JOURNAL OF BALTIC SCIENCE EDUCATION

ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

EXAMINATION OF THE QUESTIONS USED IN SCIENCE LESSONS AND ARGUMENTATION LEVELS OF STUDENTS

Ibrahim Erdogan,
Ayse Ciftci,
Mustafa Sami Topcu

Abstract. *In this research the argumentation levels of the 5th, 6th and 7th grade students and the questions of the teachers and students were examined. The sample group of the research was selected according to the homogeneous sampling method. This research is a descriptive research. The data were collected by using a voice recorder. The data of this research were evaluated according to the descriptive analysis approach. As a result of the analysis, it was determined that the students used Level 1 argumentation which has the lowest quality more frequently in comparison with the higher ones and used the claim component more than other arguments and did not use the backing, qualifier, and rebuttal components. Furthermore, it was found that the questioning rates of the teachers were higher in comparison with the students and the questions of the teachers and students were usually at the levels of remembering and understanding. One of the factors that caused the argumentation level of the students to be low may have been that the teachers asked questions which were oriented to remembering. Therefore, the high level questions that ensure the initiation and continuation of the argumentation process should be inquired in the lessons.*

Keywords: *argumentation level, teachers and students' questions, science lessons, middle school students.*

Ibrahim Erdogan, Ayse Ciftci
Mus Alparslan University, Turkey
Mustafa Sami Topcu
Yıldız Technical University, Turkey

Introduction

That the application of learned subjects in science lessons to everyday life and information is understood judged and internalized by students are some of the main goals of science education. One of the approaches that may develop the high-order thinking skills such as decision making, scientific inquiry, critical, analytical and logical thinking and solving daily life problems is argumentation-based learning approach depending on the constructivist learning theory. Argumentation has an important role in the social construction of knowledge in science classes as students have the opportunity to structure knowledge by discussing together in the argumentation process. Therefore, that learning and applying the rules of the discussing by students in a science class where the small and large group discussions have occurred will contribute to the development of individuals who are science literate, is the most general aim of science education (Kaya & Kılıç, 2008).

That the students from Turkey are below average in science literacy in internationally conducted exams such as PISA and TIMSS indicates that science achievements of the students are low. According to the results of TIMSS (2011) which measures knowledge, application and reasoning abilities, although the students from Turkey have exhibited an improvement compared to previous years in terms of grades from science field in 2011, the average grade point is 463 in the fourth-grades and 483 in the eighth-grades and these results are below the TIMSS average scale (Oral & McGivney, 2013). According to the results of PISA (2012), which measures high-order skills such as scientific inquiry, scientific explanation, use of the learned things in daily life, the ratio of the students with the level 1 and below in terms of science literacy decreased between the years of 2006 and 2012 in Turkey. But, this ratio is still well above the ratio of students with level 1 and below in average of OECD (Ministry of National Education of Turkey, 2012). That the argumentation process making the students be active takes part in the educational environment, can lead to the progression in science literacy.

Argumentation consists of the mounting an argument and the supporting and refuting processes of this argument. According to Driver, Newton & Osborne (2000), argumentation is the basic practice of science and scientists. Argumentation is a series of speeches that are made in order to explain the two opposite status that are converse to each other, or it is an activity that is made in order to arrive at rational, logical decisions (Kaya & Kılıç, 2008). According to Berland & Reiser (2009), argumentation is a social activity that helps an individual to interpret the knowledge. According to Topçu (2015), the argumentation consists of the claims developed by students about scientific phenomena, and reasoning concerning to how and why these claims can be supported. Starting from these definitions, authors of this research can state the argumentation as a process that teaches the individual thinking and reasoning and consists of processes of defense or rebuttal of ideas in the context of evidences and makes science become a social action.

There are 6 components in Toulmin's Argumentation Model. While the data, claim and warrant which are first three of these 6 components are the basic components of an argument, the backings, rebuttal and qualifiers which are the other three components, are subsidiary components (Kaya & Kılıç, 2008). The definitions of these components, which take part in this model and the examples concerning these components given by Toulmin (1958), are shown in Figure 1 (Simon, Erduran & Osborne, 2006).

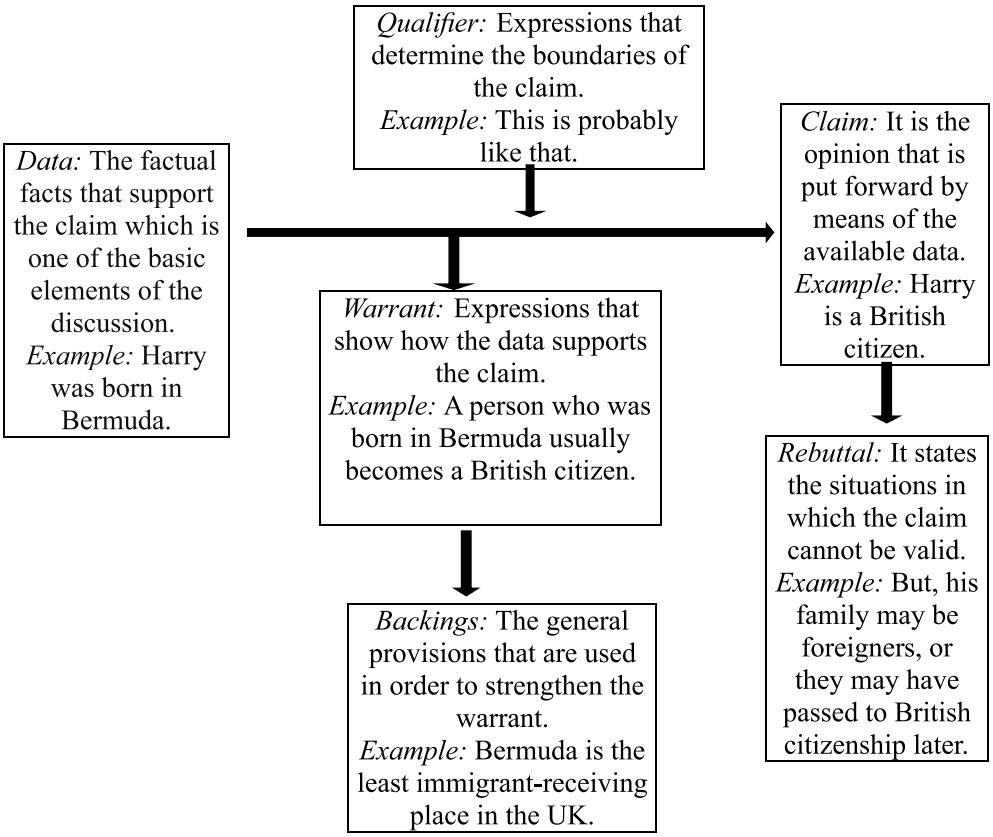

Figure 1: Toulmin argumentation model.

Teachers and Students' Questions and Argumentation

Argumentation requires responding to claims, arguments and opposite arguments, making explanations, asking questions and refuting alternative ideas (Chin & Osborne, 2010). "Questions" is one of the most important factors in providing communication in the learning environments. The questions of teachers and students in the classroom environment play a fundamental role at the starting and progressing of the argumentation process. The studies that have been done show that teachers usually have used closed-ended questions that do not refer students to the process of thinking at level of phenomenal knowledge (Blosser, 2000; Eliasson, Karlsson & Sørensen,

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

2017). However, in learning environments, the teachers' asking open-ended questions, is required to start and maintain the argumentation process.

Students are not being able to produce arguments that are insufficient in number and quality, and have difficulty during producing arguments (Patronis, Potari & Spiliotopoulou, 1999). Teachers' asking closed-ended questions that do not guide to a thinking process, can lead to students' having difficulty in producing arguments. It is also stated that the students have difficulty in producing questions requiring higher thinking skills (Chin & Osborne, 2010). Therefore, it is important that the students are provided with the necessary support in asking questions and producing arguments and training them in the scope of this subject. In addition, showing attention to the issue of teachers' being educated about effective questioning and argumentation in the teacher training programs, will contribute to students' establishing the qualified arguments. It is because of the fact that, the effective questioning structures that guide them to thinking process both facilitate the creation of a discussion environment and the generation of detailed and extensive arguments (Wang, 2005; Chun & Osborne, 2010).

Bloom's Revised Taxonomy

There are two dimensions which are called knowledge and cognitive process in this classification which was reordered in 2001. The knowledge dimension shows the content of the learning outcome. The cognitive process dimension shows how the learning outcome will be realized. The factual knowledge, conceptual knowledge, procedural knowledge, and metacognitive knowledge take part in the knowledge dimension. While, in the cognitive process dimension, there are steps of remembering, understanding, applying, analyzing, evaluating and creating. When compared to the old taxonomy, it is seen that the steps of creating and evaluation have changed their place. These steps and their explanations are given in Table 1 in detail.

Table 1. Structure of the revised taxonomy.

Knowledge Dimension	Cognitive Process Dimension
1. *Factual Knowledge* - They are the basic elements for students to identify a discipline or solve problems in discipline.	1. *Remember* – Retrieval of relevant information from long-term memory.
2. *Conceptual Knowledge* - Ensuring the interrelationships among the basic elements within a larger structure working together.	2. *Understand* - Determination the meaning of teaching messages, including oral, written and graphical communication.
3. *Procedural Knowledge* - How things are done; Using skills of the research methods and criteria, algorithms, techniques and methods.	3. *Apply* - Executing or using a function in a given state.
4. *Metacognitive Knowledge* - One's knowledge and awareness concerning own cognition, as well as cognition, in general.	4. *Analyze* - Separating the parts that make up the material, and identifying how they correlate with each other, with the general structure, or with the purpose.
	5. *Evaluate* - Making judgment by depending on criteria and standards.
	6. *Create* - Creating a new and consistent whole, or bringing the elements together to make an original product.

*** This table is taken from the research of Krathwohl (2002).*

Problem of Research, Previous Findings, Research Questions

The researches on the use of the argumentation-based learning approach in science education in the national and international field were usually examined, the effect of argumentation on learning the concept (Aslan, 2010; Çınar & Bayraktar, 2014; Driver et al, 2000; Kaya, 2012; Kıngır, 2011; Okumuş, 2012; Sadler, 2006; Teichert & Stacy, 2002; Venville & Dawson, 2010), academic achievement (Kıngır, 2011; Öğreten & Sağır, 2014; Özkara, 2011;

Üstünkaya & Savran Gencer, 2012; Yeşildağ Hasançebi & Günel, 2013) scientific knowledge skills (Ulu & Bayram, 2015), scientific process skills (Özkara, 2011) and quality of argument (Cetin, 2014; Kaya, 2012; Robertshaw & Campbell, 2013; Simon et al., 2006). Researches on argumentation in science education are generally aimed at examining the effects of argumentation after the activities based on argumentation were applied (e.g. Cetin, 2014; Munford, 2002; Osborne, Erduran & Simon, 2004; Simon et al., 2006). However, in the literature survey, it was determined that the number of researches in which the subject was studied without making any implementation concerning the argumentation were little (Aslan, 2014). In addition, although there are a lot of researches in order to examine the skills of argumentation in the national and international literature, it was determined that there was a limited number of research on the questions used in the classroom environment, and argumentation process (Günel, Kıngır & Geban, 2012). In the light of the deficiencies that were mentioned above, in this research, it was tried to learn about the level of argumentation applied in the classroom environment and examine the argumentation skills of students and the questions used in the classroom environment. Hence, this research is important in terms of contributing to a small number of studies on the co-examination of teacher-student questions and argumentation skills, and providing ready-made data to researchers about "what level of argumentation is being applied in classroom environment". The aim of this research is to examine the questions used in science courses and the argumentation skills of 5th, 6th and 7th grade students. In accordance with this general purpose, the answers were sought for the following research questions:

1. What is the level of argumentation skills of 5th, 6th and 7th grade students?
2. What is the level of the questions that are used in the science courses in 5th, 6th and 7th grades?

Methodology of Research

General Background

This research was carried out in February and March in the spring semester of the 2014-2015 academic year. Qualitative research was preferred for in depth-examination of the subject in the research. This research is a descriptive research and it is a situation determination. According to Arıkan (2007), descriptive researches reflect the situation as it is. Within this context, the level of questions used in science classes and the argumentation level of the students were tried to be described without intervention.

Sample

The participants of this research, which was conducted in the academic year of 2014-2015, were selected according to the analogous sampling method which is one of the purposeful sampling methods. The sample of the research consists of 4 middle schools with similar socioeconomic levels and academic achievement. The 129 students (70 girls and 59 boys) from the 5th grade, 127 students (58 girls and 69 boys) from the 6th grade and 131 students (65 girls and 66 boys) from the 7th grade were included in the research. A total of 12 science teachers, 6 female and 6 male, participated in the research. Besides, the voice recorder was used in the research, which was made with the permission of the teachers and students.

Instrument and Procedures

Data sources that were used in the research were audio recordings taken in the lessons. In this research, 5th, 6th and 7th grade students from each school were selected, and audio recordings were taken in science classes for 1920 minutes, namely 48 lesson hours in 12 different classes. The researcher noted student expressions during the course in order to prevent data loss. The research was carried out in the subject of "Spread of Sound and Light", "Traveling the World of the Creatures and Knowing Them" and "Indispensable of Our Life: Electricity" in 5th grade, in the subject of "Reproduction, Growth and Development in Plants and Animals" and "Matter and Heat" in the 6th grade and in the subject of "Structure and Properties of Matter" in the 7th grade.

The audio recordings were transferred to the computer and the transcripts were given to the teachers for examining them. Some parts of them were removed from the documents due to the objections to transcripts. A total of 187 pages of written documents were prepared.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Data Analysis

The data set that was obtained from the research was evaluated according to the descriptive analysis approach. The purpose of this analysis type is to present the findings to the reader in an organized and interpreted way (Yıldırım & Şimşek, 2013). The qualitative data was converted to quantitative data by calculating frequency (f) and percentage (%).

In the first instance, student expressions were coded with argumentation components such as counter-argument, data, warrant, backings, qualifiers and rebuttal which are in the Toulmin Argumentation Model (1958). Later on, these arguments were separated into the levels, according to the rubric which was developed by Erduran, Simon & Osborne (2004). The rubric, that was used in evaluating the quality of the arguments, is shown in Table 2. All written documents are coded by two researchers independent of each other. The inter-encoder reliability was calculated by the formula of [Miles and Huberman (1994: 64)] ([Consensus / Consensus + Divergence] * 100), and it was found as 91%. The researchers tried to compromise by discussing in the parts where there was no consensus. As a result of the discussions that were made, the parts that cannot be reached as consensus were removed from written documents. The questions used in the classroom environment were analyzed according to the "Bloom's Revised Taxonomy" (see Table 1). The encoder reliability in the analysis of the questions according to the Bloom's Taxonomy was calculated as 96%.

The errors that may have occurred were tried to be reduced by the data encoded by two researchers to ensure reliability in the research. In order to ensure the validity of the research,

1. It was mentioned in detail about how the research findings are obtained.
2. In order to eliminate the deficiencies of voice recording process, such as missing some words of participants because of low voice or hoarse voice, dialogs were put down on paper by researcher.
3. Direct quotations were made from the arguments of students and questions used in the classroom environment.

Table 2. Argumentation levels (Erduran et al. (2004)).

Level 1:	In this level, there is only a claim, or there are other claims that are presented against to a claim. Data, warrant, backings and rebuttal do not take part at this level.
Level 2:	This level includes claim and another claim in which data, warrant and backings are used against to this claim. But it does not contain any rebuttal.
Level 3:	It includes the claim and the claim or counterclaim including data, warrant, backings and weak rebuttal against to this claim.
Level 4:	It means arguments with a claim including explicitly identified rebuttals. This level may have the counterclaims.
Level 5:	This level of argumentation includes a broader argumentation involving more than one rebuttal and the use of all argumentation components.

Results of Research

Argumentation Components

The use of frequency of the argumentation components of 5th, 6th, and 7th grades is given in Figure 1. According to Figure 1, the claim component was used as 519 times in the 5th grade, as 399 times in the 6th grade and as 644 times in the 7th grade. It is seen that the counterargument component is rarely used, and the number of use is 7 in the 5th grade, 12 in the 6th grade and 13 in the 7th grade. As the class level increased, the frequency of the data component increased. But the same situation was not valid for the warrant component, because the warrant component was mostly used by 5th grade students. This component was used 49 times in the 5th grade, 35 times in the 7th grade, and 5 times as a very low rate in the 6th grade. Backings, qualifier and rebuttal components were not used in any class.

Table 1. Frequencies of the argumentation components.

	Claim	Counter-claim	Data	Warrant	Backing	**Qualifier**	Rebuttal
5th Grade	519	7	4	49	0	0	0
6th Grade	399	12	18	5	0	0	0
7th Grade	644	13	47	35	0	0	0

Argumentation Levels

Level 3, Level 4 and Level 5 arguments were not reached in the recorded data in this research. Therefore, the dialogue examples involving Level 1 and Level 2 argumentation are given below.

Examples of Level 1 Argumentation

Dialogue 1:

"Teacher: What does the Electroscope do?

Student 15: My teacher, the electroscope indicates the charge. ***(Claim)***

Student 20: No, it indicates whether it is charged or not. ***(Counterclaim)***

Teacher: What is the electroscope? The device that shows electrical charge of substance is termed as an electroscope. Well, what we name the electroscope if its leaves are closed?

Student 3: Neutral. ***(Claim)***

Teacher: What if it is open?

Student 8: charged. ***(Claim)***

Teacher: We cannot say anything certain. It could be positively charged, or it could be negatively charged ".

Dialogue 2:

"Teacher: Seeds are formed after the ovule is developed; and when the ovary is developed, the fruit is formed. The fruit is formed by the ovary being covered with pulp. As you see, first pollination, and then fertilization occurred, and afterwards the seed and the fruit are formed. Alright, kids, we have a subject named spreading the seeds. How is the seed spread? Please use your imagination a little.

Student 4: It spreads by budding. ***(Claim)***

Teacher: For example, can not the seed in İzmir come to Mus? Students: It can. ***(Claim)***

Student 7: It may come with the wind, I think. ***(Claim)***

Teacher: Of course, it depends on the seed. If it is a peach seed, it will not be spread with the wind. However, some seeds are small. They can be spread from one place to another with the wind.

Student 14: It can be spread by the cloud. ***(Claim)***

Teacher: How is it spread by the cloud?

Student 14: It is spread by passing over the cloud. ***(Claim)***

Student 21: It is transported by water and animals. ***(Claim)***

Teacher: How do the animals transport?

Student 12: They are transported by bees. ***(Claim)***

Student 11: It can be carried by trucks. ***(Claim)****".*

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Examples of Level 2 Argumentation

Dialogue 1:

"Teacher: Then what is to the bulb brightness? A battery can operate a light bulb, right? There is a battery for per bulb. The brightness of the three of them may be equal. What do you understand from the figure that I draw?

Student 5: It gives a moderate light in that way. But, the light bulb in figure II gives more light, since three batteries are connected to it. ***(Claim, Warrant)***

Teacher: Another idea?

Student 13: My teacher, it gives less light because there is only one battery in Figure I. Whereas, there are three batteries in the second figure. ***(Claim, Warrant)****".*

Dialogue 2:

"Teacher: One of the reptiles changes color according to the danger when there is a danger in the environment. For example, it turns green when it climbs to the green leaf, and turns brown when it is holding the trunk of the tree. Which animal is this? It is a chameleon. What do we call the name of this behavior? It comes from camouflage. We call it being camouflaged. Being camouflaged is hiding. Why does the chameleon change color? What if it doesn't change colors like other creatures? Why does it need to hide?

Student 2: They hide because they want to be protected from danger. ***(Claim, Warrant)***

Teacher: What else could it be?

Student 17: They hide to prevent being bait. ***(Claim, Warrant)***

Teacher: Yes, this is the first one. Not to be hunted by enemies, not to be bait.

Student 22: They hide to hunt other living things so that other creatures cannot see them. ***(Claim, Warrant)***

Teacher: Yes, for example, what is the chameleon fed with? With flies. If the fly sees it, it will not come closer to the chameleon. So that, it is hidden."

Findings regarding how many times each of the argumentation levels was used by 5th, 6th, and 7th grade students are given in Figure 2. If we express as a percentage; it is seen that the 5th grade students used level 1 at the rate of 90.8% and level 2 at the rate of 9.2%, the 6th grade students used level 1 at the rate of 98.8% and level 2 at the rate of 1.2% and the 7th grade students used level 1 at the rate of 94.8% and level 2 at the rate of 5.2%. It is seen that level 3, level 4 and level 5 were never used.

Table 2. Frequencies of the argumentation levels.

	Level 1	Level 2	Level 3	Level 4	Level 5
5th Grade	479	49	0	0	0
6th Grade	408	5	0	0	0
7th Grade	629	35	0	0	0

Teachers and Students' Question Levels

The sample questions are given below, in order to show how the questions are analyzed in the research.

Students' Questions:

"What is the substance in the structure of the coin? ***(Factual knowledge, Remember)***

Are the eggs of the fish soft? ***(Factual knowledge, Remember)***

Do fish wait upon their juveniles? ***(Factual knowledge, Remember)***

Cannot we satisfy our need for water by eating mushrooms, which are 90% water, as our bodies are 70% water? ***(Conceptual Knowledge-Understand)***

Are there the same amounts of spaces in all of the flowers? ***(Conceptual knowledge -Understand)***

Can the flowers survive if there is no daytime? ***(Conceptual Knowledge-Understand)****"*

Teachers' Questions:

"Which kind of parts does the flower consist of? ***(Factual knowledge, Remember)***

Is atomic mass determined by the atomic nucleus or determined by the layers in which electrons exist? ***(Factual knowledge, Understand)***

What are the differences and similarities between sexual and asexual reproduction? ***(Conceptual Knowledge, Understand)***

*Can we say that there are at least two different particles in an atom****? (Conceptual Knowledge, Evaluate)***

Can the atom break up? ***(Conceptual Knowledge, Evaluate)***

When we increase the number of bulbs, what is the reason for the decrease in brightness? ***(Conceptual Knowledge, Analyze)***

When we think about the mass of protons, neutrons and electrons, how many thousand grams of weight does the atomic nucleus have? ***(Procedural Knowledge, Apply)***

What kind of solution do you develop to protect endangered species? ***(Conceptual Knowledge, Create)***

What do carbon dioxide, water, and sunlight constitute together? ***(Factual Knowledge -Remember)***

What are the benefits obtained from the plants? ***(Factual Knowledge -Remember)****"*

Findings that are related to the questions of science teachers for the 5th grade are given in Figure 3. When we look at the distribution of questions asked by science teachers in the 5th grades during the course according to "Bloom's Revised Taxonomy", it was determined that 50.2% of the 463 questions were in the remembering step, 38.4% of them in the understanding step, 7.1% of them in the analysis step, 3.4% of them in the evaluation step and 0.9% of them in the metacognitive step and no questions were given concerning the application step. When the questions were analyzed according to the knowledge domain, it was determined that 52.3% of them were in the factual knowledge domain and 47.7% of them were in conceptual knowledge domain. It was found that questions containing metacognitive and procedural information were not used.

Table 3. Frequencies of the question levels of science teachers in 5th grades.

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	232	10	0	0	0	0
Conceptual	0	168	0	33	16	4
Procedural	0	0	0	0	0	0
Metacognitive	0	0	0	0	0	0

Findings that are related to questions of students in the 5th grades are given in Figure 4. According to the cognitive process domain, 30.9% of the questions that 5th grade students asked in the lessons are in the remembering step, 61.8% of them are in the understanding step and 7.3% of them are in the analysis step. It is seen that questions about application, evaluation and creation steps were not given. According to the knowledge domain, it was determined that 30.9% of the questions were in the factual knowledge domain and 69.1% of them were in the conceptual knowledge domain. It was found that questions containing the metacognitive and procedural knowledge were not used.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Table 4. Frequencies of the question levels of 5th grade students.

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	17	0	0	0	0	0
Conceptual	0	34	0	4	0	0
Procedural	0	0	0	0	0	0
Metacognitive	0	0	0	0	0	0

Findings that are related to questions of teachers of the 6th grade are given in Figure 5. When we look at the distribution of the questions that were asked by science teachers during lessons in the 6th grade according to Bloom's Revised Taxonomy, it was determined that 53.4% of the 432 questions were in the remembering step, 40.5% of them were in the understanding step, 4.9% of them were in the analysis step and 1.2% of them were in the evaluation step which are the steps of cognitive step, and no questions were used regarding the application and the creating step. When the questions are analyzed according to the knowledge domain, it was determined that 55.7% of them were in the factual knowledge domain and 44.3% were in conceptual knowledge domain. It was found that questions containing the metacognitive and procedural information were not used.

Table 5. Frequencies of the question levels of science teachers in 6th grades.

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	231	10	0	0	0	0
Conceptual	0	165	0	21	5	0
Procedural	0	0	0	0	0	0
Metacognitive	0	0	0	0	0	0

Findings that are related to questions of students in the 6th grades are given in Figure 6. According to the cognitive process domain, 61.9% of the questions that were asked by 6th grade students during the lessons were in the remembering step, 35.8% of them were in the understanding step and 2.3% of them were in the analysis step. It is seen that questions concerning application, evaluation and creating step were not used. According to the knowledge domain, 78.6% of the questions were in the factual knowledge domain and 21.4% of them were in the conceptual knowledge domain. It was found that the questions containing the metacognitive and procedural knowledge were not used.

Table 6. Frequencies of the question levels of 6th grade students.

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	26	7	0	0	0	0
Conceptual	0	8	0	1	0	0
Procedural	0	0	0	0	0	0
Metacognitive	0	0	0	0	0	0

Findings that are related to questions of teachers of the 7th grades are given in Figure 7. When looking at the distribution of questions that were asked by the science teachers in 7th grades according to Bloom's Revised Taxonomy, it was determined that 45.4% of the 536 questions were in the remembering step, 34.1% of them were in the understanding step, 13.1% of them were in the application step, 3.7% of them were in the analysis step and 3.7% of them were in the evaluation step which are in the cognitive domain, and no questions were used concerning the creating step. When the questions were analyzed according to the knowledge domain, it was determined that 50.3% of them were in the factual knowledge domain, 45.2% of them were in the conceptual knowledge domain and 4.5% of them were in the procedural knowledge domain. It was seen that questions containing the metacognitive were not used.

Table 7. Frequencies of the question levels of science teachers in 7th grades.

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	242	28	0	0	0	0
Conceptual	1	155	46	20	20	0
Procedural	0	0	24	0	0	0
Metacognitive	0	0	0	0	0	0

Findings that are related to questions of students in the 7th grade are given in Figure 8. According to the cognitive process domain, 52.8% of the questions that were asked by 7th grade students in the lessons were in the remembering step, 41.7% of them were in the understanding step, 2.8% of them were in the analysis step and 2.7% of them were in the evaluation step. It is seen that the questions concerning the application and creating steps were not used. According to the knowledge domain, it was determined that 61.1% of the questions were in the factual knowledge domain and 38.9% of them were in the conceptual knowledge domain. It was found that the questions containing the metacognitive and procedural knowledge were not used.

Table 8. Frequencies of the question levels of 7th grade students.

	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual	19	3	0	0	0	0
Conceptual	0	12	0	1	1	0
Procedural	0	0	0	0	0	0
Metacognitive	0	0	0	0	0	0

Discussion

In this research, it was determined that the students were successful in using the claim component (Abi-El-Mona & Abi-El-Khalick, 2006; Aslan, 2014; Aymen Peker, Apaydın & Taş, 2012; Öğreten & Sağır, 2014) but they failed at using the rebuttal component which shows the quality of argumentation (Aymen Peker et al., 2012; Öğreten & Sağır 2014). That the rebuttal component has an important place for determining the quality of the argumentation, has been emphasized by many researchers (Erduran et al., 2004; Kuhn, 1991; Osborne et al., 2004). In addition, it was determined that the backing and qualifier components were never used, and the counterclaim, data and warrant components were used at a low rate. By applying activities based on argumentation in learning environments, it may be ensured increasing in the usage level of these components.

It was determined that students used the arguments at Level 1 and Level 2 and they did not use the arguments at Level 3, Level 4 and Level 5, the highest quality ones. It was identified that the students generally failed to produce quality arguments. That Turkish students' scores have been below the average at the TIMSS exam which measures knowledge, application, reasoning skills and also that they score below average at PISA exam which measures scientific inquiry, scientific explanation and using scientific proof, can be explained by the fact that argumentation-based learning approach has not been used during the lessons. Because, by ensuring the argumentation process to be used in the educational environment, students can make progress in terms of scientific reasoning and showing scientific evidence for their claims.

Factors such as teacher questions, research group, and the fact that the units are different may be influential in the results. If the modern approaches are used substituted for of traditional teaching methods, if the classroom size is reduced, if the face to face seating order is formed instead of traditional seating order in the classroom and if the group study is encouraged, students can produce arguments having better quality in the discussions along with social interaction. Vygotsky defends that social circle should be created in the classroom, students should study together, and they should discuss the meanings that they give to concepts in order to carry out an effective science education and teaching (Çakıcı, 2012). Similarly, Kaya and Kılıç (2010) defend that students should enter into dialogues that support the discussion process in order to the effective science teaching can be realized.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Consequently, teachers should ensure that the activities based on argumentation that provide an environment of social interaction are included in their lessons.

In this research, it was determined that 91.5% of the 1564 questions asked in 12 classes throughout 48 lessons belonged to the teachers and the others belonged to the students in a very low rate like 8.5%. In addition, it was determined that most of the questions of teachers and students were oriented to the level of the factual knowledge-remembering and conceptual knowledge-understanding and it was usually determined that they were oriented to the reminding of knowledge. Similarly, the conclusion was reached that the majority of the questions usually were at the level of remembering in the other studies investigating questions of teachers (Dindar & Demir, 2006; Özcan & Oluk, 2007; Ayvacı & Türkdoğan, 2010). The questions that support the argumentation process should be included in the lessons for the explanation and internalization of knowledge. Teachers should ask the questions that support the argumentation process such as "Why do you think so?", "How do you support your opinion?". Günel, Kıngır and Geban (2012) determined that questioning strategies of teachers and the level of application were effective on the formation and continuance of the negotiation process in the classroom, and they were determined that there is a relationship between the questioning strategy of teacher and the questions generated by students. In addition, Kılıç (2016), in his research in which he investigated questions of teachers in the classrooms where the argument-based science learning approach was applied, determined that the metacognitive questions were the most effective question type in responding of students at the high cognitive level.

While the questions of teachers were fewer in the discussions that were created by the students, the rate of the questions of students were more (van Zee, Iwasyk, Kurose, Simpson & Wild, 2001). However, in the researches, similar to the results that were obtained from this research, it is stated that the questions of teachers are too much in classroom environments (Erdoğan, 2009; Floyd, 1960) and the questions of students are fewer (Dillon, 1988; Lemke, 1990). Whereas, questions of students contribute to the discussion process (van Zee et al., 2001). The questions of students are important in terms of negotiations between students and between teacher and students (Günel et al., 2012), and they support argumentation and critical thinking (Chin & Osborne, 2010). Therefore, a classroom environment where students can easily ask their questions should be created by the teachers (Arnold, 2016).

Since the discussion is an inherent part of science, it is necessary for teachers to be guiding for students in the mounting of argument, defending and discussion culture. Wang (2005) reached the conclusion in his research that the effective question structures and the discussion have improved intellectual thinking of students and facilitated the knowledge configuration process. Moreover, argumentation production of students should be supported not only by the question structure but also supported by using different argumentation components such as claims, data, warrant and backings (Chin & Osborne, 2010).

Conclusions

The results obtained from this research indicated that the questions of teachers and students were mostly information oriented, that questioning rates of the teachers were high and that both questioning rates and argumentation levels of students were low. Additionally, this research shows that students are successful in presenting claims, while they fail to use argumentation items such as data, warrant, and rebuttal.

In science education, it is important for students to be active, ask questions, build quality arguments, and express their thoughts in a comfortable way. Argumentation and effective question structures guide students to the thinking process. One of the reasons for the low argumentation levels of the students may be the fact that teachers ask questions that are often information-based. Therefore, prospective teachers and teachers should continuously be informed about effective questioning and argumentation practices and they should be trained regarding these practices. This research is important because it provides information on the questions used in science classes and the argumentation level of students; and contributes to the studies on the subject, which are in a limited number. It is also thought that this research will be a guide for the studies on questioning and argumentation.

Recommendations

Recommendations for Implementation

1. Teachers should encourage their students to ask questions, since the questions are indicative of interest and curiosity, and because they improve the scientific inquiry skills.

2. Prospective teachers with the pre-service trainings and teachers with in-service trainings should be informed about how they will apply the argumentation in learning environments.
3. Teachers should allow the activities that provide to comprise of the argumentation atmosphere.
4. Since new knowledge is structured by using the foreknowledge, teachers should try to remind their foreknowledge to students.
5. The argumentation method can be used more effectively if the learning environments and materials are organized in a way that the students are active in the classes and are engaged in scientific practices.
6. Because of the fact that the argumentation process is based on the active participation of the students, teachers can use this process to identify and eliminate the deficiencies of the students.

Recommendations for Future Research

1. The reasons for not implementing the argumentation in classes and not using the question structures that provide the development of high-level thinking skills can be examined in more detail by carrying out interviews with teachers and students, in the future studies.
2. The development of the argumentation skills can be examined by giving argumentation trainings to the students.
3. The changes in question levels can be examined by training the teachers.
4. The students' argumentation skills can be assessed by using the dilemmatic daily life problems.
5. In this study, the quality of the arguments established by the students was examined through verbal argumentation in the classroom environment. In another study, the level of argumentation of teachers and students can be examined through written argumentation.
6. Similar studies can also be conducted at primary, high school and university levels and the issue that whether the degree of argumentation varies proportionally with the age and class level can be analyzed comparatively.

Acknowledgements

The authors would like to thank the teachers and students, who participated in the research.

References

Abi-El-Mona, I., & Abi-El-Khalick, F. (2006). Argumentation discourse in a high school chemistry classroom. *School Science and Mathematics, 106* (8), 349-361.

Arıkan, R. (2007). *Araştırma teknikleri ve rapor hazırlama* [Research techniques and report preparation]. Ankara: Asil Yayın Dağıtım.

Arnold, L. (2016). *Strategies to support student argument and argumentative writing in a secondary STEM classroom*. MS thesis, State University of New York, USA.

Aslan, S. (2010). Tartışma esaslı öğretim yaklaşımının öğrencilerin kavramsal algılarına etkisi [The effect of argument based teaching approach on conceptual perception of students]. *Kastamonu Education Journal, 18* (2), 467-500.

Aslan, S. (2014). Analysis of students' written scientific argument generate and evaluation skills. *Journal of Theory and Practice in Education, 10* (1), 41-74.

Aymen Peker, A., Apaydın, Z., & Taş, E. (2012). Isı yalıtımını argümantasyonla anlama: İlköğretim 6. sınıf öğrencileri ile durum çalışması [Understanding of heat insulation with argumentation: Case study with primary 6th grade students]. *Dicle University Social Sciences Institute Journal, 4* (8), 79-100.

Ayvacı, H. Ş., & Türkdoğan, A. (2010). Yeniden yapılandırılan Bloom taksonomisine göre fen ve teknoloji dersi yazılı sorularının incelenmesi [Investigation of written exam questions according to restructured Bloom taxonomy]. *Journal of Turkish Science Education, 7* (1), 13-25.

Balcı, A. (2015). *Sosyal bilimlerde araştırma: Yöntem teknik ve ilkeler* [Research in social sciences: Methods, techniques and principles]. Ankara: Pegem Akademi Publishing.

Berland, L. K., & Reisier, B. J. (2009). Making sense of argumentation and explanation. *Science Education, 93* (1), 26-55.

Blosser, P. E. (2000). *How to ask the right questions*. Arlington: NSTA Press.

Cetin, P. S. (2014). Explicit argumentation instruction to facilitate conceptual understanding and argumentation skills. *Research in Science and Technological Education, 32* (1), 1-20.

Chin, C., & Osborne, J. (2010). Supporting argumentation through students' questions: Case studies in science classrooms. *The Journal of the Learning Sciences*, *19* (2), 230-284.

Çakıcı, Y. (2012). *Fen ve teknoloji öğretiminde yapılandırmacı yaklaşım* [Costructivist approach in science and technology teaching]. In Ö. Taşkın (Ed.), *Fen ve teknoloji öğretiminde yeni yaklaşımlar* [New approaches in science and technology teaching]

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

(pp. 275-293). Ankara: Pegem A Publishing.

Çınar, D., & Bayraktar, Ş. (2014). Evaluation of the effects of argumentation based science teaching on 5th grade students' conceptual understanding of the subjects related to "matter and change". *International Journal of Education in Mathematics, Science and Technology, 2* (1), 49-77.

Dillon, J. T. (1988). The remedial status of student questioning. *Journal of Curriculum Studies, 20*, 197-210.

Dindar, H., & Demir, M. (2006). Beşinci sınıf öğretmenlerinin fen bilgisi dersi sınav sorularının Bloom taksonomisine göre değerlendirilmesi [Evaluation of fifth grade primary teachers' questions in science exams according to Blooms' taxonomy]. *Gazi University Journal of Gazi Educational Faculty*, *26* (3), 87-96.

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

Eliasson, N., Karlsson, K. G., & Sørensen, H. (2017). The role of questions in the science classroom–how girls and boys respond to teachers' questions. *International Journal of Science Education*, *39* (4), 433-452.

Erdoğan, İ. (2009). Altıncı ve yedinci sınıf öğrencilerinin fen bilgisi, matematik ve Türkçe dersindeki hareketlerinin incelenmesi [Investigation of sixth and seventh grade students' actions at the science, mathematics and Turkish lessons]. *Kastamonu Education Journal, 17* (3), 955-966.

Erduran, S., Simon, S., & Osborne, J. (2004). Tapping into argumentation: developments in the application of Toulmin's Argument Pattern for studying science discourse. *Science Education, 88* (6), 915-933.

Floyd, W.D. (1960). An analysis of the oral questioning activity in selected Colorado primary classrooms. (Unpublished doctoral dissertation). Colorado State University, USA.

Kaya, E. (2012). *Argümantasyona dayalı etkinliklerin öğretmen adaylarının kimyasal denge konusunu anlamalarına etkisi* [The effect of argumentation-based activities on teacher candidates' understanding of chemical balance]. Paper presented at X. National Science and Mathematics Education Congress, Niğde, Turkey.

Kaya O. N., & Kılıç, Z. (2008). Etkin bir fen öğretimi için tartışmacı söylev [Argumentative discourse for the effective teaching of science]**.** *Ahi Evran University Kırşehir Education Faculty Journal, 9* (3), 89-100.

Kaya, O. N., & Kılıç, Z. (2010). Fen sınıflarında meydana gelen diyaloglar ve öğrenme üzerine etkileri [Types of dialogs and their effects on learning in science classrooms]. *Kastamonu Education Journal, 18* (1), 115 – 130.

Kılıç, B. (2016). Investigating questioning patterns of teachers through their pedagogical progression in argument-based inquiry classrooms. MS thesis, Middle East Technical University, Ankara, Turkey.

Kıngır, S. (2011). Using the science writing heuristic approach to promote student understanding in chemical changes and mixtures. PhD thesis, Middle East Technical University, Ankara, Turkey.

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into Practice*, *41* (4), 212-218.

Kuhn, D. (1991). *The skills of argument.* Cambridge: Cambridge University Press.

Lemke, J. L. (1990). *Talking science: Language, learning, and values.* Norwood: Ablex.

Miles, M.B., & Huberman, A. M. (1994). *Qualitative data analysis*. Thousand Oaks, Ca: Sage Publications.

Ministry of National Education of Turkey (2012). *Milli eğitim bakanlığı, yenilik ve eğitim teknolojileri genel müdürlüğü, PISA 2012 ulusal ön raporu* [Ministry of National Education, Directorate General of Innovation and Education Technologies, PISA 2012 national preliminary report]. Ankara, Turkey.

Munford, D. (2002). Situated argumentation, learning and science education: A case study of prospective teachers' experiences in an innovative science course. (Doctoral dissertation). The Pennsylvania State University, USA.

Okumuş, S. (2012). "Maddenin halleri ve ısı" ünitesinin bilimsel tartışma (argümantasyon) modeli ile öğretiminin öğrenci başarısına ve anlama düzeylerine etkisi [The effects of argumentation model on students achievement and understanding level on the unit of states of matter and heat]. MS thesis, Karadeniz Technical University, Trabzon, Turkey.

Oral, I., & McGivney, E. (2013). *Türkiye'de matematik ve fen bilimleri alanlarında öğrenci performansı ve başarının belirleyicileri* [Student performance in mathematics and science in Turkey and determinants of success]. Report, İstanbul: Education Reform Initiative.

Osborne, J., Erduran, S., & Simon, S. (2004). Enhancing the quality of argumentation in school science. *Journal of Research in Science Teaching, 41* (10), 994-1020.

Öğreten, B., & Sağır, Ş. (2014). Argümantasyona dayalı fen öğretiminin etkililiğinin incelenmesi [Examining the effectiveness of argumentation based science teaching]. *Journal of Turkish Science Education, 11* (1), 75-100.

Özcan, S., & Oluk, S. (2007). İlköğretim fen bilgisi derslerinde kullanılan soruların Piaget ve Bloom taksonomisine göre analizi [Analysis of questions used in science lessons at primary school according to Piaget and Bloom taxonomy]. *Dicle University Journal of Ziya Gökalp Faculty of Education, 8,* 61-68.

Özkara, D. (2011). Basınç konusunun sekizinci sınıf öğrencilerine bilimsel argümantasyona dayalı etkinlikler ile öğretilmesi [Teaching pressure subject to eight class students with activities based on scientific argumentation]. MS thesis, Adıyaman University, Adıyaman, Turkey.

Patronis, T., Potari, D., & Spiliotopoulou, V. (1999). Students' argumentation in decision-making on a socio-scientific issue: Implications for teaching. *International Journal of Science Education, 21* (7), 745-754.

Robertshaw, B., Campbell, T. (2013). Constructing arguments: Investigating pre-service science teachers' argumentation skills in a socio-scientific context. *Science Education International, 24*(2), 195-211.

Sadler, T.D. (2006). Promoting discourse and argumentation in science teacher education. *Journal of Science Teacher Education, 17* (4), 323- 346.

Simon, S., Erduran, S., & Osborne, J. (2006). Learning to teach argumentation: Research and development in the science classroom. *International Journal of Science Education, 28* (2–3), 235–260.

Teichert, M., & Stacy, A. M. (2002). Promoting understanding of chemical bonding and spontaneity through student explanation and integration of ideas. *Journal of Research in Science Teaching, 39,* 464-496.

Topçu, M.S. (2015). *Sosyobilimsel konular ve öğretimi* [Teaching of socio-scientific issues]. Ankara: Pegem A Publishing.

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

Ulu, C., & Bayram, H. (2015). Effects of teaching method based on the science writing heuristic approach on science process skills. *Hacettepe University Journal of Education, 30(1),* 282-298.

Üstünkaya, I., & Savran Gencer, A. (2012). *İlköğretim 6. sınıf seviyesinde bilimsel tartışma (argumentation) odaklı etkinliklerle dolaşım sistemi konusunun öğretiminin akademik başarıya etkisi* [The impact of argumentation based activities on academic achievement of 6th grade students in the teaching of the circulatory system]. Paper presented at X. National Science and Mathematics Education Congress, Niğde, Turkey.

van Zee, E., Iwasyk, M., Kurose, A., Simpson D., & Wild, J. (2001). Student and teacher questioning during conversations in science. *Journal of Research in Science Teaching, 38* (2), 159–190.

Wang, C. H. (2005). Questioning skills facilitate online synchronous discussions. *Journal of Computer Assisted Learning*, *21* (4), 303-313.

Venville, G. J., & Dawson, V. M. (2010). The impact of a classroom intervention on grade 10 students' argumentation skills, informal reasoning, and conceptual understanding of science. *Journal of Research in Science Teaching, 47* (8), 952-977.

Yeşildağ Hasançebi, F., & Günel, M. (2013). Argümantasyon tabanlı bilim öğrenme yaklaşımının dezavantajlı öğrencilerin fen bilgisi başarılarına etkisi [Effects of argumentation based inquiry approach on disadvantaged students' science achivement]. *Elementary Education Online, 12* (4), 1056-1073.

Yıldırım, A., & Şimşek, H. (2013). *Sosyal bilimlerde nitel araştırma yöntemleri* [Qualitative research methods in the social sciences]. Ankara: Seçkin Publishing.

Received: *August 29, 2017* Accepted: *October 28, 2017*

Ibrahim Erdogan	PhD, Prof. Dr., Education Faculty, Department of Mathematics and Science Education, Mus Alparslan University, 49250, Mus, Turkey. E-mail: erdoibrahim@hotmail.com
Ayse Ciftci	PhD Candidate, Research Assistant, Education Faculty, Department of Mathematics and Science Education, Mus Alparslan University, 49250, Mus, Turkey. E-mail: a.ciftci@alparslan.edu.tr
Mustafa Sami Topcu	PhD, Prof. Dr., Education Faculty, Department of Mathematics and Science Education, Yıldız Technical University, 34000, Istanbul, Turkey. E-mail: mstopcu@yildiz.edu.tr