective in terms of training scientifically literate individuals (Sadler & Zeidler, 2005). Some of the world's most respected research centers, such as the American National Research Council (NRC) and the American Association for the Advancement of Science (AAAS), emphasize that the SSI must take part in science curricula. AAAS (1990) defines the teaching of SSI as one of the most important goals of modern science education, while NRC (1996) states that individuals should be able to participate in discussions about science and technology. The relevance of research centers to socioscientific issues can be attributed to learning outcomes of them. For example, it is revealed that SSI increase the knowledge of concepts (Klosterman & Sadler, 2010), the motivation for lessons (Lin & Mintzes, 2010), and develop argumentation (Tal & Kedmi, 2006), decision making (Gutierez, 2015), and analytical thinking ability (Nuangchalerm, 2010). Although the contribution of SSI based instruction to education was revealed in different studies, it appears that this teaching has not been utilized enough in the science classes. One of the reasons for this is that the number of studies including the planning of SSI based instruction and its implementation in classrooms is insufficient (Sadler et al., 2015). Therefore, new studies are necessary including SSI based instruction in learning environments that supports the development of the ability to make decisions and discussion, and engage in scientific explanations and argumentation about current topics that may be encountered in real life.

1.1. Socioscientific Issues (SSI) Based Instruction

SSI have a controversial nature due to the absence of a single response (Zeidler & Nichols, 2009). These issues also base on scientific explanations (Yahaya, Zain, & Karpudewan, 2012) and can be evaluated with different perspectives (Sadler, Chambers, & Zeidler, 2004). Samples of SSI found at present are related to cloning, global warming, and nuclear power plants.

Ratcliffe and Grace (2003) listed some of the characteristics of the SSI as following:

- Include making choices at a personal or social level and producing ideas;
- have scientific bases. are reported often by the media;
- are related to social and political issues, emphasizing rural, national, and global dimensions;
- include some risk and benefit analysis;
- require value and ethical reasoning;

- are actual issues in life.

Taking the characteristics of SSI into account it can be said that these issues offer opportunities for linking science lessons with everyday life. Students can be encouraged to discuss, analyze and make informed decisions in the classroom where they engage in current SSI related to real life. Skills such as analyzing, making informed decisions, and participating in the scientific discussion are some of the important qualifications of scientific literacy, which is the ultimate goal of science education. Therefore, it can be benefited from the SSI to achieve the aims of scientific literacy. There are different instructional frameworks in the literature for the use of SSI in classrooms and for designing SSI based instruction (Kolsto, 2001; Sadler, 2011; Shoulders & Myers, 2013). In the present research, SSI instructional framework belongs to Presley et al. (2013) was preferred in designing SSI based unit instruction because of containing more practical and detailed information related to the elements that should be considered in SSI based instruction (the features of teachers and classroom environment, the peripheral influences, the experiences that students should gain in this process). In this framework, there are three core components: design elements, teacher attributes, and learner experiences. The class environment frames the core components, and the peripheral (external) influences frame all of the components. The graphical representation of the framework is shown in Figure 1.

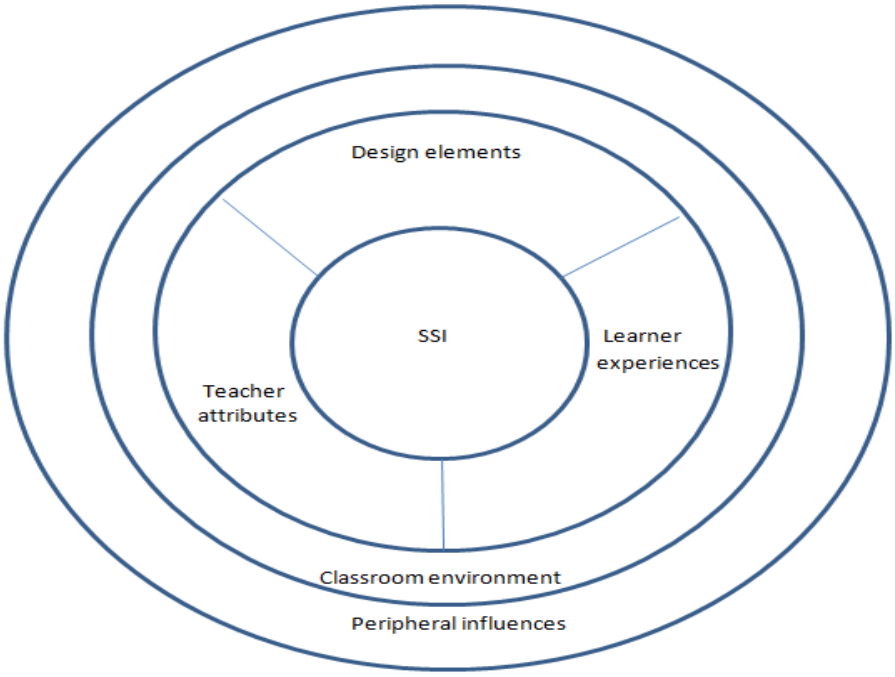


Figure 1. The Graphical Representation of the Framework (Presley et al., 2013).

The design elements emphasize that SSI based instruction should be designed around an interesting socioscientific issue, and then the instruction should be started by presenting this issue (Presley et al., 2013). In addition, it is stated that students should be engaged with high-level skills such as argumentation and inquiry during the process, while media and technology should be utilized if possible. Another element highlighted in the design elements is the completion of SSI based instruction with a culminating activity. Under the title of learner experiences, it is stated that students should collect scientific data and analyze them, engage in high-level thinking skills, face ethical and nature of science issues as well as social aspects of the SSI (Presley et al., 2013). Teacher attitudes emphasize that the teacher should have knowledge about the scientific and social aspects of the subject, be willing to act honestly about their knowledge limitations and share their authority with students. The classroom environment should be cooperative, respectful, and interactive, and the students should feel safe during SSI based instruction. The peripheral influences framing all these features emphasize providing SSI based materials, program characteristics and the co-operation of teachers, parents and school directors (Presley et al., 2013). In the present study a science unit was redesigned considering all these features explained by Presley et al. (2013) and how SSI based instruction affected students' argumentation quality was studied.

1.3 Argumentation

The impact of SSI based implementation on different variables has been the subject of many studies. These studies examined the effect of SSI based instruction on different variables such as the content knowledge (Zohar & Nemet, 2002), attitude towards science (Lee & Erdoğan, 2007), and the understanding of the nature of science (Eastwood et al., 2012). Another variable focused on is the argumentation quality. Argumentation is defined as a

reasoning process carried out to increase the acceptability of a viewpoint that is presented before deciding on a matter (van Eemeren & Grootendorst, 1996). Different institutions and organizations emphasize the importance of argumentation in science education. NRC (1996) stated that the students should be able to make informed decisions by discussing SSI. The Ministry of National Education (MoNE, 2013) of Turkey also underlines the need of discussing SSI and presenting evidence-based justifications in the classroom environment. Reasons for this emphasis on the argumentation in science education is its positive effects on the students. The students who have argumentation skills will be able to understand different perspectives about the topic (Lin & Mintzes, 2010), develop their reasoning (Rebello & Barrow, 2013) and decision making (Dawson & Venville, 2009) skills. Individuals who are able to present qualified arguments can defend their thoughts more scientifically and effectively about SSI (Lin & Mintzes, 2010). SSI based environments in which discussions, generating ideas, and making inferences are the basis (Polyiem, Nuangchalerm, & Wongchantra, 2011), provide appropriate content for the use and development of the argumentation quality (Sadler, 2004).

The effect of SSI based instruction on argumentation quality has been the subject of different studies. One of the present researches belong to Dolan, Nichols, and Zeidler (2009). In this study, hunting seals and speed limit topics were chosen as the socioscientific issue. In the lessons, students firstly carried out laboratory experiments, and then participated in group discussions. The results of the study revealed that following the SSI based learning activities, students' argumentation and reasoning qualities increased. Another work in which an SSI based unit is designed belongs to Tal and Kedmi (2006). Laboratory activities, group discussions, Internet, newspaper researches, and field trips were conducted throughout the unit. The evaluation made after all the activities showed that the argumentation quality of the students improved. In the study conducted by Topçu and Atabey (2014), SSI-related field trips were organized and thermal, wind, and hydroelectric power plants were visited in these trips. Written argumentation forms filled before and after the field trips were analyzed in terms of argumentation quality. Analyzes showed that students could offer more qualified arguments, evidence, and reasoning after SSI based field trips. Although studies reveal that SSI based instruction affect the argumentation quality positively, it is still a problem that some students present inappropriate evidence and reasoning (Acar, Türkmen & Roychoudhury, 2010; Jime´nez-Aleixandre, Rodriguez & Duschl, 2000; Krajcik & McNeill, 2009). In the study conducted by Genel and Topçu (2016) related to the implementation of SSI based instruction in middle school classes, it was determined that the argumentation quality of participants were not at the desired level and remained at the basic level which includes presenting claim without any justification. Bağ and Çalık (2017) reached the following findings in the study that drew attention to the research carried out for the argumentation. It was stated that many studies focused on middle school students, were about the effects of argumentation on students' achievement and attitudes, and fewer studies presented the results related to level of students' argument development (the number of arguments and the quality). The authors also claimed that Toulmin' argument model (1958) was often used to evaluate the levels of the argument and this leads to a limited range of studies that determine argument levels. It was also revealed that the studies related to argumentation were concentrated on physics, and new studies on environmental issues were recommended (Bağ & Çalık, 2017). The present study will contribute to filling the gap related to analyzing the quality of the argument in the literature by using the framework of Lizotte et al. (2003) as well as revealing how students' argumentation quality changed at the end of SSI based instruction. Moreover, by focusing on the global warming as the socioscientific issue, we examined how the students' arguments changed in a non-physics context as recommended by Bağ and Çalık (2017). According to this goal, the following research question is answered at the end of the study:

Did the argumentation quality of students change by SSI based instruction?

2. Methods

In this section, information about the research model, study group, implementation process, data collection process, and data analysis are given.

2.1. Research Model

The simple experimental method was used in the study. This method is defined as a method in which the control group is not present and only the change and development of the experimental group is examined (Çepni, 2009). The simple experimental method is preferred in studies in which it is not appropriate to compare the experimental and control groups, where the activities and measuring instruments are prepared for only the experimental group (Bakırcı & Çalık, 2013; Çalık, 2013).

2.2. Research Group

The study group in the study was selected using the criterion sampling from purposeful sampling. The sample is decided on a set of criteria determined by the researcher in the criteria sampling (Yıldırım & Şimşek, 2013). The criteria considered while selecting the study group are as follows:

- Curriculum should include a socio-scientific tissue.
- The curriculum should give an opportunity to the researcher to design the unit around an SSI.
- The curriculum should provide appropriate time for the implementation.
- The class should have a projection.

In the study group, students were generally from low and middle-level income backgrounds. Three of the students benefit from free lunch at school. There were 14 girls (56%) and 11 boys (44%) in the study.

2.3. Implementation Process

The implementation process of the research lasted 8 weeks, 4 hours per week. Before beginning the research, the "Human and Environment" unit in the 7th-grade science curriculum was redesigned around the global warming issue. During the SSI based instruction, a focus SSI should be identified and all unit gains should be accomplished by relating them with this focus SSI (Presley et al., 2013). The concept map created by researchers in which the relationships between focus SSI and other unit concepts were shown was given in Figure 2.

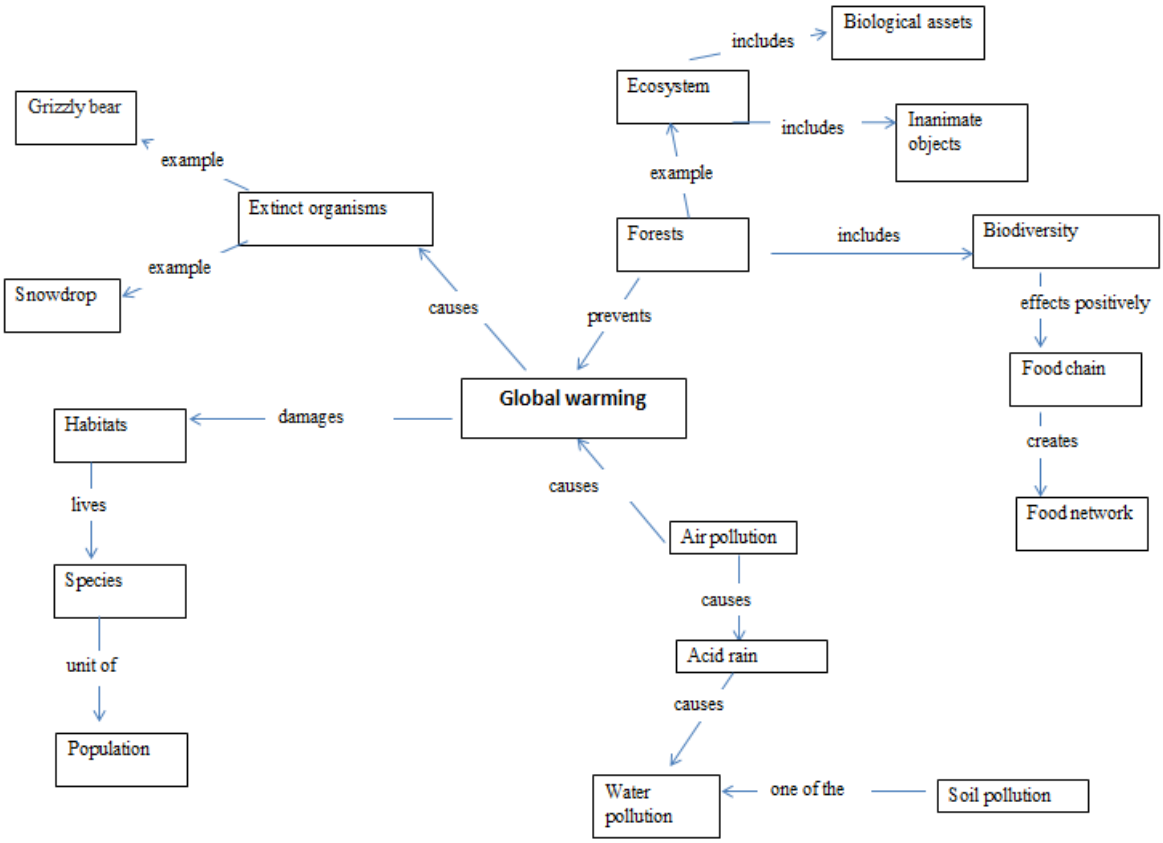


Figure 2. The Concept Map of SSI Based Unit

In the research process, students first completed a written argumentation form. Following the complementation of written argumentation forms, the SSI based instruction began with a video clip about global warming. Then two lessons including definition, importance, and components (claim, evidence, reasoning) of argumentation were completed. In the next lessons, students were asked to investigate the causes of global warming using written sources (books, magazines, newspapers, etc.) in the heterogeneous groups. This activity led students to collect evidence for their arguments related to global warming. Then, students completed the laboratory activities called “the greenhouse effect”, “the measurement of carbon dioxide in our breath, air, and exhaust”, “the effect of acid rains on plant”, “the effect of acid rains on marble”, and “the effect of soil pollution on plant growth”. Afterwards, students discussed the results of laboratory activities in terms of global warming. After that a field trip to the forest was organized to explore the role of forests in global warming. A forest engineer gave information to the students about the importance of forests in terms of biodiversity, food chain, and food network, as well as on their role in the greenhouse effect and impact on climate, and finally, about the ways of utilizing forests to prevent global warming. In the next lesson, students individually searched the results of global warming on the Internet. They argued why global warming is a problem and collected evidence to answer this question.

Later, the question of “Should countries reduce their emission of greenhouse gases?” was directed to students and they were asked to present arguments representing different parties of the issue (factory owner,

government, labor, and environmentalist group). In this process, it was recommended to use the data they collected since the beginning of the research. Finally, students were asked to prepare posters and identify slogans related to global warming in groups. The students presented their posters and the laboratory experiments they had carried out with an exhibition in the school garden. Information about the implementation process is given in details in Table 1.

Table 1. Implementation Process

Week	Activities
1	Implementation of written argumentation forms
2	Introducing of argumentation
3	Investigating the causes of global warming using written sources (books, magazines, newspapers, etc.) in the heterogeneous groups
4	Laboratory activities
5	Field trip
6	Argumentation activity in groups
7	Preparation and exhibition of posters and slogans about global warming
8	Implementation of written argumentation forms

2.4. Data Collection Process

In this research, data related to the development of the middle school students' argumentation quality during SSI based instruction were collected. The data were obtained through a written argumentation form that includes a text related to global warming that gives some information about reasons of global warming and the contributions of the countries to global warming, and a question that requires students to answer, which asks if countries should reduce their greenhouse gasses emissions or not. The written argumentation form originally belongs to Topçu (2008) and was adapted by the researcher into Turkish. The Turkish and English versions of the written argumentation forms were first examined by an associate professor in the field of Science Education. Then, a Turkish teacher checked the text in terms of grammar and understandability. After completing the sentence changes the Turkish teacher approved, the pilot study of the form was carried out with 26 students studying in 7th-grade. The following changes were made in the written argumentation form according to the feedbacks received from the students.

- Turkey was written as the country instead of the United States.
- Greenhouse gases were explained. Some examples of damages of greenhouse gases on the environment were presented.
- Quantitative data were decreased.
- A more friendly language was used.
- More clear and informative statements were used.
- The contradiction about the reduction of greenhouse gases was explained more clearly.

After completing these changes a Turkish teacher controlled the written argumentation form again. Then the written argumentation form was given the final form. Throughout the research, students filled these forms twice, at the beginning and at the end of the study. A total of 50 written argumentation forms were obtained from the research process.

2.5. Data Analysis

Two written argumentation forms were obtained for each student at the end of the study. The arguments presented by the students in the forms were analyzed using the argumentation analysis framework developed by Lizotte et al. (2003). According to this framework, a qualified argument must include the claim, evidence, reasoning, and rebuttal. However, the rebuttal element was not taken into consideration in the study. McNeill and Pelletier (2012) suggest that the rebuttal is suitable for students studying between grades 9 and 12, while for the 6-8 grade students, the claim, evidence, and reasoning elements are sufficient for a qualified argument. Lizotte et al. (2003) explained the claim, evidence, and reasoning as follows: Claim is a conclusion or an answer given to a question; evidence is adequate and correct data presented to justify the claim; reasoning is a statement used to explain how and why the evidence supports the claim. The arguments presented by the students were evaluated between 0-2 points in the study. The highest score for an argument is 2 while 0 represents the lowest level. The information about the framework was given in Table 2.

Table 2. Argumentation Quality Framework (Lizotte et al., 2003)

Level	Claim	Evidence	Reasoning
	Assertion or conclusion for a problem.	Data that support claim.	Argument that links evidence to claim.
0	Does not make a claim or make an inaccurate claim.	Does not provide evidence or only provides evidence that does not support the claim.	Does not provide reasoning or only provides reasoning that does not link evidence to the claim
1	Makes an accurate but incomplete claim.	Provides accurate but insufficient evidence to support the claim. May include some evidence that does support the claim.	Provides accurate and incomplete reasoning that links evidence to the claim. May include some reasoning that does not link evidence to the claim.
2	Makes an accurate and complete claim.	Provides accurate and sufficient evidence to support the claim.	Provides accurate and complete reasoning that links evidence to the claim.

Coding was realized by two researchers. As a result of independent coding by two researchers, the coding reliability was calculated as 97% for the claim, 96% for the evidence, and 98% for the reasoning. Disagreements between researchers were resolved and coding of argument components was completed. The average scores of the pre- and post-tests for claims, evidence, and reasoning components were calculated after evaluating the students' arguments in terms of these levels. Based on these scores, the authors tried to show how the average scores of each argument component of students changed at the end of SSI based instruction. Finally, the statistical significance of the difference between the average scores for each argument component was questioned. For this purpose, it was first investigated whether the data had a normal distribution. Since the number of samples is less than 50, the Shapiro-wilk value is taken into account in interpreting the normality test results. When the Shapiro-wilk p value is greater than 0.05, the hypothesis "there is normally no difference between them" is accepted, which meant normality is achieved (Can, 2013).

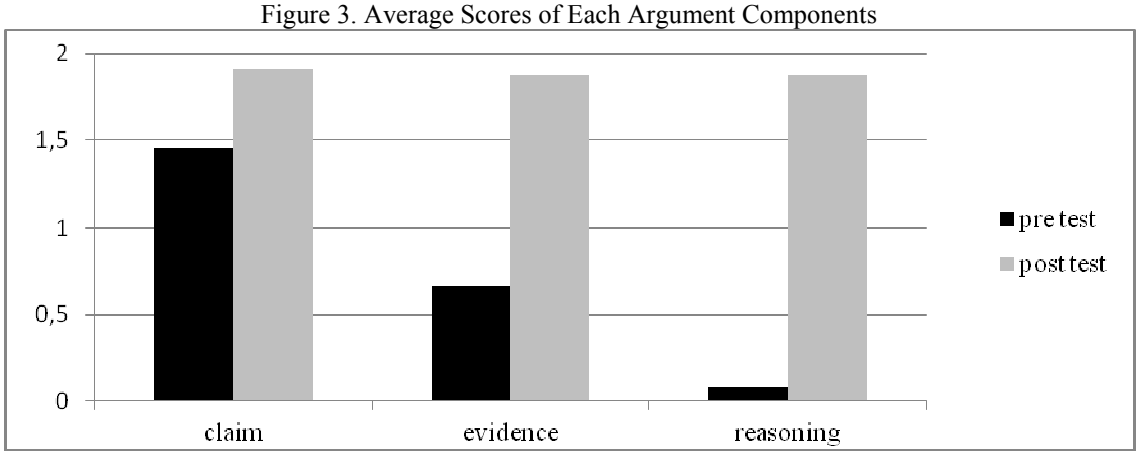
In cases where the assumption of normality is not provided, the nonparametric test called Wilcoxon signed rank test is used instead of a single sample t-test to test the statistically significant difference between pre- and post-test averages of a single group (Can, 2013). In the present study, the significant differences between the scores of the students' claim, evidence, and reasoning components were examined by the Wilcoxon signed rank test because the normality assumption was not met.

In the current research, in addition to the statistical significance, the practical significance was also questioned. It is also recommended to calculate the effect size in experimental studies where the significance of the study results is tested. The statistical significance tests cannot remove the effects of the chance factor and the number of samples, the effect size both removes the effect of the number of sample size on study results and reveals the practical significance of study results (Özsoy & Özsoy, 2013). The effect size of the data obtained by Wilcoxon signed rank is calculated by the formula $r = z / \sqrt{N}$ (Pallant, 2011). Cohen (1988) defined effect sizes as "small, r = .1", "medium, r = .3", and "large, d = .5".

3. Findings

In this section, findings related to the average scores, Shapiro-wilk values, Wilcoxon signed rank test, and effect size results of claim, evidence, and reasoning of students are given.

Figure 3. Average Scores of Each Argument Components



As shown in Figure 3, at the beginning of the SSI based instruction, the average scores for the claim component were 1.45 and at the end of the SSI based instruction, this score increased to 1.95. Another finding shown in Figure 3 is the increase of students' average scores for evidence component. This score was 0.66 at the beginning of the SSI based instruction and it increased to 1.87 at the end of the instruction. It is also seen that students' average reasoning scores increased at the end of the SSI based instruction. While the students' average score for reasoning was 0.083, it increased to 1.87 after SSI based instruction.

After calculating the average scores of argument components, it was questioned whether the increase in the average scores of each argumentation components was statistically significant or not. Before the dependent test, it was examined if the scores of claim, evidence, and reasoning had a normal distribution. The data regarding normal distribution are shown in Table 3.

Table 3. Shapiro-wilk Values of Claim, Evidence, and Reasoning

		Shapiro-Wilk		
		Statistic	df	Sig.
Claim	Difference	.554	24	.000
Evidence	Difference	.699	24	.000
Reasoning	Difference	.396	24	.000

As shown in Table 3 Shapiro-wilk p values of the three argumentation components are smaller than 0.05. According to this data, it is determined that the scores for claim, evidence, and reasoning components do not have a normal distribution. Therefore, significance of the increase of average scores of argumentation components was questioned by the Wilcoxon signed rank test. The results of this test were presented in Table 4.

Table 4. Wilcoxon Signed Rank Test Results of Students' Claim Scores for Pre-Test and Post-Test

Pre-Test-Post-Test	N	Mean rank	Sum of Ranks	z	p
Negative Ranks	0	0	0	-2.333	.020
Positive Ranks	6	3.5	21		
Ties	18				

As seen in Table 4, eighteen students' scores did not change, 6 students' scores increased and no student's score fell for the claim component at the end of the SSI based instruction. Another finding presented in Table 4 is that the value of p is less than 0.05. Based on this data, a statistically significant difference between the students' pre- and post-test claim scores was found at the end of the SSI based instruction ($z= -2.333$, $p < 0.05$). In addition to statistical significance, the effect size was also calculated to test practical significance. The effect size value was found to be 0.47. This value shows us that SSI based instruction has medium effect size on students' claim.

Following the analysis of students' claim scores, the analysis of evidence scores was completed. Due to the non-normal distribution of evidence scores, significant differences between these scores were questioned by Wilcoxon signed rank test. The results of this analysis were presented in Table 5.

In Table 5, it was seen that 8 students' evidence scores did not change, 16 students' evidence scores increased and no students' evidence scores decreased at the end of the SSI based instruction. It is also seen that the value of p is smaller than 0.05. According to this finding, it was found that there was a meaningful difference in the students' evidence scores ($z =-3.755$, $p < 0.05$). The practical significance of the results obtained from the Wilcoxon signed rank test was tried to be explained by the effect size. The effect size value was found to be 0.76. Based on this result, it is determined that SSI based instruction has a positive and large effect on the evidence scores of the students.

Tablo 5. Wilcoxon Signed Rank Test Results of Students' Evidence Scores for Pre-Test and Post-Test

Pre-Test-Post-Test	N	Mean Rank	Sum of Ranks	z	p
Negative Ranks	0	0	0	-3.755	.000
Positive Ranks	16	8.5	136		
Ties	8				

Following the analysis of students' claim and evidence scores, the analysis of reasoning scores was completed. Table 3 shows that Shapiro-wilk p-value is smaller than 0.05. Therefore a non-normal distribution was found for students' reasoning scores ($p < 0.05$). Based on this result the meaningful difference between students' reasoning scores was questioned by Wilcoxon signed rank test. The results of this analysis were presented in Table 6.

Table 6. Wilcoxon Signed Rank Test Results of Students' Reasoning Scores for Pre-Test and Post-Test

Pre-Test- Post-Test	N	Mean Rank	Sum of Ranks	z	p
Negative Ranks	0	0	0	-4.6	.000
Positive Ranks	22	11.5	253		
Ties	2				

Table 6 shows that p-value is smaller than 0.05. This result suggests that there is a significant difference for

students' reasoning scores (z = -4.6, $p < 0.05$). Therefore it can be stated that SSI based unit instruction develops students' reasoning scores significantly. The effect size value was found as 0.95. Based on this result, it was determined that SSI based instruction has a great effect size on students' reasoning scores.

Analyzes of the argument elements demonstrate that SSI based instruction can be used as an effective implementation for improving students' argumentation quality in terms of claim, evidence, and reasoning components.

4. Discussion

In this research, it is seen that the argumentation quality of middle school students improved with SSI based instruction. At the same time, medium effect size value for claim, large effect size values for evidence, and reasoning showed that SSI based instruction can lead to improvement in argumentation components. Medium effect size for claim component can be explained by the students' high claim scores before the SSI based instruction. The average score of claim component increased to 1.95 from 1.45 and this increase was lesser than other argumentation components (evidence and reasoning). In the studies conducted by Atabey & Topçu (2013) and Topçu & Atabey (2017), it was also revealed that the students offered high quality claims before the SSI based instruction. This result can be attributed to the fact that the claim component is defined as the least challenging item for students to present (McNeill & Martin, 2013). Large effect size for evidence and reasoning is due to the positive effect of SSI based instruction in constructing these components. At the beginning of the SSI based instruction the average scores of evidence and reasoning components were low (0.66 and 0.083), but at the end of the SSI based instruction they improved (1.87 and 1.87) more than claim scores. Hence, SSI based instruction caused high effect size value for evidence and reasoning components than the claim component. However this result cannot be interpreted as SSI based instruction had no effect on claim scores. The findings of the present study showed that SSI based instruction improved students claim, evidence, and reasoning scores significantly.

The results of this study agreed with the findings reported by Dawson and Venville, (2009); Dolan et al., (2009); Tal and Kedmi, (2006); Topçu and Atabey, (2017); Zohar and Nemet, (2002) involved students that are observed on in-class argumentation of SSI. In these studies, it was revealed that students could offer more than one justification for claims and their argumentation quality progressed significantly after SSI based instruction. These results can be attributed to the fact that students were able to collect scientific data (evidence) and face different aspects of the socioscientific issue during SSI based activities. SSI based activities provide suitable environments for generating claims and the collection of evidence and reasoning (Presley et al., 2013).

In the present study, students were active through researching books, newspapers, magazines and internet. Researching of SSI improves students' the ability of thinking analytically, making inferences, discussing, asking and answering questions, and using scientific principles and evidence (Khamwong, 2008). In addition students who were active in these processes had the opportunity to have meaningful learning about SSI. Student-centered environments created by SSI based activities strengthen students' ability to demonstrate their position clearly on the subject, to collect more data, and to justify their positions (Polyiem, Nuangchalerm, & Wongchantra, 2011). Understanding the subject meaningfully supports students to explain the relationship between claims, evidence, and reasoning and develop their ability of expressing why and how evidence supports their claims (Topçu & Atabey, 2017). Individuals who have an awareness of SSI can assess the socioscientific issue by taking the views of other people into account as well as their own views (Eggert et al., 2013) and present different arguments (Fernandez-Manzanal, Rodriguez-Barreiro, & Casal-Jimenez, 1999). Therefore, engaging SSI as in the present study supports development of argumentation quality.

Nonetheless, in addition to studies showing that students can present high quality arguments (Tal & Kedmi, 2006; Topçu & Atabey, 2017; Zohar & Nemet, 2002), some studies on argumentation also showed that students had difficulties in presenting appropriate and sufficient evidence for their claims (Jime´nez-Aleixandre, Rodriguez & Duschl, 2000; Krajcik & McNeill, 2009; Lin, Hong, & Lawrenz, 2012). Taken the argumentation as a process of reconstructing the knowledge through sharing ideas, questioning hypotheses, and reshaping the schemes in the social contexts (Evagorou & Osborne, 2013), it can be stated that SSI based instruction supports this process and this instruction can be used to develop students' arguments. In addition if we want students to make decisions about their lives we should give opportunities to them to engage in SSI and express their ideas through argumentation. Given that one of the most important goals of science education is to train scientifically literate individuals who are willing to participate public debate and think critically (Dillon, 2009), use their scientific knowledge to explain a phenomena, and present evidence-based conclusions (OECD, 2013), SSI based instruction and argumentation can be benefited to a great extent in that regard.

5. Conclusion

In this research, the effects of SSI based instruction on the development of middle school students' argumentation components were examined. As a result of the analysis of the data, it was determined that with the

SSI based instruction, the middle school students increased their claim, evidence, and reasoning abilities. Therefore it can be said that SSI based instruction is an effective implementation to increase students' argumentation quality. Argumentation, on the other hand, promotes decision-making skills, presenting scientific explanations, justifying ideas in a scientific manner, and evaluating issues with different perspectives. Therefore, it is important for students to have information about SSI and argumentation skills in order to acquire a degree of functional scientific literacy. Furthermore, it is thought that this research is an important example for teachers or researchers in order to facilitate implementation of SSI based instruction in the classroom and to help students develop argumentation quality.

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