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Seeking the trace of argumentation in Turkish science curriculum

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ABSTRACT: Providing students with inquiry-oriented learning environments is a major concern in science education. Argumentation discourse can enhance the effectiveness of inquiry-oriented learning environments. This study seeks the trace of argumentation in Turkish Elementary and Secondary Science Curriculum developed by the Turkish Ministry of Education (TME, 2013) with an emphasis on inquiry-based learning. The aim is to investigate learning outcomes that might be conducive to argumentation. For data analysis, latent content analysis was used, by means of which the researchers looked for the underlying meaning of the words in learning outcomes. The categorization framework was designed to include argumentation, the nature of science (NOS), content of the learning outcomes, domain of the learning outcomes, and the relationship between argumentation and the NOS. The results showed that the distribution of explicit and implicit argumentation elements, the NOS aspects, and socio-scientific issues are high in 4th and 5th grades. Argumentation elements exist explicitly or implicitly in all grades, but there is not a clear pattern in their distribution across grades. They occur more frequently in the domain of earth and space learning. The curriculum is promising as it includes argumentation to a certain extent, but improvements are nevertheless needed in future curriculum development processes.

KEY WORDS: Turkish elementary and secondary science curriculum, argumentation, nature of science, socio-scientific issues

INTRODUCTION

Engaging students in inquiry-oriented learning environments has been cited as a major goal of the current reform efforts in science education (American Association for the Advancement of Science, [AAAS], 1993; National Research Council, [NRC], 2000). Unlike the traditional perspective of science learning, which usually places the knowledge of

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scientific facts in the foreground with scientific reasoning abilities pushed to the background (Sampson, Enderle, & Grooms, 2012), the reform perspective values and emphasises the students' efforts to find opportunities to develop scientific reasoning abilities (Abi-El-Mona & Abd-El-Khalick, 2011). In line with this shift of the focus, many science educators and researchers recognise the significance of argumentation in science education (e.g. Dawson, & Venville, 2009; Driver, Newton, & Osborne, 2000; Cetin, 2014; Osborne, Erduran, & Simon 2004).

REVIEW OF RELEVANT LITERATURE

Jimenez-Aleixandre and Erduran (2008) provide a comprehensive definition of argumentation, alongside many others in the literature, that the researchers of this study have chosen to adopt. They propose a dual meaning of argumentation from individual and social perspectives. From an individual perspective, an argument refers to any information that an individual produces to justify a claim or explanation. From a social perspective, an argument refers to 'a dispute or debate between people opposing each other with contrasting sides to an issue' (2008, p. 12). Many researchers argue that science classrooms should include discourse that facilitates students' argumentation practices (e.g. Duschl & Osborne, 2002; Kuhn, 1991; Sandoval, 2005). These practices involve the evaluation of knowledge claim, assessing alternatives, weighing evidence, and coordinating the data with a claim (Bricker & Bell, 2008). Through these practices, students' learning of scientific concepts can be enhanced and their engagement in authentic practices of science facilitated (Sampson& Walker, 2012; AAAS, 1993). Of the numerous reasons for including argumentation in science education, three major ones are cited here (Erduran, Simon, & Osborne, 2004). First of all, argumentation is in line with the contemporary perspectives in the philosophy of science, which emphasize that science involves the construction of theories that are open to challenge and refutation. The second reason takes the cognitive perspective into account and explains the importance of argumentation in the externalization of students' thinking and becoming critical thinkers. The final reason touches upon the socio-cultural perspectives of cognition, which clarify the appropriation of community practices, including scientific discourse by students through argumentation.

Given its importance in science education, many researchers have dealt with argumentation from different perspectives. Standing out among them are studies that aim to link socio-scientific issues (SSI) with argumentation. Human genetic issues (Ekborg, 2008; Zohar & Nemet, 2002), environmental issues (Osborne, Erduran, & Simon, 2004; Patronis,

Potari, & Spiliotopoulou, 1999), smoking (Lee, 2007), and gene therapy (Sadler & Zeidler, 2005) are some of the issues that researchers have investigated. Sadler and Zeidler (2005) present socio-scientific issues as 'open-ended, ill-structured problems which are typically contentious and subject to multiple perspectives and solutions' (p.72). In recent years, the SSI movement has gained prominence in science classrooms. Sadler and Fowler (2006) justify this movement by arguing that school science should include a dynamic interaction of science and society by giving equal emphasis to the scientific as well as social, political, economic, and moral aspects of issues. From this perspective, SSI has had a potential to constitute a platform for an argumentative discourse.

Another emerging research area suggests a potential relationship between argumentation and the Nature of Science (NOS). The NOS is a very broad term used to explain what science is, how it functions, what the role of society is in scientific enterprise, and how scientific community operates (McComas, Clough, & Almazroa, 1998). According to Lederman (2007), the NOS is 'the epistemology of science, science as a way of knowing, or the values and beliefs inherent to scientific knowledge and its development' (p.833). Although there is disagreement among philosophers, historians, and science educators on the definition of the NOS (Alters, 1997), there is still a general consensus on the characteristics of the NOS at K-12 level (Abd- El- Khalick, 2004). For purposes of precision in analysis, this study focuses primarily on six aspects of the NOS: scientific knowledge is subject to change, it is empirically based, it involves human inferences, creativity, and imagination, it is subjective, it is culturally embedded, and there is a distinction between observation and inference. Especially in the context of socio-scientific issues, Allchin (1999) tells us that 'a deeper understanding of science, values, and objectivity ... supports a mandate for discussing values in the classroom' (p. 9). In addition, Kolsto (2001) implies that when talking about socio-scientific issues, argumentation is also an important part of decision-making. When students engage in argumentation processes, they understand and experience multiple perspectives that are based on evidence (Khishfe, 2012). Similarly, they establish hypotheses, gather data and discuss their results based on their data, and certainly exhibit how they conceptualize the nature of science aspects in inquiry processes in science classes. Actually, students use argument and try to support their claims with evidence in these processes. Thus, there is a strong link between the NOS and argumentation.

The literature presents evidence that a context that enhances and facilitates students' use of argument can be established (Osborne et al., 2004) especially where student–student interaction is permitted and encouraged (Zohar & Nemet, 2002). McDonald (2010) claims that the

inclusion of argumentation in the curricula is an important component of contemporary science education in many countries. Besides, there is also evidence showing revision in mathematics curricula in order to enhance the role of proof and argumentation in Estonia, Finland, and Sweden (Hemmi, Lepik, & Viholainen, 2013). To this end, Jimenez-Aleixandre (2008) lists the characteristics of curriculum in argumentative contexts as follows: (i) it is organized around authentic activities, (ii) it is structured as problem solving, (iii) it is designed to generate a diversity of outcomes with different epistemic statues, (iv) it uses resources that support the development of scientific epistemic practices. Even though there is no curriculum completely depending on argumentation, every country has its own history in integrating argumentation to the curriculum. Jimenez-Aleixandre and Erduran (2008) have documented in detail the argumentation strategies of some developed and developing countries such as the United States, the United Kingdom, Australia, Spain, Taiwan, South Africa, and Chile. Another case is Turkey, where the Turkish Ministry of Education (TME) carried out two curriculum development processes in 2004 and 2013 (TME, 2005; TME, 2013). Both curricula focus on the development of scientific literacy as the main goal of elementary science education. The 2004 curriculum is based on the constructivist learning approach. Although 'argumentation' is not overtly mentioned as a concept in this curriculum, there are specific goals directly representing argumentation such as:

- encourage students to think about, debate, and evaluate alternative ideas,
- mediate debate and activities in order to provide opportunities for construction of students' own scientific knowledge and understanding
- encourage students to generate hypotheses and alternative interpretations in explaining phenomena (p.15).

No longer in use, the 2004 curriculum also focused on scientific process skills, the NOS, and scientific knowledge in order to provide the epistemological background to understand how scientific knowledge is constructed and which processes are used in knowledge construction. Another important theme was the Science-Technology-Society-Environment Approach which provided the basis for argumentation in socio-scientific issues as well as interconnection between science and technology, their impact on each other, and their mutual impact on society and the environment. The assessment strategies in this curriculum focused on students' own performances by means of portfolio, rubric, and self-evaluation journals leading to communication in which students reflect upon their cognitive processes of knowledge construction.

The 2013 curriculum puts more emphasis on inquiry-based learning. As previously mentioned, Jimenez-Aleixandre (2007) emphasizes some features that the curriculum must have in argumentative contexts and points out that the curriculum needs to be organized around inquiry that provides discursive practices of scientists. Inquiry facilitates understanding of how scientific knowledge is constructed and how it is validated (justification of claim, evaluating alternative claim, finding evidence to support claim). In the curriculum, inquiry is seen as explaining and argumentation processes beside discovering and experimenting (TME, 2013, p. III). Other argumentative curriculum features cited by Jimenez-Aleixandre (2007) include authentic activities, problem solving and producing a diversity of outcomes, backing students' epistemic statuses, and supporting scientific epistemic practices. When the 2013 curriculum is evaluated by these criteria, it is found to promote argumentation much more than the previous one of 2004. The skills emphasized in this curriculum are inquiring, reasoning, effective decision-making, problem solving, being open to collaboration, effective communication, and generating alternative solutions which encourage students to improve their argumentative skills. Problem and project-based activities, argumentation, and collaborative learning that promote not only the teacher as mentor but also the student as active knowledge producer are centrally located in planning and implementing the science course as an inquiry in this curriculum. The main goal in this inquiry-based learning environment is to encourage students to explain their surrounding by engaging in argumentation including making claims by using substantive warrant. The curriculum also emphasizes the teacher's role in discursive processes by pointing out that 'the teacher provides discourse in which students can express their ideas, back their ideas with different warrants, and make counter arguments to rebut their friends' ideas. In the discussion, including oral or verbal counter arguments, the teacher is simply a guide and mentor allowing the students to make claims based on valid data (TME, 2013, p. III).

Another remarkable emphasis in terms of argumentation is the presence of the socio-scientific issues as a subtheme of the Science-Technology-Society-Environment approach. The emphasis on socio-scientific issues is related to two statements in the curriculum. One is about the goal related to the use of socio-scientific issues, stating that 'to improve scientific thinking skills by using socio-scientific issues' (TME, 2013, p. II). The other is about the content of the socio-scientific issues included in the curriculum, pointing out that 'socio-scientific issues contain scientific and moral reasoning skills to solve socio-scientific problems related to science and technology' (TME, 2013, p. VI).

Lastly, the present study is expected to contribute to the literature in two main ways. Firstly, although, there are a number of studies reflecting on argumentation from both curricular and empirical perspectives in developed and developing countries, studies on Turkey are rare. We believe that it is important to document how a developing country, namely Turkey, attempts to integrate argumentation to its science curriculum for international readers. Secondly, for readers from those countries supporting the reform movements in the construction of knowledge in the world and trying to include argumentative elements to their own curricula, the findings of this study may prove helpful.

METHODOLOGY

Research Context

The educational system in Turkey is centralized, so there is a national curriculum for each course. Compulsory education in Turkey consists of three equal parts: elementary school for grades 1-4, secondary school for grades 5-8, and high school for grades 9-12. The science curriculum for elementary and secondary education was revised in 2013. The title of the course has also been changed from 'science and technology' to 'science'. One of the most emphasized teaching strategies and methods in the new curriculum is argumentation, which was mentioned to some extent in the previous curriculum as well. In this context, the students are expected to reveal their opinions freely, support these opinions (claims) with different justifications, rebut others' claims with evidence, and share the process in an atmosphere of dialogue.

Research Questions

This study seeks to investigate how argumentation elements are reflected in the learning outcomes of the revised 2013 science curriculum for Turkish elementary and secondary education with respect to the learning domain and grade level. For this reason, all of the learning outcomes of the elementary and secondary school science curriculum including grades 3-8 were analysed from different aspects. First of all, the learning outcomes likely to promote argumentation were identified. Secondly, the learning outcomes including the NOS and SSI which might facilitate argumentation were analysed.

The two research questions guiding the present study are as follows:

- How are argumentation elements reflected in the curriculum with respect to the learning domain and grade level?

- How are learning outcomes including the NOS and SSI, which could potentially promote argumentation, distributed in the curriculum?

In order to answer these research questions, qualitative research methods were used.

Data Set

The data set was composed of the 330 learning outcomes including grades 3-8 in the elementary and secondary science curriculum. The learning outcomes are organized around four main learning domains which are *life science*, *matter and change*, *physical science*, and *earth and space*. The number of learning outcomes in each grade from 3rd to 8th is 32, 46, 44, 52, 78, and 78 respectively.

Data Analysis Process

Since a written material was studied in the context of our research, document analysis was chosen as the appropriate methodological framework, with content analysis of the data. The document is the elementary and secondary science curriculum, which is declared a public record document by Merriam (1998), published by the Turkish Ministry of Education (TME, 2013) to inform and guide teachers and administrators about the new curriculum.

According to Fraenkel and Wallen (2006) content analysis comprises two types: manifest and latent content analysis. In the manifest version, the content is words, pictures, or images that are directly accessible. In latent content analysis, the researcher looks for the underlying meaning of the words and does not focus on counting their frequency. It is important to select a unit of analysis in content analysis. Each learning outcome is stated in one sentence in the curriculum. Thus, the whole sentence for the learning outcome is the unit of analysis in this study. Since the researchers aimed at interpreting the learning outcome whether it contained argumentation elements or not, they needed to focus on the underlying meaning of the words. For instance, a learning outcome could not include the word 'discussion' directly, but it could imply argumentative processes using the words such as "decide" or "investigate and present". For this reason, latent content analysis was implemented in the study.

However, in latent content analysis, it is difficult to ensure consistency between the coders. To avoid this problem and to increase the reliability of the results, the researchers negotiated on important issues at the beginning of the coding process. They studied the 3rd grade learning outcomes as a pilot analysis. First, the three researchers coded the third grade learning outcomes separately at the beginning of the analysis. After coding, they came together and discussed their opinions about these

outcomes. They also shared their decisions on the learning outcomes such as whether a certain outcome included argumentation elements or not, and which type of learning outcomes would be coded as implicit or explicit argumentation and so on. Although they had pre-existing opinions about the categorization and coding process, they clarified these processes after examining 3rd grade learning outcomes. The categorization framework was decided to include argumentation (implicit or explicit), the nature of science (implicit or explicit), content of the learning outcomes (scientific and socio-scientific), the learning domain of the learning outcomes, and the relationship between argumentation and the nature of science. After the standardization of the coding process, the researchers re-analysed the 3rd grade learning outcomes according to the emerging coding scheme. Then, they coded the next grade's learning outcomes separately. They came together again, discussed their decisions and achieved a conservative consensus on each learning outcome. The same process was repeated for the other grades. Consensus among the coders was finally found to be at least 80% across the grades.

In the coding scheme, learning outcomes including phrases such as 'discuss, discuss based on data, discuss according to experimental result' were considered appropriate for facilitating the argumentative context directly and were coded as 'explicit argumentation'. On the other hand, learning outcomes including such phrases as 'predict probable results, predict and test, show the relationship between variables based on his/her own experiment, explain based on observation, investigate and present' would lead to argumentation if the teacher moved the argumentative context in this direction. Thus, such learning outcomes were coded as 'implicit argumentation'.

Since the argumentation context is significant, in addition to explicit and implicit argumentation, the learning outcomes were also coded in terms of the scientific and socio-scientific context. The researchers coded learning outcomes such as air, soil, and water pollution, solar energy, bio-diversity, the ozone layer, and global climate change as the 'socio-scientific context'. They also coded the learning outcomes based on subject matter such as mass and weight, states of matter, and liquid pressure as 'scientific context'. Additionally, learning outcomes implying the nature of science aspects such as doing experiments and collecting data were coded as 'implicit nature of science'. Learning outcomes directly emphasizing the basic aspects of the nature of science were coded as 'explicit nature of science'. On the other hand, some learning outcomes including both nature of science and argumentation were coded as 'argumentation related with NOS'. Following are sample quotes for each code:

- Explicit argumentation:

*The students **discuss** the necessary principles to protect respiratory system **based on the research data**.*

- Implicit argumentation:

The students do experiments about heat transfer by mixing liquids which are at different temperatures and interpret results.

- Socio-scientific context:

*The students discuss the factors that threat **biodiversity** based on the research data and suggest a solution.*

- Scientific context:

The students predict which separation technique works best for a mixture and test their predictions.

- Explicit nature of science:

*The students question how the ideas about atom have **changed from the past to the present**.*

- Implicit nature of science:

The students determine the factors affecting dissolving rate by doing experiment.

- Argumentation related with NOS:

The students do an experiment in order to test the effect of force on motion and shape of an object and discuss the results.

FINDINGS AND DISCUSSION

This study investigated how argumentation elements, the NOS aspects, and socio-scientific issues are distributed across grades in elementary and secondary schools science curriculum. The overall results of the analysis are presented in Table 1. Since the number of learning outcomes is different at each grade, the percentages would be more reliable if compared to the learning outcomes across grades. For this reason, the percentage of each datum is reported in parentheses.

Argumentation elements exist explicitly or implicitly in all grades, but there is not a clear pattern in their distribution across grades. There are more implicit argumentation elements than explicit ones in learning outcomes across 3rd and 6th grades. On the other hand, explicit argumentation elements outnumber implicit argumentation elements in 7th and 8th grades. The total percentages of argumentation elements (explicit or implicit) are 15, 31, 41, 20, 25, and 20 from 3rd to 8th grades respectively. Since this is the first attempt to integrate argumentation into elementary and secondary school science curriculum in Turkey, these percentages are interpreted positively. Interestingly, the percentage of argumentation elements was higher in 4th (31%) and 5th (41%) grades.

The context of the learning domains could also affect the inclusion of argumentation elements in learning outcomes. For this reason, the argumentation elements in the curriculum were also classified

according to the learning domains and are presented in Table 2. There are four learning domains in the curriculum content which are life science, matter and change, physical science, and earth and space. The results show that, in total, the argumentation elements mostly occur in the earth and space learning domain. Approximately 32% of the learning outcomes in the earth and space learning domain in all grades include argumentation elements. On the other hand, approximately 28% of the learning outcomes of life science, 20% of the learning outcomes of matter and change, and 21% of the learning outcomes of physical science include argumentation elements. This overall distribution of argumentation elements across learning domains could be considered as effective, but their distribution across grades would be better as discussed earlier in this section.

In addition, most of the argumentation elements are implied, rather than explicitly stated, in the learning outcomes in the matter and change and physical science learning domains. On a positive note, argumentation elements are explicitly stated in the life science learning domain. The percentages of implicit and explicit argumentation elements are equal in the earth and space learning domain. As it proved successful in the life science learning domain, argumentation elements should be stated explicitly in other learning domains in future curriculum development studies.

Both argumentation and the NOS could be integrated to enhance learners' understanding of science. For this reason, distribution of the NOS aspects in the curriculum was also analysed as mentioned above (Table 1). The NOS is emphasized in the introduction part of the curriculum and included in the Science-Technology-Society-Environment dimension. Thus, the researchers expected to find the NOS aspects explicitly stated in the learning outcomes. However, it was found that the NOS aspects were only implied in some of the learning outcomes, but explicitly stated in only one outcome in 7th grade. The NOS literature has already documented that the NOS aspects should be emphasized explicitly for effective learning (Akerson, Abd-El-Khalick, & Lederman, 2000; Akerson & Volrich, 2006; Khishfe & Abd-El Khalick, 2002). Therefore, the NOS aspects should be explicitly stated in future curriculum development processes. It was also noticed that implicit NOS aspects were more frequent in 4th and 5th grades than other grades. Argumentation elements are also high in 4th and 5th grade. Thus, some of the argumentation elements seem to have been combined with the NOS aspects in 4th and 5th grades. More detailed analysis also showed that there were some learning outcomes including both argumentation elements and NOS aspects through 4th to 7th grades. On the other hand, there is not a learning outcome reflecting a relationship between argumentation elements and the NOS aspects in 3rd and 8th grades. The learning outcomes

stating 'do experiment to test the effect of force on motion and shape of an object and discuss the result' or 'predict the factors that influence the brightness of light and test their predictions' are examples of the learning outcomes reflecting argumentation related to the NOS.

Socio-scientific issues can form an effective argumentation context. For this reason, socio-scientific issues in the learning outcomes were also analysed in detail and presented in Table 3. There are 40 learning outcomes indicating socio-scientific issues. 12 of them indicate implicit argumentation while 13 of them indicate explicit argumentation. There are also 15 learning outcomes which are not related to argumentation. The context of the socio-scientific issues stated in the curriculum is diverse. The socio-scientific issues referred to in the curriculum are national economy, noise pollution, human beings and the environment, environmental pollution, healthy lifestyle, biodiversity, acid rain, ozone layer, biotechnology, global climate change, power plants, light pollution, and organ donation. The most mentioned socio-scientific issue is national economy in terms of using electricity economically and solar energy efficiently, and discussing them in a more national way.

The learning domain is also a factor that influences the distribution of socio-scientific issues. Thus, further analysis was conducted to figure out the distribution of socio-scientific issues among learning domains. The results of this analysis are presented in Table 4. Socio-scientific issues recur more in the life science and psychical science learning domain. Argumentation is stated explicitly or implied in nearly half of the learning outcomes regarding socio-scientific issues.

Grade level is another factor that influences the distribution of socio-scientific issues. For this reason, a similar analysis was done to find out the distribution of socio-scientific issues across grades. The results are presented in Table 5. Just like argumentation elements, socio-scientific issues are also high in 4^{th} (26%) and 5^{th} (21%) grades but more than half of them do not include argumentation either explicitly or implicitly in 4^{th} grade. The 6^{th} grade has the fewest learning outcomes including socio-scientific issues. Positively, other grades have considerable learning outcomes including socio-scientific issues and most of them include argumentation either explicitly or implicitly.

The purpose of the study was to reveal how argumentation is reflected in the learning outcomes in Turkish elementary and secondary school science curriculum. Methodologically, the researchers analysed the percentage of learning outcomes with respect to the grade level, learning domain, explicit/implicit NOS, and explicit/implicit argumentation in scientific and socio-scientific contexts. Thus, a comprehensive analysis of argumentation in the curriculum was conducted yielding insightful results.

An overview of the analysis shows that the philosophy of the curriculum is in line with the contemporary view of science education. The vision of the curriculum is to develop scientific literacy. In order to attain this goal, the science curriculum includes underlying concepts of scientific literacy such as the nature of science, inquiry, socio-scientific issues, and argumentation. Project 2061: Science for All Americans (AAAS, 1989) and the National Research Council (NRC, 1996) are the publications that guide current reform efforts in science education in Turkey and abroad. The National Research Council states that 'teaching should be consistent with the nature of scientific inquiry' (AAAS, 1989, p. 147). In keeping with this, scientific inquiry is the focus of the science curriculum in Turkey (TME, 2013). Moreover, scientific inquiry is levelled through grades. The main learning strategy is structured inquiry in 3rd and 4th grades, guided-inquiry in 5th and 6th grades, and open-inquiry in 7th and 8th grades. This also indicates a strong and systematic approach to applying scientific inquiry in elementary and secondary grades. Furthermore, the role of the students and teachers defined in the elementary science curriculum is also aligned with the contemporary approach. The role of the students is explained as being responsible for their learning and actively participating in the knowledge construction process whereas the role of the teachers is described as guiding students throughout their learning process (TME, 2013). In addition, the contemporary approach also has a bearing on assessment and evaluation: 'the essential view of assessment and evaluation is to consider the whole process as well as the product' (TME, 2013, p. IV). By considering all these suggestions about science teaching in the elementary and secondary school science curriculum, we can conclude that this curriculum mirrors the standards specified in the current educational reform documents.

Our analysis is specially focused on the argumentation elements in the elementary and secondary school science curriculum. The results show that the percentages of explicit and implicit argumentation are the highest in 4th and 5th grades. However, we cannot observe a straightforward link between the grades and percentages of explicit and implicit argumentation. Kuhn (1991) suggests that there is developmental improvement in argumentation skills from age eight (third grade) through early and middle adolescence, but no additional improvement is observed from adolescence through adulthood. So, it would make more sense to organize the argumentative activities in the elementary and secondary grades. Nevertheless, when we take into consideration that this is the first time that argumentation is integrated in the elementary and secondary school science curriculum in Turkey, it can be seen as a promising beginning. Nevertheless, the argumentation elements should be increased in the upper grades in the next curriculum development process.

In total, 25% of the learning outcomes in the science curriculum reflect argumentation (either explicit or implicit). When we consider that deliberative discussions have commonly occupied only 2% of all science lessons in junior high schools (Lemke, 1990) in the U.S., the percentage of the learning outcomes in the science curriculum can be deemed reasonable as a starting point by accepting in advance that not all implicit learning outcomes cause an argumentative discourse. While the learning outcomes reflecting explicit argumentation give much more clues to the teacher to promote an argumentative context, the learning outcomes reflecting implicit argumentation need to be clarified by the teacher's efforts. Our analysis reveals that the total percentage of implicit argumentation (14%) is higher than that of explicit argumentation (11%). Osborne et al. (2004) argue that argumentation skills can be improved if argumentation is explicitly addressed and taught. Erduran et al. (2004) also conclude that the use of argument is teacher-dependent. We argue that the learning outcomes including explicit argumentation are more conducive to facilitating argumentation for teachers, especially for those inexperienced in creating such an environment. However, due to its nature, the success of the learning outcomes including implicit argumentation in creating an argumentative environment is more dependent on the teachers' knowledge and skills. So, when the curriculum includes learning outcomes reflecting implicit argumentation at that percentage, it is inevitable to train our teachers in argumentation. Teachers with an inadequate knowledge of argumentation probably face problems in utilizing these learning outcomes reflecting implicit argumentation in creating discourses where students' argumentation is facilitated. For instance, Bryce (2004) found that Scottish biology teachers were reluctant to consider social and ethical aspects of controversial issues in facilitating argumentation, because they felt that they did not have the skills to effectively use discussion. Similarly, Oulton, Dillon, and Grace (2004) report that a lack of teacher expertise in facilitating discussions may inhibit students' ability and opportunity to engage in argumentation. Thus, most of the implicit argumentation elements would be better if turned into explicit argumentation elements in future curriculum development attempts to better guide teachers toward implementing argumentation.

Moreover, it is evident that in classrooms where traditional approaches to science instruction are adopted, it is difficult to elaborate student argumentation (Driver, Newton, & Osborne, 2000). The in-service teachers who adopt a traditional view of learning and teaching are faced with difficulties in creating environments which promote students' argumentation. Yerrick (2000) observes that argumentation is rare in K-12 science classrooms. Jimenez-Aleixandre, Rodriguez, and Duschl (2000) explain the reason behind this observation by arguing that the contexts

necessary for promoting argumentation are not part of the teaching settings that typify most of these classrooms. In resolving this issue, Simon, Erduran, and Osborne (2006) focus on the development of teachers' use of argumentation throughout a year and they interpret their findings. Teachers reported that giving students the opportunity to reflect, discuss, and argue how evidence did or did not support a theoretical explanation was beneficial to students' engagement with scientific ideas. They concluded that educating science teachers to adapt and develop their classroom discourse practices was possible. In addition to pre-service and in-service teachers' experiences and practices, their self-efficacy and beliefs are also important in using and adapting to curricular novelty. Cotton (2006) suggests that all curricular novelty attempts, for instance the environmental agenda, are doomed to fail unless curriculum developers take teachers' beliefs into account in designing new curriculum materials and unless teachers can be convinced that this is indeed desirable. Teacher education programmes should also be designed according to curricular novelty and efforts should be made to change pre-service and in-service teachers' educational practices in a way that contributes to curricular documents. Witz and Lee (2009) suggest in their study about teachers' orientations to science and science education reform that teachers' intellectual experience and their vision of science should also be taken into account in both in-service and pre-service teacher training. Because teachers are the ones putting reform ideas into practice, they should be involved, and supported, in the curriculum design process (Huizinga, Handelzalts, Nieveen, & Voogt, 2014).

Apart from the need for teachers to have a sound knowledge of and skills in argumentation, time dedicated to argumentative activities is also crucial in the development of students' argumentation skills. Several researchers debate this issue. Although Zohar and Nemet (2002) found significant improvements in students' argumentation skills after a relatively short interval, many researchers claim that it takes time to improve students' argumentation skills (e.g. Osborne et. al., 2004; Zohar & Nemet, 2002). It is encouraging to know that the science curriculum that we analysed includes argumentation either explicitly or implicitly from 3rd grade through 8th grade, which provides enough time to develop students' argumentation skills. Since there are fewer learning outcomes in the 2013 curriculum than the previous one, it could be an advantage for argumentation improvement.

In this study, we also examined the percentage of learning outcomes that involve both argumentation and the NOS. In the literature, there are two lines of research that investigate the relationship between students' NOS views and their argumentation. The first line investigates the effect of the NOS view on the quality and complexity of

argumentation (e.g. Walker & Zeidler, 2007) while the other line explores the impact of argumentative activities on students' NOS views (e.g. McDonald, 2010). Although these studies need additional empirical support, it is logical to examine how the learning outcomes are related to these two dimensions. The results show that, with the exception of the 3rd and 8th grades, there are approximately five learning outcomes (out of a total of 21) for each grade level which involve both the NOS aspects and argumentation. Although the NOS is reflected in the curriculum to a certain extent, the NOS aspect emphasized in the learning outcomes is limited. Most of the learning outcomes reflecting the NOS emphasize the empirical nature of science. It is also interesting to note that all the NOS aspects are implicit in the learning outcomes except for one in the 7th grade in which the NOS aspect is stated explicitly. Meanwhile, the previous curriculum involved specific NOS learning outcomes in a separate section in Science-Technology-Society-Environment and most of them were reflected explicitly. Specific learning outcomes regarding explicit NOS aspects should likewise be added in future curriculum development processes.

Finally, our analysis also included the relationship between argumentation and scientific/socio-scientific issues. The analysis results show that, except for the 3rd grade, there are socio-scientific issues in all grade levels. A detailed analysis of the learning outcomes shows that the context of the socio-scientific issues is diverse and equally distributed with respect to the grade level. Sadler and Zeidler (2005, p. 113) explain the socio-scientific issues as they are 'based on scientific concepts or problems, controversial in nature, discussed in public outlets and frequently subject to political and social influences'. When we investigated the content of the socio-scientific issues, it was clear that they possessed all these characteristics. Moreover, the percentage of learning outcomes that involve socio-scientific issues is 12.1. While Osborne et.al. (2004) conclude that initiating argument in a socio-scientific context is easier for both students and their teachers, Zohar and Nemet (2002) claim argumentation skills are best achieved when they are structured on everyday problems from students' real lives, such as socio-scientific issues, because students more easily understand socio-scientific issues, which guide them in constructing arguments. In other words, in a socio-scientific context, it is much easier to prompt discussion and to encourage students to engage in it. In such a context, (e.g. during a discussion about environmental pollution), students could use their emotional, ethical, logical, economic, or even intuitive reasoning skills as well as scientific reasoning skills. Thus, establishing links with their daily lives is more convenient in socio-scientific contexts than in scientific contexts.

Thus, argumentation could be more easily integrated into the learning outcomes in socio-scientific contexts. In our curriculum, the net pattern in our analysis is that distribution of argumentation elements, the NOS aspects, and socio-scientific issues in 4th and 5th grades is better compared to the other grades. Although socio-scientific issues are fewer in upper grades, students could construct arguments in scientific contexts after they got used to argumentation in socio-scientific contexts in 4th and 5th grades. The curriculum needs to be balanced with respect to these three areas. It should be considered as an example in future curriculum development studies.

CONCLUSIONS

Curriculum development is an ongoing process. Argumentation related to the NOS and socio-scientific issues is new for the Turkish elementary and secondary school science curriculum. It can be concluded from the results of this study that the curriculum is promising in including argumentation to a certain degree, but the following improvements are recommended for future curriculum development processes.

- The argumentation elements should be emphasized more in the learning outcomes.
- Argumentation elements should be explicitly stated in the learning outcomes rather than being implied.
- The distribution of argumentation elements should be increased in the upper grades to enhance application of argumentation skills already developed in the lower grades and thus support science learning.
- Argumentation elements should be more integrated to the NOS aspects to be beneficial in both areas.
- Socio-scientific issues should occur more frequently in the curriculum and be better interrelated to argumentative elements.
- Argumentation elements should also occur more frequently in scientific contexts in the upper grades after students develop argumentation skills in the lower grades.

All countries follow their own paths in curriculum development, but they inform one another of the inclusion of philosophies, concepts, and issues in their curricula and the ways of implementation. The researchers have wished to share the Turkish endeavours in the inclusion of argumentation elements in elementary and secondary school science curriculum.

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Table 1. Argumentation Elements, NOS aspects and Socio-scientific Issues in Elementary and Secondary School Science Curriculum

	Learning outcomes included							
	Argumentation elements		NOS aspects		Relationship between argumentation and NOS	Issues		Total number of learning outcomes
Grades	Explicit f(%)	Implicit f(%)	Explicit f(%)	Implicit f(%)	f(%)	Scientific f(%)	Socio-scientific f(%)	f
3	2(6%)	3(9%)	0	2(6%)	0	32(100%)	0	32
4	4(9%)	10(22%)	0	8(17%)	5(11%)	34(74%)	12(26%)	46
5	6(14%)	12(27%)	0	9(21%)	7(16%)	35(80%)	9(21%)	44
6	4(8%)	6(12%)	0	8(15%)	4(8%)	48(92%)	3(6%)	52
7	12(15%)	8(10%)	1(1%)	10(13%)	5(6%)	71(91%)	8(10%)	78
8	9(12%)	6(8%)	0	7(9%)	0	70(90%)	8(10%)	78

Table 2. The Percentages of Argumentation Elements from 3rd to 8th Grade according to the Learning Domains

Learning Domain	Grades						Total learning outcomes (%)
	3(%)	4(%)	5(%)	6(%)	7(%)	8(%)	
Life Science	0	1implicit(7%) 1explicit(7%)	5 implicit (31%) 2 explicit (13%)	1 implicit (6%) 3 explicit (17%)	2 implicit (10%) 8 explicit (40%)	1 implicit (4%) 5 explicit (21%)	10(10%) 19 (19%)
Matter&Change	0	3 implicit (27%) 1 explicit (9%)	2 implicit (33%) 1 explicit (17%)	3 implicit (21%) 1explicit (7%)	3 implicit (14%) 1 explicit (5%)	1 implicit (4%) 0	12(15%) 4(5%)
Physical Science	3(20%)implicit 2(13%)explicit	5 implicit (26%) 2 explicit (11%)	3 implicit (25%) 0	2 implicit (13%)	2 implicit (7%) 2 explicit (7%)	1 implicit (7%) 1 explicit (7%)	16(15%) 7(7%)
Earth&Space	0	1 implicit (100%)	2 implicit (20%) 3 explicit (30%)	0	1 implicit (11%) 1 explicit (11%)	3 implicit (19%) 3 explicit (19%)	7 (16%) 7(16%)
Total	5 (16%)	14 (30%)	18(41%)	10(19%)	20(26%)	15(19%)	

Table 3. The Distribution of Argumentation Elements in Socio-scientific Issues Context

Socio-scientific Issues	Implicit Argumentation (f)	Explicit Argumentation (f)	No Argumentation (f)	Total number of learning outcomes (f)
National Economy	3	5	2	10
Noise Pollution	1	0	2	3
Human&Environment	1	2	4	7
EnvironmentalPollution	2	1	0	3
Healthy Lifestyle	1	2	0	3
Biodiversity	0	2	1	3
Acid Rain	1	0	0	1
Ozone Layer	1	0	0	1
Biotechnology	0	1	2	3
Global Climate Change	1	0	0	1
Power Plants	0	0	1	1
Light Pollution	1	0	2	3
Organ Donation	0	0	1	1
Total	12	13	15	40

Table 4. The Distribution of the Number of Socio-scientific Issues with respect to Learning Domain

Learning Domains	Implicit Argumentation (f)	Explicit Argumentation (f)	No Argumentation (f)	Total number of learning outcomes (f)
Life Science	4	7	8	19
Psychical Science	4	1	5	10
Matter&Change	3	2	1	6
Earth&Space	1	3	1	5
Total	12	13	15	40

Table 5. The Distribution of the Number of Socio-scientific Issues with respect to Grade Level

Grade Levels	Implicit Argumentation (f)	Explicit Argumentation (f)	No Argumentation (f)	Total number of learning outcomes (f)
3	0	0	0	0
4	3	2	7	12
5	3	5	1	9
6	1	1	1	3
7	2	3	3	8
8	3	2	3	8
Total	12	13	15	40