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An Examination of the Evidences Used by the Secondary School Students in the Process of Socio-Scientific Argumentation: Global Climate Change Sample

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Abstract

The aim of study was to determine the functions of the evidence used by the secondary school students during the whole group and small group socio-scientific argumentation, and to determine the differences with respect to grade level. In this single case study, a total of 70 secondary school students studying at a public school in the Black Sea region were administered an open-ended knowledge test consisting of three open-ended questions to determine their level of conceptual knowledge of global climate change. Then, the students were included in small and whole group argumentation through two different socio-scientific scenarios in the context of global climate change. The whole and small group argumentations among the students of each class level were audio- recorded. The evidences students used during small and whole group argumentation were analyzed with the analytical evidence assessment tool that includes different categories of evidence. Analysis of the data revealed the eighth grade students who were better in terms of knowledge were also leading the total evidence use. Another important conclusion is that students tend to use evidence to refute predominantly counter claims and to support their own claims.

Ortaokul Öğrencilerinin Sosyobilimsel Argümantasyon Sürecinde Kullandıkları Kanıtların İncelenmesi: Küresel İklim Değişikliği Örneği

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Öz

Araştırmanın amacı; ortaokul öğrencilerinin sosyobilimsel argümantasyon sürecinde kullandıkları kanıtların fonksiyonunun sınıf düzeyi ve bilgi düzeylerine göre nasıl değiştiğini incelemektir. Çalışmada ilk olarak, Karadeniz bölgesindeki bir devlet okulunda öğrenim gören toplamda 70 ortaokul öğrencisine küresel iklim değişikliği hakkındaki kavramsal bilgi düzeylerini belirlemek için açık uçlu üç sorudan oluşan bilgi testi uygulanmıştır. Ardından öğrenciler, küresel iklim değişikliği bağlamındaki iki farklı sosyobilimsel senaryo aracılığıyla büyük ve küçük grup tartışmalarına dâhil edilmişlerdir. Her sınıf düzeyindeki öğrencilerin kendi aralarında yaptıkları büyük ve küçük grup tartışmaları, ses kayıt cihazları ile kayda alınmıştır. Öğrencilerin büyük ve küçük grup tartışmaları sırasında kullandıkları kanıtlar, farklı kanıt kategorilerini içeren analitik bir kanıt değerlendirme aracı ile analiz edilmiştir. Analizler; bilgi düzeyi açısından daha iyi durumda olan sekizinci sınıf öğrencilerinin toplam kanıt kullanımında da önde oldukları sonucunu ortaya çıkarmıştır. Öğrencilerin ağırlıklı olarak karşı iddiaları çürütme ve kendi iddialarını destekleme amaçlı kanıt kullanma eğiliminde oldukları da elde edilen önemli sonuçlar arasındadır.

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Introduction

One of the main objectives of contemporary science education is to educate students as science literate individuals (MNE, 2013; NRC, 2013; ACARA, 2014). The majority of the science education researchers (e.g., Sandoval, 2005; McNeill, 2011) emphasized that students should be a part of the scientific practices which are essentially based on questioning, reasoning, and using evidence. Therefore, it is important to include the argumentation as a process in science classes so that students can gain some potential benefits such as learning science subjects, participating scientific discourse, evaluating their peers' views on science, and supporting their decisions on a socio-scientific issue. Beyond all these, students who participated argumentation activities will also have the opportunity to understand the epistemology of scientific knowledge and evaluation on the basis of information structures, based on evidence from different perspectives (Driver, Newton, & Osborne, 2000). Accordingly, argumentation, with the most general expression is an essential epistemic practice that allows students to take part in science through the use of evidence in order to accept or reject the scientific theory, data and claims (Simon, Erduran, & Osborne, 2006; Bricker & Bell, 2008). However, the researchers studying in the field of argumentation (e.g., Zeidler & Sadler, 2008; Sadler, 2009) asserted that the scientific context is not enough alone to make students explore scientific concepts, to understand the relationship between science and their own life and to create interest and motivation for science. This situation reveals the importance of socio scientific context, which involves process, and products of science and controversial issues intersecting science and society (Sadler, 2004). To establish a link between scientific knowledge and data will not be enough for the students involving socio-scientific argumentation process they also need to be considered to the cultural, ethical, social and economic aspects of the problem and to critically suggest the knowledge claims and evidences. (Nielsen, 2012). This will allow the primary and secondary school students to see interdisciplinary interactions more clearly and to make more qualified reasoning. For this reason, it has been considered that there is a need for research to determine the function of the evidence that primary and secondary students use while evaluating a socio-scientific context and how they are influenced by the grade level and level of knowledge.

Socioscientific Argumentation and Evidence Used

One of the most fundamental points that researchers studying on science education, argumentation and socio-scientific issues come to a consensus is that students' involvement in argumentations that arise in daily contexts about socio scientific issues that have an impact on their own lives will develop their understanding of science (Zeidler, Sadler, Applebaum, & Callahan, 2009; Dawson & Venville, 2010). In parallel with this claim, it is seen that there have been many studies in the literature aimed to evaluate the socio scientific argumentation produced by high school or university students in terms of independent variables such as nature of science (Kutluca & Aydın, 2017), content knowledge (Cetin, Doğan, & Kutluca, 2014), context (Dawson & Venville, 2010) and cultural interactions (Sadler & Donnelly, 2006). The idea that individuals involved in the socio-scientific argumentation process with basic epistemological features should use evidence as the main component to assess and construct the knowledge claims (Nielsen, 2013) may be the basis of the rationality of evidence-based research. However, since the evidence used in the socio-scientific argumentation process has less certainty and greater change in nature than those used in the scientific context, it will be necessary to create more specific arguments on these issues and to be more dependent on the nature of the argumentation. Therefore, socio-scientific argumentation will enable students to have a conscious understanding of the science and world in which they live, to internalize science both epistemologically and socially, and to provide evidence-based decisions about the socio-scientific issues that they faced (Dawson, 2015). In the literature, when the rational basis of the research is examined; it is revealed that there is a limitation in terms of quantity, the studies are mostly conducted with the participation of high school or university students and there is no research to determine the effect of grade level on evidence. For example, McNeill (2011), who examined the explanation, arguments and evidence presented by fifth grade students to different contexts, found that participants' evidence used changed during the argumentation process and had reached the findings that shows improvement about how they could use their knowledge structures in the right place and time. Glassner, Weinstack and Neuman (2005) who were aimed to specify the objectives of the evidence use in the argumentation process stated that 9th grade students had difficulty in using evidence-based justifications. Iordanou and Constantinou (2014) who investigate the function and metacognitive awareness of the pre-service teachers' while they were presenting an arguments about the global climate change, determined that participants were more aware of the function of highly qualified evidence involved in the socio-scientific argumentation process, and that they attempted to put more emphasis on the evidence used. Similarly, it is examined how 11th grade students use evidence in argumentation in another study by Iordanou and Constantinou (2015). The

researchers, who included participants in the evidence-driven argumentation process, suggested that students increased the evidence use and used more accurate evidence. Albe (2008), who examines what kind of evidence they use in the process of evaluating students 'knowledge claims on smartphones, and how they interpret these contradictory evidences, concluded that the most important factor affecting the students' decision-making is the quality of the evidence use. Emery, Harlow, Whitmer and Gianes (2017) who investigated 53 female students' comments on some conflicting arguments about environment and science and how the type of evidence they used affects their decision making; noticed that there were no change on their attitude after reading the most of students' opposite information presented as evidence. In another study by Yang (2005) how 10th-grade students evaluate evidence and expert opinions on a socio-scientific issue has been investigated. The researcher concluded that most of the students focused on numerical data and trust expert opinions as a definite source of information while they were doing reasoning. Levinson (2006) who investigates the quality of evidence presented by teachers to make the socio-scientific argumentation process more effective has reached the conclusion that students who are faced with clearer evidence create more quality arguments. In the study conducted by Roberts and Gott (2010) to investigate how 65 pre-service teachers reached evidences during socio- scientific argumentation process, it is concluded that participants reached more complex evidence and formed more quality arguments after 15 weeks of socio-scientific argumentation process. By the researchers, this result interpreted as the potential of using evidence for individuals involved in socio-scientific argumentation has been increased. In summary, the claim that the use of knowledge-oriented evidence with a qualified epistemological basis brings with it a better quality socio-scientific argumentation process was confirmed by many theoretical and experimental studies. However, the fact that there is no study to base the idea on whether this is valid for primary and secondary school students brings about an important research need. Therefore, the purpose of this research is to examine how the function of the evidence used by the sixth, seventh and eighth grade students in the socio-scientific argumentation process changes according to their class and therefore their level of knowledge. Accordingly, the research questions sought in this study are as follows:

1. What is the conceptual knowledge of secondary school students about global climate change?
2. How the evidence used by secondary school students in whole group argumentation differs according to grade level?
3. How the evidence used by secondary school students in small group argumentation differs according to grade level?

Method

Research Design

This study was conducted through a case study design. A case study representing a qualitative and constructive paradigm, that a specific research strategy that allows identification of the reality behind any phenomenon (Meyer, 2015). Besides, case study is not only an investigation of a single perspective, but it also is possible to explore with various perspectives that allow them to be revealed and understood (Baxter & Jack, 2008). According to Yin (2003) the main focus of a case study is to seek an answer for ''how and why'' questions. Therefore, the case investigated in this study is how and for what purpose secondary school students presents their evidences that used in the socio scientific argumentation process. As the case at hand in this study is limited to examining the functions of the evidence presented by secondary school students, the research design can be thought as a single case study. To describe this single situation in more detail and to identify the underlying reality through various data sources, such as detailed socio-scientific argumentation processes in the form of small groups and whole group argumentations (through voice recordings), observation notes and conceptual comprehension tests on global climate change has been used.

Participants

The study group consisted of 70 secondary school students in the sixth, seventh and eighth grades of a secondary school in the Black Sea region in the 2018-2019 academic year. The characteristics of the participants are presented in Table 1.

Table 1. Participant Features

		f
Gender	Female	35
	Male	35
Grade Level	6th grade	20
	7th grade	24
	8th grade	26
TOTAL	70	

When table 1 is examined it can be seen that the study group consisted of 35 female and 35 male secondary students so totally 70 secondary students. However, it is noteworthy that 20 of the participants were in the 6th grade, 24 were in the 7th grade and 26 were in the 8th grade. Students from each grade level included in the study were divided into five small groups on a random basis to conduct small group argumentations.

Data Collection Tools

Two different data collection tools as global climate change knowledge test and socio-scientific argumentation scenario were used in the study. Detailed information on data collection tools is given below.

Global Climate Change Knowledge Test: This test was developed by the researchers to determine the conceptual understanding of the participants about the global climate change before the socio-scientific argumentation process. At the beginning of the study we hypothesize that grade level effects students' level of knowledge on global climate change which in turn play a significant role in function of evidences they use. The test consists of three open-ended questions related to global warming and climate change at the level of comprehension of the Bloom taxonomy. The lowest score that students can obtain from the test is determined as "0"and the highest score determined as ''100''. Expert opinion from two different faculty members in the field of science education was taken in order to ensure the internal validity of the questions in the test (Creswell, 2014). The researchers then made a pilot study with randomly selected six students from all grade levels to determine whether the questions were clear and understandable, expressed the same thing to participants and served the purpose of the study. The researchers, who sent the questions and students' answers in the pilot study back to the experts to check the form, completed the test and made it ready for implementation.

Socio- Scientific Argumentation Scenarios: Two different scenarios that covering similar goals were used to integrate students into the global socio-scientific argumentation process. The reason for using small and whole group argumentations with two different scenarios is to give students more opportunity to express their ideas. The first scenario 'Emerging Technology and Global Climate Change' was used for whole group argumentation while the scenario called 'Ecology or Technology?' was used for the small group argumentations. The context of the scenarios prepared by paying attention to the appropriateness of the curriculum and the relevance of the subjects to daily life. Expert opinion was taken from two different faculty members who were experts in their field in order to verify whether it is suitable in terms of argumentation and language. Necessary corrections have been made on the scenarios with respect to feedback taken from the expert and the scenarios have been finalized.

Data Collection

The data collection process of the study lasted 3 weeks. During the first week, all students were asked to conduct the Global Climate Change Knowledge Test, while the second week, a whole group and the third week, a small group argumentation were conducted. During the whole and small group argumentations students were asked questions such as *"what are the reasons you need to think about this in this way?*", "*Do you have any evidence that supports this idea?*" in order to make the process effective and contribute to the depth of the argumentation. Whole and small group argumentations recorded with the help of voice recorders lasted an average of 35-40 minutes. The weekly flow is given in Figure 1.

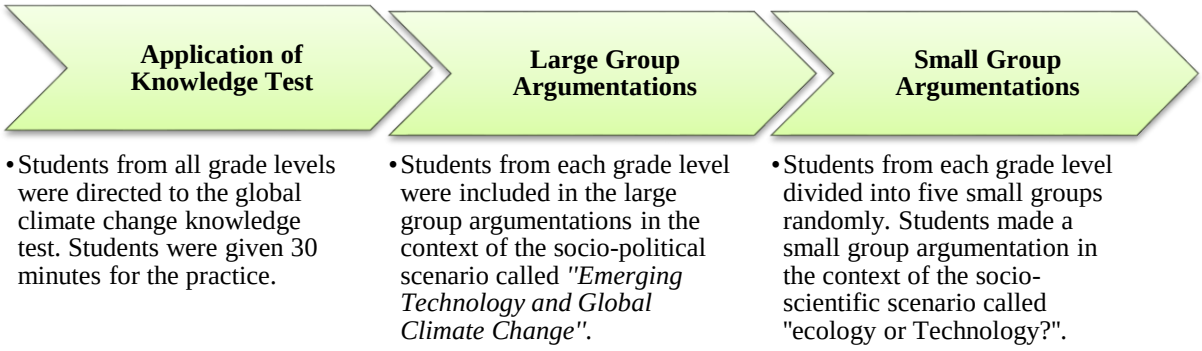

Figure 1. Data Collection Process

Data Analysis

Before the socio-scientific argumentation process the test responses of students from each grade level scored by two different experts in order to determine the conceptual knowledge of the subject matter. 95% consistency was achieved between the scoring made by different experts at the same time. The function of the evidence and forms of utilization in the arguments presented by the students during the whole group and small group argumentations was analyzed with the help of the analytical evaluation tool developed by Kuhn and Moore (2015). The tool to help to determine the function of evidence presented in the process of argumentation consists of four different categories. Coding categories and the explanations related to them are presented in Table 2.

Table 2. Evidence Coding Categories According to Functions

Category	Evidence function	Example
E_1	To undermine others claims	Participant A: I decided it should be used because the technology is developing. Participant B: But in different parts of the world when the balance deteriorates, floods, storms and hoses can occur.
E_2	To support his/her own claim,	Because of climate change and global warming, the weather is sometimes cold and sometimes hot that's why agricultural products are decreasing and a lot of trees, many animals and people can be damaged.
E_3	To intentionally accepting the evidence of the other side,	Participant: Teacher, I think fossil fuels should be used, but this use should not be overrated, I mean it should be used valuable because we cannot effort the energy needs if it is not used.
E_4	To intentionally support other party with other evidences	Participant (renewable energy source in favor): Yes, it has advantages, if we use it consciously, the damage is reduced. For example, if the bulbs are more economical, then fossil fuels will be used less and losses in the world will be reduced. Technology will be even more important to us. They're bringing the end of the world in return of money.

The whole group and small group socio-scientific argumentation that recorded by voice recorder was transcribed. Because of the three different grade levels (6-7-8) and two different argumentation processes (whole and small), the analysis were performed on six different forms. After transcribing voice recordings, the dialogue between participants is divided into sections of opinion, which is defined as a claim that can be given with any possible reason during whole and small group argumentations. The analysis performed by the researchers on the relevant sections were compared by using the fit percentage formula proposed by Miles and Huberman (1994). The formula for determining the number of consensus and disagreement and calculating the reliability is as follows:

$$\text{Compliance Percentage} = \frac{\text{Consensus}}{\text{Consensus} + \text{Disagreement}} \times 100$$

Inter coder reliability rates was found as 84% (small group), and 89% (whole group) for the sixth-grade, 92% (small group), and 90% (whole group) for the seventh-grade, and 94% (small and whole group)for the eighth grade. The percentages obtained confirm that the coding is reliable (Miles and Huberman, 1994). The frequency values of the coding categories are presented in tables that allows comparison of whole group and small group argumentations in every grade level from the analyzes. Excerpts from the arguments created by participants in whole group and small group argumentation processes were named independent from the research in order to ensure the confidentiality of the identity information. (*Representative naming; WGG_6E_1: whole group sixth grade evidence 1*).

Findings

The aim of this study was to determine the functions of the evidence used by the sixth, seventh and eighth grade students during the whole group and small group socio-scientific argumentation, and to determine the differences with respect to grade level. The findings of the data analysis are presented in detail below; firstly, the findings of the students' answers to the knowledge test are presented. Afterwards, tables are presented which show the frequency and categories of evidence use in each group of grade level in socio-scientific argumentation.

Comparison of Conceptual Knowledge Levels According to Grade Level

Table 3 presents the findings obtained from the conceptual knowledge test scores of the students to determine their conceptual understanding of global climate change.

Table 3. Conceptual Knowledge Levels by Grade Level

	6th grade	**7th grade**	**8th grade**	**Total**
Participants	20	24	26	70
Mean Score	42,38	45,00	65,41	51,59

The results given in Table 3 show that secondary school students have low conceptual understanding of global warming and climate change. In other respects, it was found that the conceptual knowledge of the sixth and seventh grade students was very close to each other, and that the eighth-grade students had a higher conceptual understanding than the others.

Comparison of the Evidences Used In Whole Group Argumentations

Evidence from each grade level during the whole group argumentations of the participant through the socio-scientific scenario called ‘’Emerging Technology and Global Climate Change’’ analyzed with the help of the related analytical evaluation tool and presented comparatively in Table 4.

Table 4. Whole Group Argumentations by Grade Levels

Evidence Type	**6th grade (f)**	**7th grade (f)**	**8th grade (f)**	**Total Usage**
E_1	13	13	29	55
E_2	29	28	18	75
E_3	1	2	4	7
E_4	3	3	3	9
TOTAL	**46**	**46**	**54**	**146**

As it is seen in Table 4 where the evidence used during the big group argumentations according to class levels is compared in terms of certain categories of evidence, it is seen that the sixth and seventh grades have the same frequency in terms of total evidence use and that the eighth grade students are in the forefront in terms of the use of evidence.. It is also among the important findings that the evidence used by students from all class levels in the whole group argumentations mainly aims to support the claims. A similar finding was found when the class was compared specific to evidence categories with different characteristics. In terms of the E_1 category, which represents the evidence that students use in whole group argumentations to weaken the claims of others; the use

of E_1 in the eighth-grade argumentations was more than the sum of the other two classes (Table 4). Examples of each class level for the use of E_1 can be presented as follows.

> **WGG_6E_1:** Teacher, everybody says not to use but when you ask ‘’why?’’ everyone says because of cars, technology but they also use it. For example, nature is harmed when women squeeze deodorant. For example, deodorants, gases coming from refrigerators and many other things cause global warming.
> **WGG_7E_1:** Teacher, you know that they say that fossil fuels must be used, but people always use it in a bad way to harm animals and nature.
> **WGG_8E_1:** I object to my friend's claim. He/she says that factories produce more mass production, but there are wastes of factories, they harm the environment and cause the extinction of living things in water. He/she could not explain the effects of the climate.

In category (E_2), most common examples of the evidence used in the whole group argumentations in socio-scientific context are as follows:

> **WGG_6E_2:** I think that fossil fuels should not be used because it crates balance deterioration in nature.
> **WGG_7E_2:** Teacher I want to say something, Because of climate change and global warming, the weather is sometimes cold and sometimes hot that is why agricultural products are decreasing and a lot of trees, many animals and people can be damaged.
> **WGG_8E_2:** It is not something positive for me. Enough is as good as a feast so surplus of technology is also harmful with the development of technology, the need for energy will increase and the use of fossil fuels will increase. Global climate change will also increase.

The eighth-grade students were less likely to apply to this category of evidence than students of other grades are another interesting finding about the E2 category. The first of the rarest categories of evidence in whole group argumentations in socio-scientific context; The E3 category is to intentionally reason against own side with evidence. Here, participants tend to present thinking and arguments like the other side in order to convince the other party. Exemplary quotations from participant arguments are presented below.

> **WGG_6E_3:** Yes, it has negative impacts on climate. For examples people become sick because of poisonous gasses. It can even lead to death but we have to use it. Nothing happens without using it.
> **WGG_7E_3:** OK. Fossil fuels should be used, but this use should not be exaggerated, so something must be used valuable because if it is not used, we cannot meet the energy needs.
> **WGG_8E_3:** Fossil fuels have an impact on climate change. Because it can disrupt the balance of nature, hose, storm can cause. However, the benefits still prevail.

Exemplary excerpts from each grade level for category E_4 where equal use is available at all grade levels representing the evidence used to deliberately support counterparty's evidence with other stronger evidence are presented below.

> **WGG_6E_4:** My teacher ok we use it but we have to use it without using anything else. It has a negative impact on the climate, yes. For instance, he is sick people from poisonous gas and can lead to death in this case.
> **WGG_7E_4:** Firstly, fossil fuels are harmful, but we can prevent this, but it is also wrong to say that we should not use coal (fossil fuel) because if it were not for him, we would have a huge energy source. So the technology in the world will never move forward. I do not know if my idea will work, but, for example, they can use technology to compress many fossil fuels and make super energy fuel. Thus, both more energy and less gas such as carbon dioxide are emitted.
> **WGG_8E_4:** There are benefits yes, if we use it consciously reduce the damage. For example, if the bulbs were more economical then fossil fuels would be used less and the damages in the world would be reduced. Technology will be even more important to us. For the money, they bring the end of the world.

Comparison of the Evidences Used In Small Group Argumentations

Evidence from each class level during the whole group argumentations of the participants through the socio-scientific scenario called ‘’Emerging Technology and Global Climate Change’’ analyzed with the help of the related analytical evaluation tool and presented comparatively in Table 5.

Table 5. Small Group Argumentations by Grade Levels

Evidence Type	6th grade (f)	7th grade (f)	8th grade (f)	Total Usage
E_1	26	25	62	113
E_2	63	62	71	196
E_3	4	5	9	18
E_4	2	3	8	13
TOTAL	**95**	**95**	**150**	**340**

The findings in Table 5 show that the use of total evidence in small group argumentations is considerably greater than in whole group argumentations. When the related finding is examined in terms of class levels; It was found that the sixth and seventh grades had the same frequency values in terms of total evidence use, and the eighth grade students were far ahead in terms of the use of evidence. In addition, it is also important that the evidence used by students from all class levels in small group argumentations is mainly aimed at supporting the claims (E_2). It is also an important finding that evidence used by the students from all class levels is for more predominantly to support their own claims (E_2). Examples of each class level for the use can be presented as follows.

> **SGG_6E_2:** I think that fossil fuels have an impact on climate change. For example, it is written that the temperature increases in sea water due to global warming caused damage in the Pacific Ocean.
> **SGG_7E_2:** I think the use of fossil fuels is beneficial because if we didn't have fossil fuels, we wouldn't get warm, for example, those who burn natural gas would use it to warm up.
> **SGG_8E_2:** For example, renewable energy is being produced, but just for now, for example, the coal of course will end. When it finishes, factories will suddenly stop, everything will be expensive and then the famine and the economic crisis will begin.

Another important finding related to the category of evidence is that students from different grade levels use the frequency values close to each other. A similar finding was found when class comparisons were made in terms of categories of evidence with different characteristics. In terms of the E1 category, which represents the evidence that students use in small group argumentations to weaken the claims of other party; The use of E1 in the eighth-grade argumentations was more than the sum of the other two classes (Table 4). Exemplary uses are provided below.

> **SGG_6E_1:** But whenever we use fossil fuel, a gas called greenhouse gas emerges and it reflects the harmful lights of the sun, causes the seas to become warmer and the corals in the sea become destroyed and climate change.
> **SGG_7E_1:** But on the other hand, these fossil fuels disrupt the atmosphere of the world, With the deterioration of the world's balance, the animals in the nature, in forests and their homes can be destroyed because of natural disasters caused by global warming. İt is also has influences on the poles. The glaciers are melting, the bears die because of the glacier's melts.
> **SGG_8E_1:** But if there were no fossil fuel, there won't be coal. When we couldn't use coal, our house wouldn't warm up. Electricity could not be generated in thermal power plants, there would be no fuel in jets, planes, cars.

In small group argumentations in socio-scientific context, the first of the rare categories of evidence, as encountered in the same whole group argumentations; The E3 category is used to intentionally accept the evidence of the other party. It can be stated that the eighth-grade students are better than the students in other classes in this category of evidence. Exemplary quotations from participant arguments are presented below.

> **SGG_6E_3:** It has been recognized that fossil fuels have some harmful effects for humans and the environment, but I am still in the middle of the two.
> **SGG_7E_3:** Okay, yes, we really need to use technology, but people use fossil fuels really, really too much, and we see that global warming is increasing every day.
> **SGG_8E_3:** I also think that fossil fuels are beneficial, but in some respects it can be harmful. Because if the percolators are not attached to the chimney, toxic smoke damages the atmosphere. I think fossil fuels are also useful in some cases.

Findings in the E_4 evidence category, which emerged in small group argumentations, revealed that eighth grade students used this evidence category more than the students in other classes. Examples from each grade level for the category E_4 where equal use at all grade levels are presented below that are Evidence that is used to support the other party's evidence intentionally with other stronger evidence.

> **SGG_6E_4:** Yes, fossil fuel causes an increase in the greenhouse gasses in atmosphere. But the reason for preferring fossil fuel is that it is accessible and gives more energy.
> **SGG_7E_4:** We should use fossil fuels, but we should not use too much, you should also pay much attention. We shouldn't waste electricity either, because our fuel can be exhausted day by day, so everything is limited. For example, Oil is used for transportation and natural gas is also needed in the winter to warm up
> **SGG_8E_4:** I think fossil fuels are useful, but in some ways it can also be harmful. When technology develops, it can cure and heal diseases, but this time it kills with other damages. Let us to die in this way if technology wouldn't heal us completely. Do not let our World to be destroyed.

Conclusion and Discussion

This study focuses on the function of the evidence used in whole group and small group argumentations and how this function changes according to the grade level. For this purpose, firstly; the sixth, seventh and eighth grade students' conceptual knowledge levels about global climate change were tested. Then, the evidence they used during whole and small group argumentations through two different socio-scientific scenarios was analyzed by using an analytical evidence assessment tool. The first remarkable results reached in the light of the analysis is that the conceptual knowledge of the students included in the study on global climate change is quite low. However, it is also observed that eighth grade students are better in terms of their level of knowledge than the students in other grade levels. This result is consistent with the findings of similar studies in terms of the context of global climate change-information level in the literature (e.g. Karpudewan, Roth, & Abdullah, 2015). For example; Ulutaş (2013) found that secondary school students knowledge about global warming and climate change is quite low and the knowledge of the eighth-grade students differ significantly in the other grade levels. In addition, this result also reveals that the students involved in the socio-scientific argumentation in the context of global warming and climate change did not have sufficient knowledge before the implementation. This raises a possible rationality to test whether the level of knowledge of students on any subject context affects the quality of the arguments they generate, whether or not they apply to the evidence they use (Von Aufschnaiter, Erduran, Osborne, & Simon, 2008; Clark & Samspon, 2008). Analyzes conducted to determine the possible relationship between the level of conceptual knowledge and evidence function show that eighth grade students are better off in terms of evidence use than other students. The results of the sixth and seventh grade students' knowledge levels and the evidence they used during whole and small group argumentations were very similar. This result also confirms that students' level of knowledge affects the evidence they use as well as their argumentation. Another point that draws attention in the results of the research is that the total evidence used during small group argumentations is much higher than in whole group argumentations (e.g. Driver et al. 2000; Sadler, Chambers, & Zeidler, 2004; Sampson & Clark, 2011). This detail shows that the participants formed more arguments in small group argumentations and were able to express themselves better. Sampson and Clark (2009) suggests that learning outcomes can be seen more clearly because they have the advantage of evaluating the different cognitive levels of the students involved in small group argumentations using the same pool of knowledge, and this claim has consistency with research results.

The results obtained in this research, were also evaluated in the category of evidence in the analytical tool where students evaluate the evidence they use in whole and small socio-scientific argumentation processes. Accordingly, it is concluded that the students mainly tend to use evidence to weaken others claims (E_1) and to support their own claims (E_2). This result has consistency with the results of the research conducted by Iordanou and Constantinou (2014). The researchers suggested that the participant students generally used evidence to undermine others' claims or to support their own claims, and their metacognitive awareness in epistemological terms was quite low, and students should participate more frequently in argumentation processes to correct this situation. Similarly, it is concluded that the evidence used by secondary school students is often aimed at protecting their positions and their cognitive awareness is quite low in this study (Iordanou, 2010). The fact that students tend to use evidence rebuttal-oriented (E_1) and justification-oriented (E_2) in both whole and small socioscientific

argumentation processes was also reflected in the criterion components of the analytical assessment tools developed to evaluate the quality of student argumentation. For example, the primary determinant of argumentation quality according to the argumentation assessment scale developed by Erduran, Simon and Osborne (2004), is rebuttals, while the secondary determinant component is the justifications presented by the students. In according to another analytical assesment tool developed by Sadler and Fowler (2006), the number and nature of the justifications presented by the students are considered as the primary determinant of the quality of argumentation. Therefore, the fact that the students use predominantly justification-oriented and rebuttal-oriented evidence is a direction that confirms the criteria for analytical tools developed to determine the quality of argumentation.

Suggestions

As a result of the argumentation of the results obtained in this research on the basis of the relevant literature some suggestions may be given to increase the quality of science education and to contribute to the literature. The first of these is that it is aimed to increase the activities that will encourage the evidence used in socio-scientific argumentation processes of secondary school students in particular. If students participate in argumentation processes more frequently within science education, the opportunities will be provided for their meta-level awareness development. In addition, it may be necessary to include researches to examine the pedagogical competences of teachers and teacher candidates in order to include students in socio-scientific argumentation processes and to encourage the evidence used in different functions. In this way, both the role of teachers on the students' use of evidence will be determined and the opportunity to see and develop their pedagogical competences will be created. Finally, as the results of this study, it may be necessary to increase direct activities to increase the conceptual understanding of secondary school students with low levels of knowledge in the context of global climate change. In this way, students will be able to use valid evidence.

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