An Analysis of Science Teachers' Views on Argumentation-Based Science Learning and the Activities they have Prepared

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Abstract
This study is an attempt to examine science teachers' views on Argumentation-Based Science Learning (ABSL) and the activities they have prepared. The study employed a qualitative case study method. The working group consisted of 5 science teachers who work in secondary schools affiliated with the Ministry of National Education in Turkey and who have master's degree. This study deployed the "Semi-structured Preliminary Interview Form", "The Evaluation Rubric related to the Activities Based on Argumentation-Based Science Learning " and "Semi-structured Final Interview Form". Content analysis and descriptive analysis were used during data analysis. The results revealed that the teachers' perceptions towards ABSL before the implementation were mostly grounded on giving opinions and argumentation. Four teachers did not use ABSL in lessons before and they did not prepare any activities. On analyzing the activities prepared by the teachers through use of ABSL, all the teachers were identified to consider grade level, unit, subject area, learning outcome and associating them with daily life while preparing the activities. The teachers were also determined to use concept cartoons, competing theories with stories, and experiment design techniques in the activity papers. Besides, the Toulmin argumentation model steps were taken into consideration in the activity papers. Concerning the analysis of last interview data, teachers' perceptions towards ABSL were found to be opinions, claims, opposing ideas and arguments. The teachers also indicated that they avoided creating misconceptions and that they took into account the student and grade levels in the ABSL activities. In addition, the teachers noted that preparing the activity is time-consuming and unsuitable for every subject. This study is paramount in terms of giving information to teachers and pre-service teachers related to the teachers' views on ABSL and how they have prepared ABSL activities.

Keywords: Argumentation-Based Science Learning, Science Education, Toulmin Argumentation Model, Activity Preparation, Teacher Views

Introduction

In today's world, information seeking is increasing rapidly and hence, access to information is developing in line with scientific advances. Therefore, individuals experience some difficulties in adding new information to existing information (Akkaş, 2017). Curricula are also updated in conjunction with these advances in science, and considerable attention is paid to student-centred courses (Ministry of National Education, 2013; MoNE, 2018). In this regard, the recently updated science curriculum aims at raising all individuals as science literate (MoNE, 2013, 2017, 2018).

Science literate individuals seek, examine and question information, establish the relationship between science and daily life, think critically and solve problems (MoNE, 2018). Argumentation-Based Science Learning (ABSL) is a method that allows the emergence of these personal characteristics in students and makes them active in the process (Antiliou, 2012; Şahin, 2016).

ABSL is a learning approach that aims to raise students who can make research and question, gather scientific information, express their thoughts clearly and justify their claims (Güler, 2016). Arguments form the basis of ABSL. Toulmin (1958) defined argument as the coordination of evidence put forward to refute or support an event or a decision. Argumentation, on the other, is defined as a constructivist learning approach used to create claims about issues or situations that are likely to occur in daily life, to support the claims and to welcome the reality of these claims (Çepni et al., 2014). Argumentation also appears as the Toulmin argument model in the relevant literature. A simple argument must include data, claim and warrant components. In complex-level arguments, other components such as backing, qualifier and rebuttal are needed along with the three fundamental components (Erduran et al., 2004).

Used in different educational contexts, argumentation is a vital component of scientific discourse and a significant tool in the growth of knowledge (Erduran et al., 2004). An effective argumentation process requires a safe environment where students' evaluations and opinions are valuable and where they can express themselves comfortably. Teachers play a significant role in creating this safe environment in educational areas. Besides, another important feature that teachers should hold in the argumentation process is the ability to pose questions. The safe environment created by the teachers will make it easier for the students to defend themselves, present more evidence and backing, create more opposing arguments, put forward different ideas, and thus ensuring active participation in the discussion with better arguments.

Erduran et al., (2004) implicated that the use of various argumentation strategiesis of great importance to obtain the expected and desired results and to carry out the process more effectively in learning environments. These strategies are the table of statements, constructing arguments, evaluating arguments, using evidence, evaluating evidence, concept cartoons, predicting-observing-explaining, vee diagram and theories that compete with stories (Osborne et al., 2004). Teachers should learn more about argumentation and they should possess the necessary equipment and skills about the argumentation process so that they may engage students in scientific argumentation (McNeill & Knight, 2013; Sampson & Blanchard, 2012). In this sense, teachers play a vital role in the argumentation intended to be included in classroom instruction since their use of instructional strategies influences how they are integrated into argumentation (González-Howard & McNeill, 2019).

Despite the increasing interest in ABSL, there is a dearth of studies conducted with science teachers (Evagorou & Dillon, 2011; McNeill & Knigh, 2013). Argumentation is a significant method in science education, yet teachers have difficulties using the method in science lessons, and therefore it is not used frequently in lessons (Sadler, 2006). Thus, there is a great need to consult teachers' views on their knowledge and experience to enhance their competence in engaging in and teaching argumentation (Liu & Roehrig, 2019). Since science teachers are the real administrators of science lessons, it is vital to examine their views on ABSL and the activities they have prepared through using ABSL in terms of contributing to science instruction. However, the related literature reveals that science teachers have limited knowledge about ABSL (Özcan, 2016; Namdar & Tuskan, 2018; Özcan et al., 2018).

This may be because they did not receive guidance on argumentation during the undergraduate period (Apaydın & Kandemir, 2018). Driver et al., (2000) also noted that teachers should be trained in order to use argumentation effectively in lessons and that they referred to the significance of the argumentation process. Upon analysing relevant literature, there are few studies (Günel et al., 2012; Namdar & Tuskan, 2018; Özcan, 2016; Özcan et al., 2018) regarding science teachers' views on ABSL at the national level. However, the international literature covers studies on the instructional strategies of science teachers through the use of ABSL (Choi et al., 2019; González-Howard & McNeill, 2019; Lee & Lin, 2005; McNeill et al., 2016; Mork, 2012; Sampson & Blanchard, 2012; Liu & Roehrig, 2019). Based on the studies carried out in the national and international literature, there is a need for this study to examine science teachers' views on ABSL and their knowledge and experience in preparing activities based on ABSL.

This study analysed not only science teachers' views on ABSL but also the ABSL activities they have prepared. In this vein, the study is paramount in terms of examining teachers' views and the ABSL activities they have prepared. Besides, this study is of great value for providing information to teachers and pre-service teachers about teachers' views on ABSL and how they have prepared ABSL activities. Another contribution of the study to the related literature is that teachers are active in the argumentation process and that such studies allow them to improve themselves in terms of instructional strategies. This study is also expected to be a guide for further studies. Thus, the present study is an attempt to examine science teachers' views on ABSL and the activities they have prepared. In service of this aim, answers to the following questions were sought.

- Sub-problem: What are the preliminary views of science teachers regarding Argumentation-Based Science Learning (ABSL)?
- Sub-problem: What kind of activities do science teachers prepare based on ABSL?
- What kind of content does the activity prepared by science teachers have?
- Which techniques do the science teachers use in the activity papers they have prepared?
- How are the steps in the Toulmin argumentation model included in the activity sheets prepared by science teachers?
- Sub-problem: What are the science teachers' views on ABSL after the implementation?

Method

This study employed a qualitative case study method since a phenomenon that emerged in a certain time was sought in depth through multiple data collection tools. A case study is a research method that investigates phenomena in depth at a certain time period as a whole within their real-world own context through using data collection tools containing multiple sources (interviews, observations, documents, reports) and that boundaries may not be clearly evident (Creswell, 2007; Yıldırım & Şimşek, 2008).

Working Group

The working group was chosen by purposive sampling, which provides the opportunity to conduct a detailed research by concentrating on rich-content phenomena related to the main objective of the study (Büyüköztürk et al., 2019). The participants consisted of 5 science teachers working in public secondary schools in Turkey during the 2021-2022 academic year. Besides, those with master's degree were included in the working group. Because it is vital for teachers to have postgraduate education in terms of specializing in the teaching profession, adapting to innovations in education, and the ability to use methods and techniques in the classroom environment (Alabaş, 2011). Table 1 depicts the demographic information regarding the participants.

Table 1 Demographic Information Regarding the Participants

Teacher Code	Age Range	Working Year Range	Education Level	Receive Guidance on ABSL
T1	30-34	6-10	Master degree	Yes
T2	40-44	16-20	Master degree	No
T3	35-39	11-15	Master degree	No
T4	35-39	11-15	Master degree	No
T5	30-34	6-10	Doctoral degree	No

Data Collection Tools

This study deployed the Semi-Structured Pre-Interview Form, the Evaluation Rubric related to the Activities Based on Argumentation-Based Science Learning, and the Semi-Structured Final Interview Form as data collection tools. Semi-structured interviews have a unifying feature in terms of answering pre-prepared questions and obtaining in-depth information about the data on the subject being researched (Büyüköztürk et al., 2019). The questions in the semi-structured pre-interview form were prepared by the researchers to obtain data on science teachers' views regarding ABSL and delivered to two faculty members who are experts in the field of science. The questions were revised and the form consisting of 4 open-ended questions got its final version in line with the expert views. An evaluation rubric was prepared to evaluate the

activities prepared by the science teachers. The researchers investigated the related literature and determined 25 items appropriate for the aim of the study. These items include the content of the activity sheet, the ABLS technique and the steps of Toulmin's (1958) argumentation model. The items in the rubric were delivered to two experts in the field of science education to ensure validity. 7 of the items were excluded as they were not found to be suitable for the purpose of the study, and the other 18 items were revised. The items in the rubric were categorized according to the content of the activity papers prepared by the teachers (grade level, unit, subject area, learning outcome and associations with daily life), the argumentation technique (concept cartoons, designing experiments, theories competing with stories, etc.) and Toulmin's (1958) argumentation model (data, claim, warrant, backing, qualifier and rebuttal).The semi-structured final interview form consisting of 10 items was prepared to reveal the science teachers' views on the process of preparing the activity through using ABSL. Büyüköztürk et al., (2019) noted that there are some criteria to be considered while preparing the interview questions. These are; the questions should be prepared to reveal the data, they should be easy to answer and not difficult for the person who will participate in the interview. The form was presented to two science experts in order to ensure validity. The experts examined the questions in terms of their suitability for the purpose of the study and made the necessary corrections and removed some of the questions from the interview form. In this regard, the questions were arranged in a sequence to facilitate obtaining the data that is appropriate, understandable and desired to be reached. The tool was conducted as a pilot study for two teachers. Accordingly, the semi-structured final interview form consisting of 6 open-ended questions got its final version.

Data Analysis

Content analysis and descriptive analysis methods were used during data analysis. Content analysis requires coding the data, finding the themes, putting the elicited data and themes in a certain order, defining the findings and interpreting the findings (Yıldırım & Şimşek,2008). Considering the data obtained from the semi-structured pre-interview and post-interview forms, the keywords were initially determined, and then the concepts that were similar to each other were gathered under the same keyword. The data obtained from the keywords were coded and divided into categories. The similarities and differences of the responses were revealed through categories. The elicited data were presented to an expert in the field of science and requested to analyse the data through content analysis with a view to ensuring reliability. The data were compared and hence the researchers finalized the content analysis. The data regarding the pre-interview and post-interview forms are displayed in tables in the findings section in order to understand the relationships across the categories. The teachers were coded as T1, T2, T3, T4 and T5.Descriptive analysis was used to analyse the ABSL activities prepared by the science teachers. The main objective of descriptive analysis is to present the data obtained from interviews, observations and documents to the reader by dividing them into groups in an organized way (Yıldırım & Şimşek, 2008). The activity papers prepared by the teachers were analysed in three different sections according to the Evaluation Rubric on ABSL Activities prepared by the researchers. In the first part, the activity sheets prepared by the teachers (grade level, unit, subject area, learning outcome and associations with daily life) were examined in terms of the content, while the activity sheets prepared by the teachers were analysed according to the ABSL technique preferred by the teachers in the second part. The ABSL technique was investigated descriptively across its characteristics in the related literature. Lastly,the activities were analysed according to the question containing the argumentation steps of Toulmin (1958), which consists of six basic elements as claim, data, warrant, backing, qualifier and rebuttal.

Data Collection Process

There was a 2-week period between the first and the last interviews. Before the interviews, permission was obtained from the teachers for the voice recording and the process was pre-planned by the researchers in order to avoid any disruptions during the data collection process.

Table 2 Data Collection Process

	The practices	Time
1st Week	Preliminary Interview + Interview	45 min.
	Information on ABSL	40 min.
	Presentation of sample activity papers appropriate for ABSL	40 min.
2nd Week	ABSL activity preparation	2 Weeks
	Determining activities	20 min.
	Last interview	45 min.

Preliminary interviews were conducted face-to-face with science teachers and lasted an average of 45 minutes in the first week of the implementation process. At first, they were requested to fill in a semi-structured pre-interview form. Afterward, interviews were conducted to obtain more detailed data due to insufficient data. The teachers were informed about ABSL by the researchers. Then, they were requested to analyse activity papers using different argumentation techniques at different grade levels. Before determining the activities, the theses in which ABSL was implemented were examined in the national thesis centre, and argumentation activities with different grade levels and techniques were identified. These activities were reduced to four activities in which the content of Toulmin's argumentation step was best reflected with the support of the experts in the field of science education. Among the activities used during the implementation, the 8th grade activity was borrowed from Cömert (2019), the 7th grade activity from Kızkapan (2019), the 6th grade activity from Uçar (2018) and the 5th grade activity from Gür (2019). Necessary permissions for the activity samples were obtained in advance. After examining the activities obtained from the literature, the teachers were requested to make an argumentation-based activity paper through using two different techniques suitable for the science learning outcome they chose. The reasons why they were asked to prepare two different activities were to provide data diversity, gain experience in preparing events and enable them to determine the appropriate activity themselves. Teachers were given two weeks for this practice. The activity papers prepared by the science teachers regarding the science learning outcomes they determined were collected in the second week of the implementation process. Afterwards, they were asked to determine the activity they thought would give the best results in ABSL from the activity papers they had prepared. The teachers submitted the activity sheets to the science teachers for analysis. Besides, the teachers were requested to fill in a semi-structured final interview form to receive their views about the implementation process. Interviewing was employed to obtain in-depth data. Each interview lasted approximately 45 minutes.

Findings

Findings regarding the Pre-Interview Form Analysis

Semi-structured pre-interview form was administered to science teachers in order to receive their views about ABSL before the implementation. In this regard, the findings related to science teachers' perceptions about ABSL, their preparation of activities and their use in lessons are depicted categorically. The codes and categories are displayed as follows.

On examining Table 3, science teachers' perceptions towards ABSL before the implementation were as follows: "Pondering" (f=2), "Discussion" (f=2), "Gather data and strengthen or refute claims" (f=2), "Solving the problem" (f=1), "Supporting ideas with scientific statements" (f=1) and "Traditional education" (f=1). The teacher's view on ABSL is as such:

T3: "Argumentation-based science learning is to guess about a subject. I mean, pondering and discussing it."

With regard to the findings on the teachers' experiences of preparing ABSL activities in Table 3, one teacher prepared the activity while others did not. The teacher's view is presented as following:

T1: "Yes. I prepared and implemented a lesson plan and activity with the 5th grade students by using the table of statements technique within the scope of the "Force and Motion unit". I took care to use simple, understandable and appropriate statements for the level of the students."

As in Table 3, two teachers were identified to use ABSL in classes; whereas, three teachers did not. The emerging codes obtained from the views

of teachers who used ABSL in their lessons were found as a science laboratory, grade level and misconception. Teachers' views regarding the use of ABSL in classes are presented as follows:

T1: "I used it. I used this method to identify misconceptions, identify misunderstandings and explain the correct information to the students for eliminating these misconceptions. I tried to use the method by the level of the students."

T5: "I used the method. Science lesson is actually action-packed lesson. Although I did not plan it, I applied it in a laboratory for an experiment. I used it in the electricity unit as the classes were not crowded due to the pandemic last year. I didn't plan, yet I used it spontaneously. The subject I used was about circuit components and circuit."

Table 3 Science Teachers' Preliminary Views on ABSL

ABSL Perception	Activity Preparation Experience	Use in Classes
Pondering Discussion Gather data and strengthen or refute claims Solving the problem Supporting ideas with scientific statements Traditional education I don't know	Yes Table of statements No	Yes In science laboratories Grade level Misconception No

Findings Regarding the Data Obtained from the ABSL Activity Sheets

The "Evaluation Rubric related to Activities Based on Argumentation-Based Science Learning" was analysed separately according to the content of the activity, the technical characteristics of ABSL and Toulmin's argumentation model steps with the aim of evaluating the ABSL activities prepared by the teachers.

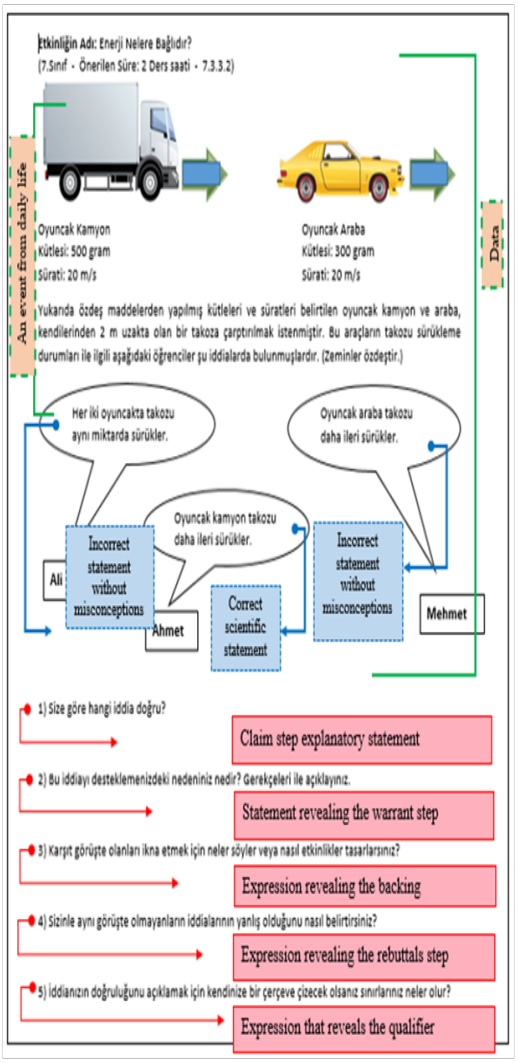

Figure 1 Activity Sheet Prepared by T1

Figure 1 suggests that T1 prepared an activity sheet for the 7th grade level, Force and Energy unit, Physical Events subject area and 7.3.3.2 learning objective content. He stated the duration of the activity as 2 lesson hours in the activity sheet and presented an event from daily life as "Comparison of the energies of the truck and the car, which have different masses and the same speed". Figure 1 also shows that T1 used the concept cartoon technique, one of the ABSL techniques. Upon analysing this activity sheet according to the concept cartoon features, the activity sheet was identified to include an event from daily life, conversation bubbles, at least three characters, correct scientific statements

and two or more false statements. Besides, incorrect statements without any misconceptions were also found in the activity prepared by the teacher. T1 asked the following questions in the activity sheet for each argumentation component: “Which claim is correct in your opinion?” for claim; “What is your reason for supporting this claim? Explain with justifications.” for warrant; “What do you say or what kind of activities do you design to persuade those who have opposing views?” for backing; “If you were to draw a framework for yourself to explain the accuracy of your claim, what would your limits be?” for qualifier and “How can you state that the claims of those who do not agree with you are false?” for rebuttal.

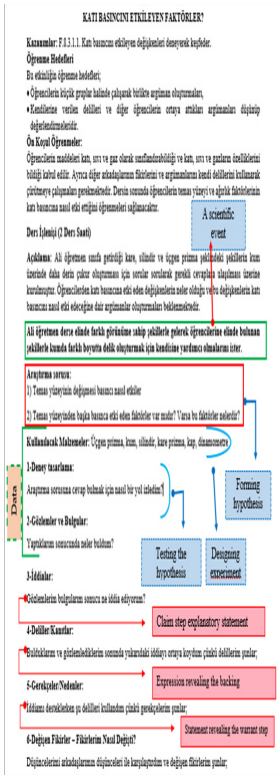

Figure 2 Activity Sheet Prepared by T2

Figure 2 suggests that T2 prepared an activity sheet for the 8th grade level, Pressure unit, Physical Events subject area and 8.3.1.1 learning objective content. He mentioned the duration of the activity as 2 lesson hours and included an event from daily life: “The depth of the pits that a square, cylinder and triangular prism will form on the sand”. Figure 2 displays that T2 used the experiment design technique as one of the ABSL techniques. On analysing this activity in terms of the characteristics of designing an experiment, the activity was determined to hold the features of introducing a scientific event, forming hypotheses and designing experiments; while it did not include those of determining the experimental variables and the process of experimentation.T2 revealed the claim component with such a question as “What do I claim as a result of my observations and findings?”, the warrant component as “I used the following evidence while supporting my claim because my reasons are as follows;” and backing step as “After what I found and observed, I put forward the above claim because my evidence was as follows;”. However, the activity sheet did not involve the statements related to qualifier and rebuttal steps.

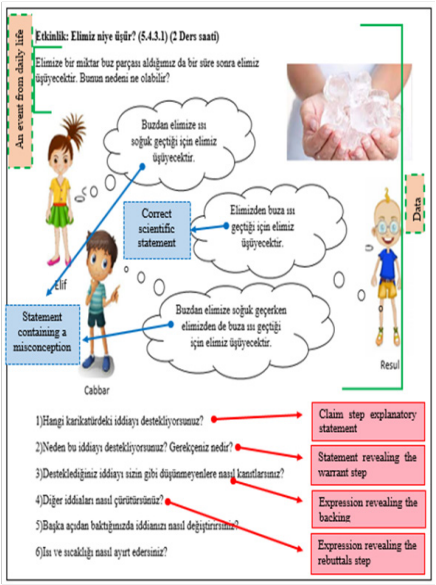

Figure 3 Activity Sheet Prepared by T3

Figure 3 suggests that T3 prepared an activity sheet for the 5th grade level, Matter and Change unit, matter and its nature subject area and 5.4.3.1 learning objective content. T3 mentioned the implementation period of the activity as 2 lesson hours and used an event from daily life “What is the reason why our hands get cold when we take the ice in our hands?”. Figure 3 suggests that T3 used the concept cartoon technique for the activity sheet. Considering the characteristics of concept cartoon, the activity sheet was identified to include an event from daily

life, conversation bubbles, at least three characters, correct scientific expressions and two or more incorrect expressions. The activity prepared by the teacher were found to have incorrect statements that may lead to misconceptions. In the activity prepared by T3; the claim component was revealed with such a question as "Which claim do you support in these cartoons?", the warrant component as"Why do you support this claim? What is your claim?", backing component as "How can you prove the claim you support to those who do not think like you?" and rebuttal component as"How do you refute other claims?". However, the activity did not include any questions related to qualifier component.

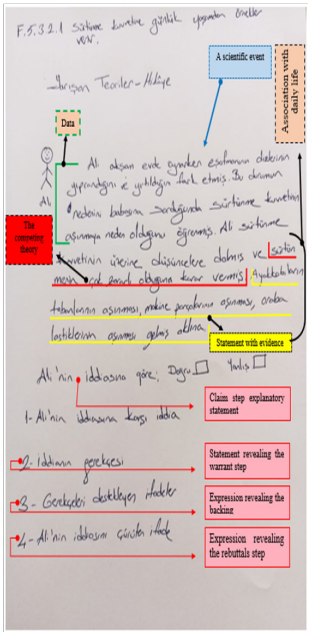

Figure 4 Activity Sheet Prepared by T4

Figure 4 suggests that T4 prepared an activity sheet for the 5th grade level, the Measurement of Force and Friction unit, the subject area of Physical Events and 5.3.2.1 learning objective content. The teacher did not specify the implementation duration in the activity sheet and gave an event from daily life as "Abrasion of the soles of the shoes, the abrasion of the machine parts". Figure 4 also demonstrates that T4 used the theories competing with the stories as an ABSL technique.When this activity sheet was examined according to the features of competing theories with stories, it involved introducing a scientific event and having two or more claims and statements containing evidence. T4revealed the claim with such a question, "According to Ali's claim: Is it true? False?"; warrant as "Justification of the claim?"; basking as "Statements supporting the grounds?" and rebuttal as "The statement that refutes Ali's statement?". However, the activity did not involve a statement revealing the qualifier element.

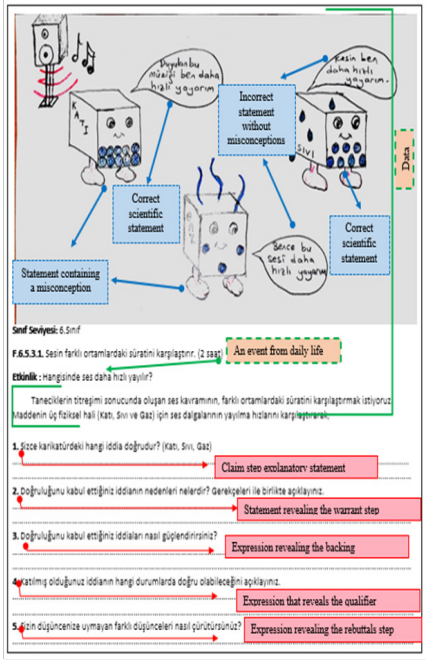

Figure 5 Activity Sheet Prepared by T5

Figure 5 suggests that T5 prepared an activity sheet for the 6th grade level, Sound and Properties unit, Physical Phenomena subject area and 6.5.3.1 learning objective content. The teacher determined the duration of the activity as 2 lesson hours on the activity sheet and gave an event from daily life as "comparison of the speeds of sound in solid, liquid and gas states". Figure 5 suggests that the teacher used the concept cartoon technique. Considering the characteristics of concept cartoon, the activity sheet was identified to include an event from daily life, conversation bubbles, at least three characters, correct scientific expressions and two or more incorrect expressions. The activity prepared by the teacher was found to have incorrect statements with no misconceptions. T5 revealed the argumentation components with such questions as: "Which

claim in the cartoon do you think is true? (Solid, Liquid, Gas)"for claim; "What are the reasons for the claim that you accept as true? Explain with the justifications." for warrants; "How can you strengthen the claims that you accept as true?" for backing; "Explain in which cases the claim you have joined may be true."for qualifier and "How do you rebut different ideas that do not fit yours?"for rebuttal.

Findings Regarding the Last Interview Form Analysis

Semi-structured final interview form was deployed to receive the science teachers' views on ABSL after the implementation. The findings related to the questions in the semi-structured final interview form such as the perception towards ABSL, considerations, the role of the teacher in ABLS, the role of the student in ABSL, the challenges and the benefits of ABSL for students were depicted categorically. Table 4 summarizes the codes and categories.

Table 4 Final Views of Science Teachers Regarding ABSL

ABSL perception	Considerations	Teacher Role	Student Role	Challenges	Benefits of ABSL for students
Information	Not creating	Being a guide	Being active	Time consuming	Permanent learning
Idea	misconceptions	Interference	Learning by doing	Time consuming	Argument elements
Claim	Student level	Guidance for seeking truth	Information exchange	Subject appropriateness	Problem solving skills
Opposing view	Grade level	Creating a discussion environment	Responding questions with evidence	Subject appropriateness	Active student
Result	Suitability of the subject to the method	Giving clues with images	Guessing	Students' level	Teaching knowledge with reasons
Cause-effect	Learning outcome	Giving a problem	Verifying predictions	Students' level	Scientific process steps
Argument	Questions Clarity of statements Images	Presenting preliminary information about the subject		Readiness	Creating an atmosphere of discussion
Active participation		Content preparation according to the method		Readiness	Critical thinking skills
Permanent learning				Number of students	
Scientific perspective				Number of students	
Guessing				Technological problem	
Verifying predictions				Technological problem	

Lead to think				Making explanations in cartoons	
				Transferring concepts to cartoons	
				Drawing images in cartoons	

Upon investigating the teachers' perceptions towards ABSL after the implementation; the emerging codes were determined as "Information" (*f*=2), "Idea" (*f*=2), "Claim" (*f*=2), "Opposing view" (*f*=2), "Result" (*f*=2), "Cause and effect" " (*f*=2), "Argument" (*f*=2), "Active participation" (*f*=1), "Permanent learning" (*f*=1), "Scientific perspective" (*f*=1), "Guessing (*f*=1), "Verifying predictions" (*f*=1) and "Lead to think" (*f*=1). Some of the teachers' views are presented as follows.

T1: "Argumentation-based science learning is a method in which students can actively participate in the lesson, express their thoughts easily, defend their claims and produce ideas that will refute the counter-claims. Permanent learning may be ensured in this regard. It is a method that may create a scientific perspective for students."

T3: "It is the process of making predictions about an event and confirming the predictions."

As for the considerations teachers took into account in the ABSL activities, the emerging codes were identified as "Not creating misconceptions" (*f*=3), "Student level" (*f*=2), "Grade level" (*f*=1), "The suitability of the subject with the method" (*f*=1), "Learning outcome" (*f*=1), "Questions" (*f*=1), "Clarity of statements" (*f*=1) and "Images" (*f*=1). Here are some excerpts regarding teachers' views.

T1: "The students' level, the grade level, the feature of the subject, the method and technique we chose were effective in the activities we prepared."

T2: "I made sure that it was appropriate for the level of the student and did not lead to any misconceptions."

As regards the responses of the teachers regarding the role of the teacher in the ABSL activity process, the codes were determined as "Being a guide" (*f*=4), "Interference" (*f*=2), "Guidance for seeking truth" (*f*=2), "Creating a discussion environment" (*f*=1), "Giving clues with visuals" (*f*=1), "Giving a problem" (*f*=1), "Presenting preliminary information about the subject" (*f*=1), and "Content preparation according to the method" (*f*=1). As to the analysis of the teachers' views on the role of the student in the ABSL activity preparation process, various codes were determined as "Ensuring one's own learning" (*f*=4), "Being active" (*f*=3), "Learning by doing" (*f*=1), "Information exchange" (*f*=1), "Responding questions with evidence" (*f*=1), "Guessing" (*f*=1) and "Verifying predictions" (*f*=1). Some of the teachers' views are presented below.

T1: "The teacher should serve as a guide while carrying out the activities after presenting the basic information to the students depending on their class level and readiness. In this way, students will be able to carry out activities actively and ensure their own learning."

T3: "The teacher gives the problem. S/he guides the process of validating the predictions. The students guess and they are active researchers trying to verify their guesses."

Table 4 also demonstrates the challenges experienced by the teachers while preparing ABSL activities. Accordingly, the emerging codes were found as "Time-consuming" (*f*=3), "Unsuitable for each subject" (*f*=2), "Activities suitable for students' levels" (*f*=1), "Student's readiness for the method" (*f*=1), "Number of students" (*f*=1), "Technological problems" (*f*=1), "Making explanations in cartoons" (*f*=1), "Transferring concepts to cartoons" (*f*=1) and "Drawing the visuals in the cartoon" (*f*=1). Some of the teachers' views are displayed below.

T1: "Determining which method and technique would be more appropriate depending on the nature of the subject may be time-consuming. It also takes time to create activity papers and then evaluate them."

T3: "Student's readiness for the method, democratic environment level of the class, duration, number of students"

When the benefits of the activities prepared by the teachers in accordance with ABSLwere examined in Table 4, the codes were noted as "Permanent learning" (*f*=3), "Argument elements" (*f*=2), "Problem- solving skills" (*f*=2), "Active student" (*f*=1), "Teaching knowledge with reasons" (*f*=1), "Scientific process steps" (*f*=1), "Creating a discussion environment" (*f*=1), and "Critical thinking skills" (*f* =1). Some of the teachers' views are summarized as such.

T2: "I think it will be useful. Students learn knowledge with its reasons and rebuttals. Knowledge becomes more permanent."

T3: "They can produce solutions to the challenges they encounter in daily life by using the scientific process steps."

The teachers' views about the question available in the last interview form, "What other subjects is it appropriate to use argumentation-based science learning in science courses? Explain why." were divided into science subject area categories and illustrated in Table 5.

Table 5 Science Teachers' Views Regarding Science Subjects Suitable for ABSL

Earth and Universe	Living Things and Life	Physical Phenamena	Matter and Its Nature
Formation of Seasons	Photosynthesis Classification of living things Consanguineous Marriage Global warming	Electricity Electrical Resistance Bulb brightness Light Kinetic energy Potential energy Speed Mass and Weight Sound	Acids and Bases Density Dissolution rate Separation of mixtures Classification of elements Changes of state Heat and temperature

Table 5 demonstrates teachers' views on other subjects that ABSL can be implemented. In this regard, the concept of "The Formation of Seasons" (*f*=2) in the subject area of the Earth and the Universe; the concepts of "Photosynthesis" (*f*=1), "Classification of living things" (*f*=1), "Global warming" (*f*=1) and "Consanguineous marriage"(*f*=1) in the subject area of Living things and Life; the concepts of Electricity" (*f*=2), "Bulb brightness" (*f*=1), "Electrical resistance" (*f*=1), "Light" (*f*=1), "Kinetic energy" (*f*=1), "Potential energy" " (*f*=1), "Speed" (*f*=1), "Mass and weight" (*f*=1), "Sound (Subject not specified)" (*f*=1) within the subject area of physical phenomena; "Acid-base" (*f*=1), "Density" (*f*=1), "Dissolution rate" (*f*=2), "Separation of mixtures" (*f*=1), "Classification of elements" (*f*=1), "Changes of state" (*f*=2), "Heat and temperature" (*f*=2) in the subject area of Matter and its Nature were determined. Science teachers evaluated the appropriateness of using ABSL in teaching these concepts as "Subjects that may lead to misconceptions" (*f*=3), "Observable subjects" (*f*=2), "Concrete subjects" (*f*=1) and "Provable subjects" (*f*=1). Some of the teachers' views are depicted below.

T1: "The argumentation method will be extremely effective in experimental subjects, subjects related to social life, and those including many misconceptions. Experimental topics: Acid-base, speed, electricity, light, density; Social topics: consanguineous marriage, global warming"

T3: "Electricity, Structure of matter (dissolution rate, separation of mixtures), Formation of seasons, Heat and temperature, Sound; numerous misconceptions. We can make inferences as a result of experimental and research examination as well as observation"

Discussion

This study is an attempt to examine science teachers' views on Argumentation-Based Science Learning (ABSL) and the activities they have prepared. In this regard, the findings were discussed and presented in line with the research questions.

The study initially employed a semi-structured pre-interview form to reveal science teachers' views

on ABSL. Hence, the teachers' perceptions towards ABSL were identified as making a discussion, giving an opinion, collecting data and strengthening the claims. This refers to the fact that teachers had limited knowledge about ABSL. In a study conducted with pre-service classroom teachers, Karaer et al., (2019) concluded that they had a low-level readiness for the definition of the argumentation method, such as making arguments, getting the opponents to accept their ideas and discussing scientific topics before argumentation practices. On analysing the teachers' preparation of activities suitable for ABSL and their use in their lessons, most of them did not prepare and use ABSL activities in their lessons before. This may be because they did not receive any training on ABSL and they did not have experience in the implementation of this method. In their study, Sampson and Blanchard (2012) confirmed that teachers had inadequate content knowledge to use the argumentation method. Besides, several studies suggested that teachers need guidance on how to approach activities engaging students in argumentation (Mork, 2012). Deveci and Konuş (2020) also highlighted that teachers do not use ABSL due to a lack of knowledge. Özcan (2016) outlined that science teachers could not use the argumentation method in classroom instruction, and that they were unfamiliar with the concepts in argumentation and argumentation activities. In another study conducted with a group of science teachers, Choi et al., (2019) affirmed that they had never experienced ABSL before and thus, they did not implement it in science classes.

With regard to the analysis of activity sheets prepared by the teachers in terms of content, all teachers were determined to concentrate on the grade level, unit, subject area, learning outcome and associating them with daily life while preparing the activities involving ABSL. While four of the teachers stated the duration of the activities they prepared, one teacher did not specify the time. The activities carried out by the teachers were found to involve some significant information about the practice (grade level, unit, learning outcome, duration, associating with daily life), referring that teachers have sufficient knowledge in preparing activities. In their study, Öztürk and Işık (2020) pointed out that it is vital to include important considerations (purpose, class level, equipment, duration, directive) in the plans for the success of the activity.

As for the analysis of ABSL activity papers prepared by the teachers in terms of the argumentation technique, the concept cartoon technique (N=3), the theories competing with the stories (N=1) and the experiment preparation technique (N=1) were mostly used by the participants. The activities of all teachers who prepared concept cartoons were determined to involve an event from daily life, conversation bubbles, at least three characters, correct scientific expression and two or more incorrect statements. While only one of the teachers who prepared concept cartoons had incorrect statements that may lead to a misconception, two of them included incorrect statements that were free from any misconceptions in the activities. This indicates that the teachers have sufficient knowledge related to the characteristics of the concept cartoon technique. Aktamış (2017) implicated that one of the most important points to be considered while preparing a concept cartoon is to have a concept related to a scientific event that can be associated with daily life, and to include an expression in which this concept is used correctly and the one that is generally used twice or more incorrectly (involving misconceptions). The activity sheet prepared by the teacher using the theory competing with stories technique was found to involve a scientific event, two or more competing claims and statements containing evidence. This indicates that the teacher has sufficient knowledge about the techniques of competing theories with stories. Aktamış (2017) emphasized that the characteristics such as creating arguments by using evidence to discuss an idea or the other should be available in the techniques of competing theories with stories. The teacher included the features of the theory technique that competes with the stories in the activity involving ABSL. The activity of the teacher preparing an experiment design activity included statements about introducing a scientific event, forming a hypothesis and designing an experiment. However, no statements were found related to determining the experimental variables and the process of the experiment. Çınar (2013) concluded that the ABSL experiment design

technique is significant for students to know what the experimental variables might be and how to do the operations in order. These features were lacking in the experiment design activity.

On examining the activity papers prepared by the teachers according to Toulmin's argumentation model, all the teachers were determined to use questions that reveal the data, claim, warrant and backing elements. Besides, two teachers asked questions related to qualifier element, while three did not. Likewise, 4 teachers asked questions for the rebuttal element in the activities; whereas, one teacher did not. It may be wise to mention that science teachers have difficulty in writing questions related to qualifier element. Toulmin argumentation model includes 3 fundamental elements as data, claim and warrant, and 3 other elements as backing, rebuttal and qualifier (Toulmin, 1958). The Toulmin argumentation model facilitates teachers in explaining the relationships between argumentation elements (Kaya & Kılıç, 2008). Yeh (1998) asserted that the Toulmin argumentation model is a valid model with its argumentation elements as it can meet the criteria of widespread acceptance, suitability, applicability to education or suitability for development. In addition, this model is among the most used models in education in argumentation analysis despite its disadvantages such as field dependence, lack of clarity of the elements and deficiencies in analysis (Aldağ, 2006).

The present study deployed a semi-structured final interview form to reveal science teachers' views on ABSL. Accordingly, the emerging codes were determined as knowledge, opinion, claim, counter-idea, conclusion and discussion. These results suggested that teachers' perceptions changed due to teacher guidance during the implementation. Deveci and Konuş (2020) affirmed that teachers' perceptions towards ABSL were related to evidence, argument, claim, warrant, questioning and criticism. This may be because the Toulmin (1958) argumentation is the most widely used method in science education in our country. The findings also revealed considerations that teachers took into account when preparing activities involving argumentation ssuch as not leading to misconceptions and the level of the student. McNeill and Martin (2011) and Namdar and Demir (2016) stressed that grade level is vital in the implementation of ABSL.

With regard to the analysis of teachers' views on the roles of teacher and student in the implementation process of ABSL, the most common codes related to teacher roles were determined as being a guide, intervening and guidance for seeking truth, while student roles were mostly identified as ensuring their own learning, being active and learning by doing. This means that teachers are aware of their role as a guide during this process. Many studies revealed that teachers act as a guide for students in the argumentation process (Deveci, 2009; Tümayet al., Köseoğlu & Budak, 2008; Uluçınar-Sağır & Kılıç, 2013). In a study carried out with pre-service teachers, Kabataş-Memiş (2017) found that teachers need to serve as guides and provide information when necessary in the argumentation process. Another study conducted with the pre-service teachers revealed that students' roles consisted ofbeing responsible for their own learning, learning by doing and exchanging information (Ecevit & Kaptan, 2021). Teachers' views on the challenges they experienced while preparing ABSL activities demonstrated that they were time-consuming, unsuitable for every subject, the number of students and the readiness level of the students for the method. Choi et al., (2019) implied that Korean science teachers who did not implement argumentation-based science instruction gave reasons regarding teachers themselves (lack of experience, understanding and teaching skills), students (experience, knowledge and unwillingness to participation) and the learning environment (negativities such as time, exam-oriented class and number of students).Last but not least, science teachers' views on the benefits of the activities prepared in accordance with ABSL suggested that they provided permanent learning, made the students active, created a discussion environment and taught the information together with the reasons. This shows that teachers expressed positive views about the benefits of ABSL after the implementation. Similar results emerged in various studies (Güler, 2016; Özcan, 2016; Namdar & Tuskan, 2018). Besides, teachers' views on the subjects that can be prepared in accordance with ABSL showed that they generally made suggestions for the subjects of

physics and chemistry. They gave reasons related to choosing these subjects. Accordingly, the students' misconceptions about these subjects and the subjects are more observable and concrete, and it is easier to prove the subjects. This may be the reason why physics subjects are frequently encountered in daily life. Namdar and Tuskan (2018) concluded that science teachers should use the argumentation method mostly in physics subjects. The thematic content analysis study on argumentation studies at primary education level (Bağ & Çalık, 2017) affirmed that the subjects in argumentation studies conducted at the national and international level were physics, biology, environment, socio-scientific issues and chemistry, respectively, according to the total number of studies. In their study, Ayaz and Söylemez (2015) stated that the reason why teachers see physics subjects as the most suitable for argumentation is that physics comes first among those that are associated with daily life.

Recommendations

Based on the research findings, various recommendations were provided.

- This study examined teachers' views on ABSL. Further studies may be conducted to reach results that are more comprehensive by determining what factors affect teachers' views on ABSL.
- Although similar studies are available in the international literature, the national literature may be enriched with different studies.
- On analysing the science teachers' view on ABSL, they were identified to have limited knowledge about ABSL and that they did not receive guidance on ABSL. Therefore, science teachers should be provided training on ABSL during in-service training or end-of-term seminars.
- The results suggested that the teachers had some difficulties while preparing the activity. Sample activities related to ABSL that teachers can use in lessons should be included in the textbooks with a view to overcoming these difficulties.
- The roles of students and teachers are vital in the ABSL process. Practical activities may be conducted to engage students in the process so that science teachers may understand the roles of students and teachers.
- Projects based on ABSL may be carried out with science teachers and students.
- The results also showed that the teachers generally preferred physics subjects while doing ABSL activities; they suggested doing ABSL activities for the subjects of biology and chemistry. Teachers may also be ensured to prepare activities involving biology and chemistry.

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