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A rating scale development study for the evaluation of lesson plans and teaching practices on argumentation-based inquiry

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Abstract: The purpose of this study was to develop a reliable and valid rating scale for the use of the assessment and evaluation of lesson plans and teaching practices that are based on argumentation-based inquiry (ABI). The study covered two academic years (four academic semesters). Qualitative and quantitative methods were utilized throughout the development of the rating scale including data collection and data analyses. A purposive sample of 72 pre-service science teachers (PSTs) who were enrolled in a public university located in East Black Sea region of Turkey constituted the sample of the study. Content Validity Ratio (CVR=.80) and Content Validity Index (CVI=.94) values were calculated as measures of content validity. Pearson Correlation Coefficient (r=.96) and Cohen's Kappa value (κ value was between .60 and 1.00) were calculated to test inter-rater reliability of the scores obtained by the rating scale. Findings provided evidence for the reliability and the validity of the ABI rating scale. ABI lesson plan template and ABI rating scale developed for the assessment and evaluation of ABI lesson plans and subsequent teaching practices are provided to the readers. Contributions to the field are discussed.

1. INTRODUCTION

Countries should focus on training qualified people to have a word in scientific and economic fields and capture future changes and developments that will occur in these fields (Stohlmann, Moore & Roehring, 2012; Şahin, Ayar & Adıgüzel, 2014; Tunkham, Donpudsa & Dornbundit, 2016; Turkish Industry and Business Association [TÜSİAD], 2017). From this point of view, it has become important to raise individuals who are responsible for their own learning and who can investigate and question various issues they are confronted with. Moreover, it has also become very important to educate citizens who can express their opinions on controversial contemporary issues and persuade others by presenting logical arguments instead of rejecting every other opinion/idea or directly accepting them as they are. The primary way to raise individuals who have the desired characteristics described above is to make necessary changes in education systems. In this context, cultivation of higher-level thinking skills, such as 21st

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century skills, is one of the emphasized educational goals that take place in educational reform documents (Leou, et. al., 2006).

Problem solving, critical thinking, reflective thinking, collaboration, and entrepreneurship are some of the skills included in 21st century skills (National Research Council [NRC], 2011) and they have a natural and strong connection with science education. For instance, Nature of Science (NOS) views and their development are proposed to be related to many of the 21st century skills (NGSS Lead States, 2013). Argumentation-based teaching practices are also recommended as an effective teaching approach to improve students' 21st century skills (Ecevit & Kaptan, 2021). Considering group work and small/large group active negotiation processes that include social interaction, argumentation improves communication skills, collaboration, critical thinking and decision-making skills which are listed among 21st century skills (Driver, Newton & Osborn, 2000; Ecevit & Kaptan, 2021; Kabataş Memiş, 2017; Nam, Choi & Hand, 2011; Sevgi & Şahin, 2017; Yeşildağ-Hasancebi & Günel, 2014). Based on these, this study focused on the development of a rating scale that may be used for the assessment and evaluation of argumentation-based inquiry (ABI) lessons. Details of the ABI teaching approach and its utilization in science education and the necessity of developing a rating scale that is based on ABI teaching approach are given in the following sections.

1.1. Theoretical Framework

This study is theoretically grounded by argumentation-based inquiry (ABI), which is based on Science Writing Heuristic (SWH) approach. The SWH approach is proposed as a way to help students gain deeper understanding about the big ideas of science by planning, constructing and testing questions, justifying their claims with the evidences they have gathered, making comparisons with others' ideas, and elaborating on the changes in their ideas through the process they went through (Akkuş, Günel & Hand, 2007). Accordingly, SWH template for teacher and student (Choi, Hand & Greenbowe, 2013; Hand, Wallace & Yang, 2004; Nam, Choi & Hand, 2011) and researchers' ABI application experiences were utilized while constructing the items of the ABI rating scale.

Argumentation is the process of constructing data and claims, and their justifications, by making experimental and theoretical connections (Erduran & Jimenez-Aleixandre, 2007). Osborne (2005) defined argumentation as the way of predicting, evaluating, and proving evidences and operating mechanisms of reasoning on the opposite/contradictory arguments in the process of knowledge construction. Argument, on the other hand, is a form of discourse that needs to be taught explicitly through appropriate teaching activities, support, and modeling (Simon, Erduran & Osborne, 2006). As stated by Toulmin, an argument consists of basic components of claims, data, warrants, qualifiers, backings, and rebuttals (Toulmin, 1958). With the help of the utilization of these components, an argument includes the ability to put forward reasons for an event or situation and to test the causes of the event/situation with appropriate evidences from different viewpoints (Driver et al., 2000).

As an instructional approach that is designed to support students' science learning, ABI applications aim to foster science discourses among students (Hand & Norten-Meier, 2011) and supports creation of sound arguments (especially in written forms) in a scientific inquiry (Cavagnetto, Hand & Norten-Meier, 2010; Choi et al., 2010). By this way, ABI helps students construct scientific knowledge through scientific inquiry (Cavagnetto et al., 2010; Hand & Keys, 1999). ABI approach also helps students to personally experience the argumentation processes that scientists go through while constructing a scientific theory or law (Burke, Greenbowe & Hand, 2006) and, thus, enables students to better understand scientific explanations and related theories and laws (Erduran, Simon & Osborne, 2004).

In ABI approach, where thinking and writing activities are at the forefront, students ask questions, test their evidences, make claims based on their findings, and make decisions after comparing their claims with the already existing scientific knowledge (Hand, 2008; Hand, Wallace & Yang, 2004; Martin & Hand, 2007). In this process, students organize their own research questions, create strategies/methods (e.g., making observations, doing experiments etc.) to answer them, analyze and interpret their findings, and share their claims (together with their evidences) with others (Hand et al., 2004; Martin & Hand, 2007). Small group discussions made with group mates and classroom discussions made with all of the students in the classroom are among the important elements of the ABI approach. During these processes students have the chance of experiencing testing and meaning making of their own knowledge about the issues (Burke et al., 2006). At this point, teacher guidance plays a vital role in the realization of these processes, and thus, efficiency of the application of the ABI approach.

1.1.1. *Argumentation-Based Inquiry Approach in Science Education*

Inquiry based teaching strategies are adopted in many science curricula all around world (e.g., Australian Curriculum, Assessment and Reporting Authority [ACARA], 2012; Ministry of National Education, Turkey [MoNE], 2018; National Research Council [NRC], 2000; NGSS Lead States, 2013). Contemporary science education curriculum standards make explicit reference to "Science is based on empirical evidence" (Guilfoyle, Erduran & Park, 2021; National Science Teaching Association [NSTA], 2020). In these curricula, it is highlighted that the inquiry processes should include more than making experiments but should foster students' skills in making explanations and generating arguments about their findings as well as the processes they went through while conducting their experiments (MoNE, 2018; NGSS, 2013). Relationships between argumentation and scientific literacy are also highlighted by Simon, Erduran, and Osborne (2006) who propose the ability to understand and follow scientific arguments as essential aspects of scientific literacy.

In addition to promoting scientific literacy, using argumentation in science education is reported to have many other benefits such as supporting cognitive development of students, creating opportunities for their critical thinking, and encouraging students for utilizing scientific language. These processes, in turn, are proposed to contribute to the development of students' social skills (e.g., communication skills), enable them to acquire a sense of culture of science, and develop more sophisticated epistemological beliefs (Jimenez-Aleixandre & Erduran, 2008). Moreover, argumentation approach has been found to improve students' conceptual understanding and play an important role in their science learning that is centered on thinking and reasoning processes (Chin & Osborne, 2010). In addition to promoting in-depth learning, argumentation processes make students curious and active, encourage them to create explanations, and provide opportunities for students and teachers to examine and solve errors that may be faced during learning of science (Kaya & Kılıç, 2008). Enabling students to approach events and issues from different perspectives and developing their creativity and imagination are also among the outcomes observed as a result of utilizing argumentation in educational settings (Aktamış & Atmaca, 2016; Gencel & Ilıman, 2019). Necessity of reflecting on evidences, identifying contradictory claims, imagining alternatives, and approaching issues and situations from different perspectives can be given as the main features of argumentation that result in the above-mentioned educational outcomes (Bean, 1996; Chen & She, 2012; King, 2000).

Based on the critical role that teachers play in the effectiveness of argumentation-based learning environments, many researchers emphasize the need for teachers who are well-equipped in this field (Sampson & Blanchard, 2012; Yıldırır & Nakiboğlu, 2014). The importance of teacher pedagogy for achieving desired learning outcomes has also been put forth in a number of research studies (Akkuş et al., 2007; Martin & Hand, 2007). More specifically, in order to efficiently utilize argumentation in science classes, teachers must have the necessary skills to perform evidence-based argumentation activities and be prepared for the difficulties they may face during their implementation (Yıldırır & Nakiboğlu, 2014; Zohar, 2008). Teachers' level of knowledge about argumentation is also among the factors that are found to be influential on their classroom practices (Sampson & Blanchard, 2012; Simon et al., 2006). Therefore, it is important to improve teachers' pedagogical competencies and knowledge levels about argumentation strategies since teachers have vital roles in the implementation of educational reforms (Çepni & Çil, 2016).

Research shows that teachers do not have sufficient resources and pedagogical competencies for implementing argumentation in science classes (Sampson & Blanchard, 2012; Simon et al., 2006). Moreover, teachers frequently state that argumentation activities are time-consuming (Aktamış & Atmaca, 2016; Simon & Johnson, 2008; Torun & Şahin, 2016) and lesson hours are not sufficient for integrating argumentation in their teaching (Gencel & Ilıman, 2019; Namdar & Tuşkan, 2018). In addition to inexperience in using argumentation in their teaching, teachers' pedagogical insufficiencies and inabilities for making efficient planning for argumentation-based lessons may be regarded as the main reasons of these time-related concerns (Namdar & Tuskan, 2018). In this respect, teachers are suggested to use effective time management strategies and detailed planning in order to overcome many of the problems that may be faced during the implementation of argumentation in their lessons (Gencel & Ilıman, 2019). In line with these suggestions, in the present study it was aimed to develop a rating scale that can be used to guide teachers and teacher candidates in the preparation and implementation of argumentation-based lessons and evaluation of their efficiency in using argumentation strategies in their teaching, respectively.

Review of literature reveals that there is limited number of studies conducted on teaching of argumentation and most of the studies are focused on examining classroom practices of teachers after their participation in teacher training courses (Erduran, Ardac & Yakmacı-Güzel, 2006; Namdar & Tuşkan, 2018; Simon et al., 2006). Some of the studies are about the relationships between patterns of questioning and argumentation (Günel, Kıngır & Geban, 2012), efficiency of argumentation strategy for improving science teachers' self-efficacy perceptions toward technological pedagogical content knowledge (Çoban et al., 2016), and views of science teachers with different teaching experiences about scientific argumentation (Namdar & Tuşkan, 2018). As a common conclusion, researchers state that there is need for improving teachers' and teacher candidates' perceptions about and skills in using argumentation in their teaching (Aydeniz & Özdilek, 2016; Namdar & Tuşkan, 2018). Teachers should provide their students with appropriate discussion environments so that students can form valid arguments and support their arguments with variety of evidences (Cirit Gül, Apaydın & Çobanoğlu, 2021). In order to be able to integrate argumentation process into their teaching it is important for teachers to understand what they need to know in this process (McNeill et al., 2017). Therefore, it is necessary for the teacher to understand what argumentation is and how to carry out this argumentation process (Chan, Fancourt & Guilfoyle, 2020). In the literature, studies on teachers' learning and teaching of argumentation generally focus on science education (Chan & Erduran, 2022). In one of these research, İsbir and Yıldız (2021) examined limitations and difficulties faced by teachers during implementation of argumentation. The researchers grouped these limitations as limitations arising from (i) teacher, (ii) student, (iii) working with the group, (iv) educational environment, (v) method and the curriculum.

1.2. Purpose and Significance of the Study

In the present study it was mainly aimed to develop a reliable and valid rating scale for the use of the assessment and evaluation of lesson plans and subsequent teaching practices that are based on argumentation-based inquiry (ABI). The significance of this rating scale development study was (i) evaluating teachers'/teacher candidates' ABI lesson plans and subsequent teaching practices with a validated instrument, (ii) providing detailed feedback aligned to certain criteria to teachers/teacher candidates regarding every stage of their ABI lesson plans and/or subsequent teaching practices, (iii) providing guidance on teaching of the ABI instructional model and supporting teachers'/teacher candidates' skills in designing ABI lessons in pre-service and in-service teacher training programs, and (iv) enabling teachers/teacher candidates to self-evaluate their ABI teaching with a validated instrument.

2. METHOD

2.1. Research Design

This research is a rating scale development study. Research design of the study is exploratory design. Exploratory design is a type of mixed-methods research that is especially useful in developing and testing instruments (Fraenkel, Wallen, & Hyun, 2012). In this study, as typically realized in exploratory design, application of the qualitative phase of the study was followed by quantitative analyses, which were used to validate quantitative findings. Preparation of the rating scale's draft form and taking expert opinions for confirming its validity constituted the qualitative dimension of the study; whereas, determination of the harmony among expert opinions and statistical analyses applied for testing reliability and validity of the rating scale required quantitative methods (McGartland et al., 2003).

2.2. Participants

Participants of the study were 72 pre-service science teachers (PSTs) who were enrolled in a public university located in East Black Sea region of Turkey. Criterion sampling method was used for sample selection. This allowed for making in-depth analyses with a group of participants who meet certain criteria of interest (Büyüköztürk et al., 2020). Experience with a phenomenon of interest is an important criterion for selecting participants with this method (Cresswell & Plano Clark, 2011). In accordance, PSTs who participated in the present study were selected among the ones who were experienced with the ABI approach. That is, the participants had taken courses in the university which were designed through ABI approach offered by the researchers of the study who have sufficient theoretical and practical expertise in ABI. 40 PSTs participated in the first year of the study for piloting the ABI rating scale. Data collected from these participants was not used in data analyses.

2.3. Context of the Study and Development of the Rating Scale

Rubrics are defined as criterion-based scoring tools which are developed by following theoretical processes and opinions of small samples of experts (Yurdagül, 2005). Accordingly, findings of previous research and expertise of researchers (including researchers of the present study) were utilized for the development of the ABI rating scale. In line with Goodrich Andrade (1997, 2001), Mertler (2001), and Kan's (2007) suggestions, the following stages were followed for the development of the ABI rating scale:

1) Review of the rating scale development and ABI literature
2) Determination of the criteria, definitions and scoring level to be used in the rating scale
3) Preparation of the draft version of the rating scale (see First Year of the Study section for detailed information)
4) Taking expert opinions (see Validity section for detailed information)
5) Application of the draft version of the rating scale (see Second Year of the Study for detailed information)
6) Determination of the reliability and validity values of the rating scale (see Reliability and Validity sections for detailed information)
7) Finalizing the rating scale

Development process of the ABI rating scale took place in "Science Teaching and Laboratory Applications" course (four hours a week) which was offered for 3rd grade PSTs. The PSTs who took the course were expected to realize laboratory experiments and activities on physics, chemistry, and biology subjects through Argumentation-Based Inquiry teaching approach. The study included two academic years (four academic semesters). The first year (Fall and Spring semesters) and the second year (Fall and Spring semesters) (see Figure 1).

Figure 1. *Procedures followed in the first and second year of the study.*

*Note: PSTs (Pre-service science teachers) who participated in the second year of the study were different from the ones who participated in the first year.

2.3.1. *First year of the study*

Before the beginning of the first semester, three researchers determined the sections and contents to be included in the ABI lesson plan template. In addition to previous research (Choi, Hand, & Greenbowe, 2013; Hand, Wallace, & Yang, 2004), personal experiences of the researchers in planning and applying ABI lessons were utilized for this phase. Researchers of the study are experienced in planning and implementing ABI lessons in primary school, secondary school, and university level science classes. Moreover, they have conducted teacher training programs for the development of teachers' skills in implementing argumentation-based science lessons.

The sections and contents expected to be given place in each section of the ABI lesson plans were submitted to two experts (one university professor and one science teacher) who implement ABI lessons in their courses. The first draft of the lesson plan was prepared in the light of the received feedback from these experts. Then, in line with this lesson plan draft, rating scale to be used for the assessment and evaluation of lesson plans were prepared.

Sections of the lesson plan (Appendix 3 and 4) are in the following: (i) Pre-lesson preparation: constructing concept map of the unit, determination of the big idea and the sub-ideas, (ii) Discussion on the research question to be investigated (planning of the introductory activity), (iii) Procedures followed during experiments/observations/research by students (investigation of research questions; formation of claims and evidences) (iv) Procedures followed during argumentation of students' claims and evidences, (v) Procedures followed during comparison of students' findings with the literature, (vi) Providing opportunities to reflect on the change of the ideas, (vii) Linking the lesson with Nature of Science and Nature of Scientific Inquiry throughout the lesson, (viii)Linking the lesson with the subsequent lesson, (ix)Additional lesson plan components.

In the first semester of the "Science Teaching and Laboratory Applications" course researchers planned and implemented 20 ABI science lessons (two implementations for each of the 10 weeks). During these 10 weeks the PSTs had student roles and worked in groups of 4-5 to follow the directions given by the instructors (researchers of the study). By this way, PSTs had the opportunity to learn and experience ABI approach and its implementation in science lessons. At the beginning of the second semester of the course, the researchers presented one of the lesson plans they implemented in the previous semester (as an example) to the same PSTs to explain how they prepared ABI lesson plans and what they paid attention to while preparing and implementing the lesson plans. Questions of the PSTs about the lesson plans and their implementation were answered and necessary explanations were given in detail. Then, the PSTs were asked to form groups of two (a total of 20 groups was formed). For the rest of the semester (Fall semester of the first year), the PSTs in these groups were asked to prepare and implement two ABI lesson plans for two science subjects they selected. The PSTs who implemented their lesson plans had the roles of teachers and the rest of the class (including the researchers) had the roles of students during this process. The main purpose of this process was to develop PSTs' skills in preparation of ABI lesson plans and implementing the lesson plans in classroom environment in accordance with their plan.

Giving feedback was a very crucial element of this process (preparation of lesson plans and implementing them in the classroom environment). In order give feedback in the fastest and the most efficient way, an e-mail address was created for the course. PSTs sent their lesson plans one week prior to their implementation and took feedback by all of the three researchers before their classroom implementations. The researchers utilized Google Drive in order to be able to give joint feedback to the lesson plans. In addition, before each course day the researchers and the PSTs who would implement their lesson plans met face to face to discuss details of the lesson plan applications.

In addition to its use as a tool for evaluating the performance of the PSTs who implement their lesson plans (data collected from these participants was not used in data analysis), ABI rating scale and the item statements in it were subjected to a continuous evaluation in terms of their clarity, usability, measurability etc. After each classroom session the researchers discussed their evaluations in terms of the PSTs' performance and ABI rating scale's ability to evaluate those performance.

ABI rating scale was also used as a self-evaluation tool by the PSTs to evaluate their performance in planning and implementing ABI lessons. PSTs individually completed ABI rating scale and submitted it to the researchers after their ABI lesson plan implementations. In addition, classroom discussions were done after each lesson plan implementation where PSTs and the researchers discussed their ideas about the PSTs' performance and the rating scale (necessity of use during the process, its shortcomings etc.). Notes taken during these discussions and after-class discussions made among the researchers were utilized in the revision of the ABI lesson plan and ABI rating scale after two academic semesters. The first year of the research especially includes the determination and clarification of the criteria in the rating scale.

2.3.2. *Second year of the study*

This phase includes application of the ABI rating scale and processes realized for testing its reliability and validity. Issues related to the rating scale's validity (taking expert opinions, revisions done based on the taken expert opinions, calculation of Content Validity Ratio (CVR) and Content Validity Index (CVI) etc.) and details of the rating scale's reliability analysis findings are presented under Findings section. Data used for the reliability analyses were collected from 72 PSTs other than the ones who participated in the first year. The opinions of 10 experts were taken for validity before applications.

Procedures followed in the second year of the study were similar to the ones followed in the first year. That is, in the first semester (Fall semester) of the "Science Teaching and Laboratory Applications" course the researchers planned and implemented 20 ABI lessons on various physics, biology, and chemistry topics. PSTs participated in the courses in groups of 4-5 and followed instructions given by the researchers. In these classroom sessions, the PSTs learned and gained experience in lesson plan implementations realized through ABI approach. At the beginning of the second semester (Spring semester) the PSTs were presented a sample lesson plan that they experienced in the previous semester in order to give details about the preparation of ABI lesson plans and applications in classroom environment. After clarifying PSTs' questions about the ABI approach and related issues (preparation of the lesson plans, issues that should be paid attention during implementation of the lesson plans, etc.) PSTs were asked to form groups (two PSTs in each group) that they will work together until the end of the semester. Each week groups acted as teachers and implemented their ABI lesson plans in the classroom environment. Rest of the class (including the researchers) had student roles in these implementation sessions. Similar to the first year of the study, joint feedback was given to the lesson plans of the PSTs by the three researchers (via e-mail and Google Drive application) one week prior to the classroom implementations. Moreover, face to face discussions were made among the researchers and the PSTs who would be implementing their lesson plans. Each group of PSTs planned and implemented two ABI lessons in total. These lesson plans and implementations were evaluated by the three researchers (during the ABI lesson plan implementations) and the PSTs (as self-evaluation realized after the ABI lesson plan implementations) by use of the ABI rating scale. Researchers' evaluations were used for reliability analyses. See Appendix 1 and 2 for the Turkish and English versions of the rating scale.

2.4. Reliability of the Rating Scale

Consistency of scores obtained by the use of a rating scale by different raters and in different occasions refers to the reliability for that rating scale (Kutlu, Doğan & Karakaya, 2010; Moskal & Leyden, 2000). In order to achieve reliability of the ABI rating scale researchers paid attention to some important facets suggested by colleagues with regard to the development and design of rating scale such as writing criteria to be assessed by the rating scale in a clear and understandable way, limiting content of each criteria assessed by the rating scale in a way that they were intensely focused on the purpose of the criteria, and writing descriptive explanations of the level (degree) definitions in a way that they correctly reflected the levels of the scoring used in the rating scale(Jonsson & Svingby, 2007; Moskal & Leydens, 2000). Finally, as suggested by Kutlu et al. (2010), in order to obtain a more reliable scoring, levels used in the rating scale was designed based on a 5-point scale (0 = *not acceptable*; 1 = *poor*; 2 = *average*; 3 = *good*; 4 = *very good*).

The reliability of the rating scale is expressed as the scoring does not change from one rater to another (Kutlu et al., 2009). Rater reliability is examined in two ways: intra-rater reliability and inter-rater reliability. Cronbach's Alpha coefficient is generally used to calculate intra-rater reliability (consistency of scores given by the same individual) (Jonsson & Svingby, 2007). Cohen's Kappa is often used to determine inter-rater reliability (concordance between scores of more than one rater) (Cohen, 1960). Cohen’s Kappa was used to calculate the inter-rater reliability of the scores (consistency of the scores given by independent raters) obtained by the use of the ABI rating scale because there was more than one rater in this study. Cohen’s Kappa values range from 0 to 1 where grater values correspond to higher levels of consistency (Kutlu et al., 2010). Cohen’s Kappa values calculated for the ABI rating scale indicated that the rating scale has a good inter-rater reliability (see Table 2 under findings section of the article). In addition, Pearson Correlation Coefficient was calculated to determine inter-rater reliability among the two researchers’ total scores.

2.5. Validity of the Rating Scale

In the present study, the researchers consulted expert opinion while developing the ABI rating scale and for analyzing its content validity. That is, at the beginning of the second year of the study (see Figure 1) three experts in Measurement and Evaluation in Education departments of three different universities provided their expertise while revising the ABI rating scale that was used in the first year of the study. Based on taken expert opinions, item statements in the rating scale were written in a clearer way and some items were divided into two so that each item statement measured only one aspect of the ABI lesson plan and its implementation. In addition, explanations in the brackets were removed from the item statements so that the rating scale became simpler and easier to follow by its users.

“Modified Lawshe Technique” (Ayre & Scally, 2014; Wilson et al., 2012), which is a revised version of Lawshe’s (1975) (critical CVR) content validity measure, was used to ensure the rating scale’s content validity. This technique includes (i) establishment of experts group, (ii) preparation of the draft version of the rating scale, (iii) taking expert opinions, (iv) calculation of content validity ratios (CVR=Content Validity Ratio) of the item statements, (v) Calculation of content validity index (CVI= Content Validity Index) of the rubric, (vi) Development of the final version of the rating scale based on CVR and CVI values.

The quality and number of experts are of great importance in obtaining objective results from the analyses carried out for determining content validity. According to Ayre and Scally (2014) and Lawshe (1975), this number should be between 5 and 40. Correspondingly, opinions of 10 experts were used for the content validity analyses of the study. Three of the experts were university professors in the Measurement and Evaluation in Education department and four of the experts were university professors who had numerous studies in the subjects of argumentation and Nature of Science. The remaining three experts were science teachers (with at least a master's degree) who implement argumentation-based science activities in their classrooms. The experts were asked to rate each item statement in the rating scale based on a three-point scale (1 = Should be removed (item does not measure the targeted structure); 2= Should be revised (item is related to the targeted structure but it is unnecessary); 3= Proper (item measures the targeted structure).

2.6. Data Analysis

Content validity is a professional subjective judgment of experts about the degree of relevant construct in an assessment instrument (Yaghmaie, 2003). The judgments of experts (N=10) were taken to test the content validity of the rating scale. Ayre and Scally (2014) stated that critical value for the CVR should be 0.80 for 10 experts at $\alpha = .05$ significance level. This means that items with a CVR value below .80 should be excluded from the rating scale. In addition, when the CVI value is greater than the CVR value, the content validity of the remaining items in the rating scale is considered statistically significant (Lawshe 1975; Öngöz, 2011; Yeşilyurt & Çapraz, 2018).

Kolmogorov-Smirnov Normality Test ($p>.05$) showed that total scores given by the raters were normally distributed. Since collected data (i.e., scores given by the researchers) had a normal distribution, Pearson Correlation Coefficient was calculated in addition to Cohen's Kappa value to test inter-rater reliability of the rating scale. SPSS 21 program was used in the analysis.

3. FINDINGS

3.1. Reliability Findings

Cohen's Kappa values (κ) were calculated to determine inter-rater reliability of the scores (consistency of the scores given by independent raters) obtained by the use of the ABI rating scale. Cohen's Kappa values (κ) range from 0 to 1 where grater values correspond to higher levels of consistency (Kılıç, 2015; Kutlu et al., 2010). According to Landis and Koch (1977), Cohen's Kappa values (κ) between .61 and .80 indicate good agreement and Cohen's Kappa values (κ) between .81 and 1.00 indicate very good agreement between raters. Therefore, as tabulated in Table 1, Cohen's Kappa values (κ) calculated for the ABI rating scale might be considered to be good or very good in all criteria. All of the values were statistically significant between .60 and .91 ($p<.01$).

Consistency among raters can also be determined by looking at the level of compliance on the total scores obtained from rating scale (Kutlu et al., 2010). Accordingly, as a second analysis conducted for testing reliability of the ABI rating scale, inter-rater reliability among researchers' total scores were calculated. Results showed that minimum inter-rater consistency value was $r = .96$ ($p<.05$), which provided additional evidence for the reliability of the ABI rating scale.

Table 1. *Cohen's Kappa values for the item statements in the ABI Rating scale.*

Criteria	Item	κ	p
Pre-lesson preparation	1	.91	.00
	2	.87	.00
	3	.61	.00
	4	.83	.00
Discussion on the research question to be investigated	1	.78	.00
	2	.70	.00
	3	.60	.00
	4	.65	.00
	5	.64	.00
	6	.62	.00
	7	.81	.00
Testing/investigation of research questions	1	.76	.00
	2	.76	.00
	3	.60	.00
Claims and evidences	1	.84	.00
	2	.75	.00
	3	.69	.00
Discussion on the claims and evidences	1	.83	.00
	2	.60	.00
	3	.60	.00
	4	.68	.00
Comparison of the findings/observations with the existing literature	1	.84	.00
	2	.80	.00
Providing opportunities to reflect on the change of the ideas	1	.67	.00
	2	.72	.00
	3	.81	.00
Linking the lesson with Nature of Science and Nature of Scientific Inquiry	1	.81	.00
	2	.77	.00
Linking the lesson with the subsequent lesson	1	.76	.00
Additional lesson plan components	1	.80	.00
	2	.77	.00
Overall Evaluation	1	.70	.00
	2	.82	.00

Note. κ: Cohen's Kappa, N=72

3.2. Validity of the Rating Scale

Content Validity Ratio (CVR) and Content Validity Index (CVI) values were calculated as measures of the content validity of the rating scale. As seen in Table 2, CVR values of each item in the rating scale are above .80 as suggested by Ayre and Scally (2014). In addition, the CVI value belonging to the whole rating scale was determined as.94 (CVI values belonging to the sub-dimensions of the rating scale are also presented in Table 2). Since the CVI value (.94) is greater than the CVR (.80) value (i.e., CVI > CVR), content validity of the remaining items in the rating scale is accepted to be statistically significant.

Table 2. *CVR and CVI values for the item statement in the ABI Rating scale.*

Criteria	Item Number	Necessary	Unnecessary/ Unsatisfactory	Should be removed from the rating scale	CVR	CVI
Pre-lesson preparation	1	10	0	0	1.00	.95
	2	10	0	0	1.00	
	3	10	0	0	1.00	
	4	9	1	0	.80	
Discussion on the research question to be investigated	1	10	0	0	1.00	.94
	2	9	1		.80	
	3	10	0	0	1.00	
	4	10	0	0	1.00	
	5	10	0	0	1.00	
	6	10	0	0	1.00	
	7	9	0	1	.80	
Testing/investigating research questions	1	10	0	0	1.00	.93
	2	9	1	0	.80	
	3	10	0	0	1.00	
Claims and evidences	1	10	0	0	1.00	1
	2	10	0	0	1.00	
	3	10	0	0	1.00	
Argumentation on the claims and evidences	1	10	0	0	1.00	1
	2	10	0	0	1.00	
	3	10	0	0	1.00	
	4	10	0	0	1.00	
Comparison of the findings/observations with the existing literature	1	9	1	0	.80	.90
	2	10	0	0	1.00	
Providing opportunities to reflect on the change of the ideas	1	10	0	0	1.00	.93
	2	10	0	0	1.00	
	3	9	0	0	.80	
Linking the lesson with Nature of Science and Nature of Scientific Inquiry	1	10	0	0	1.00	1
	2	10	0	0	1.00	
Linking the lesson with the subsequent lesson	1	10	0	0	1.00	1
Additional lesson plan components	1	9	1	0	.80	90
	2	10	0	0	1.00	
Overall Evaluation	1	10	0	0	1.00	.90
	2	9	1	0	.80	
Strengths and weaknesses of the ABI implementation	1	10	0	0	1.00	.1
Total score	Total	9	0	1	.80	.80

Note. Number of experts = 10. Content Validity Ratio (CVR) =.80; Content Validity Index (CVI) =.94.

4. DISCUSSION and CONCLUSION

In this study, it was mainly aimed to develop a reliable and valid rating scale for the use of the assessment and evaluation of lesson plans and subsequent teaching practices that are based on argumentation-based inquiry. Rating scales have some benefits in guiding teachers and students in the teaching and learning processes. For example, rating scales show students the learning goals of the lessons in a clear way, guide them in getting prepared for their studies and provide them with feedback through self-assessment and peer assessment (Frazel, 2010; Wolf & Steven, 2007). In addition, rating scales guide teachers in the assessment and evaluation processes and serve for making assessment and evaluation of the learning outcomes more accurate and fairer. Therefore, the ABI rating scale developed throughout the present study is not planned just a scoring tool but as a guide for teachers, teacher candidates and teacher educators who want to practice argumentation in their teaching.

CVR values of each item in the developed rating scale was calculated to be significant and larger than .80 (there was only one item with a CVR value below .80 and this item was removed from the rating scale with the consensus of expert opinions). Threshold CVR value was determined to be .80 since opinions of 10 experts were used for the validity analyses (Ayre & Scally, 2014). CVI of the rating scale was large (.94) and greater than the CVR value, indicating significance of the content validity of the rating scale (Lawshe, 1975; Öngöz, 2011; Yeşilyurt & Çapraz, 2018).

Kutlu et al., (2010) states that rating scale is reveal the differences among the graded/scored individuals and result in more reliable if grading is realized on a 4 to 7-point scale. Based on this, the ABI rating scale developed throughout the present study was designed on a 5-point scale (0 = *not acceptable*; 1 = *poor*; 2 =*average*; 3 = *good*; 4 = *very good*). Findings of the reliability analyses calculated for each item of the rating scale ($\kappa_{min.}$ = .60) indicated that consistency among the raters ranged from "good" to "very good" (Landis & Koch, 1977; Şencan, 2005). Moreover, total scores given by the raters by use of the ABI rating scale were found to be highly correlated providing additional evidence for the reliability of instrument.

ABI rating scale consists of two parts. The first part includes 33 items which allows raters to make quantitative evaluations regarding the appropriateness of the lesson plans and lesson plan implementations for argumentation-based inquiry teaching (ABI) approach. These 33 items are grouped into 11 sections (e.g., pre-lesson preparation, discussion on the research question to be investigated, testing/investigation of research questions, etc.; see Table 1 and Table 2 for a full list of 11 sections and their validity and reliability values). At the beginning of the rating scale, raters are presented with criteria for scores (scoring criteria section) that will be used for evaluating ABI lesson plans and lesson plan implementations. The second part of the rating scale includes a general evaluation where raters can write their views about the strengths and weaknesses of the enacted ABI lessons.

Each section of the ABI rating scale corresponds to an important step for the argumentation process. For instance, pre-lesson preparation section includes the processes that are critical for the teacher to do before practicing of the planned lesson, such as determining the objectives targeted in the application, creating a concept map of the unit to be taught, and determining the big idea and sub-ideas of the unit. At this point, creating his/her own concept map about the unit will make it easier for the teacher/teacher candidate to be able to evaluate the sufficiency of his/her knowledge about the subject area, focus on the purpose of the subject to be taught together with connections of the subject related concepts with each other, and determine the big idea and sub-ideas of the lesson. The big idea can be described as the point that we want our students to reach in accordance with the objectives of the unit plan, and sub-ideas are the main themes of each argumentation activity implemented throughout the lesson and act as paths to reach the big idea of the unit (Yeşildağ-Hasancebi & Akbay, 2017). Accordingly, determination of the big idea and the sub-ideas of the lesson provides a basis for the subsequent steps of the lesson and ensures that argumentation processes are carried out in a better way (e.g., keeping the focus of the argumentation on the related subject).

As another example, claims and evidences and discussion on the claims and evidences sections of the ABI rating scale are essential steps for constructing reasoning components of the argumentation process. Reasoning components of the argumentation basically include students' justifications about how their evidences support their claims (Berland & McNeill, 2010; Sandoval & Millwood, 2005). Moreover, argumentation includes reasoning about whether information at hand is scientific or not (Arık & Akçay, 2017). Findings of research show that students generally have difficulties in presenting skills in the reasoning components of the argumentation process such as developing qualified arguments in their argumentation-based lessons (Aydeniz & Bilican, 2016; Bell & Linn, 2000; McNeill et al., 2006). Therefore, providing guidance in structuring claims and evidences based on the data gathered for research questions, establishing question-claim-evidence relationships, forming convincing arguments, and creating supporting or counter arguments in response to a presented argument is very crucial for the sake of the desired outputs (e.g., skills in developing qualified arguments) of the argumentation process.

In order for teachers to integrate the argumentation process into their own teaching, it is necessary to understand what they need in this process (McNeill et al., 2017). In addition, teachers' own science learning experiences are mostly limited to textbooks or curricula determined by exams and they do not know how to argue due to lack of experience in engaging and maintaining scientific discussion (Sampson & Blanchard, 2012; Zembal-Saul & Vaishampayan, 2019; Zohar, 2007). Therefore, keeping in mind that argumentation requires knowledge and experience (Türkmenoğlu & Çopur, 2021), teachers may need a guide to create and continue argumentation processes in the classroom environments.

ABI rating scale developed in the present study includes all these essential steps and thus might be used as an effective tool for guiding teachers, teacher candidates, and students in the implementation of argumentation in their lessons. The rating scale provides a roadmap that its users may use as a base for their ABI lessons by focusing on what is expected in an ABI lesson and what they should focus on during the planning and implementation of their ABI lessons. The rating scale might also be used as an evaluation tool for evaluation of the ABI lessons. Moreover, teachers and teacher candidates can benefit from the ABI rating scale to self-evaluate themselves and develop their skills in the planning and implementation of ABI lessons.

4.1. Suggestions for Further Research

ABI rating scale developed throughout the present study was shown to be a reliable and valid instrument to be used in the evaluation of ABI science lesson plans and subsequent implementations. Nonetheless, findings of further research carried out with diverse samples will add to improving its reliability and validity. Use of the ABI rating scale with science teachers will provide additional data for testing the efficiency of its use in ABI science lesson plans and implementations. Similarly, literature will benefit from further research that utilize the developed ABI rating scale in other disciplines such as social studies courses which can benefit from argumentation approach in their implementations in schools (Torun & Şahin, 2016). Findings of research carried out with diverse samples (i.e., teachers and teacher candidates from different school disciplines) will provide evidences regarding the generalizability of the present study's findings and efficiency of the use of the ABI rating scale in scholarships other than science education. Finally, more detailed information about the efficiency of the use of the ABI rating scale and its potential contributions for the teachers and teacher candidates can be gathered though the use of qualitative research methods. For instance, interviews can be conducted with teachers/teacher candidates who use the rating scale in their lessons in order to collect data on their views about the efficiency of the use of the ABI rating scale and suggestions for its further development.

Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest. This research study complies with research publishing ethics. The scientific and legal responsibility for manuscripts published in IJATE belongs to the authors. **Ethics Committee Number**: Giresun University/ Scientific Research and Publication Ethics Committee, 2018-18/2.

Authorship Contribution Statement

Authors are expected to present author contributions statement to their manuscript such as; **Funda Yesildag Hasancebi**: Investigation, resources, determination of the methodology of the study, data collection, data analyses, writing-original draft of the manuscript, revision of the manuscript. **Busra Tuncay Yuksel:** Determination of the methodology of the study, data collection, writing original draft of the manuscript, revision of the manuscript. **Gunkut Mesci**: Determination of the methodology of the study, data collection, supervision and control of the original draft of the manuscript, revision of the manuscript.

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APPENDIX

Appendix 1. Argumentation-based Inquiry Rating Scale (English)

Name-Surname: Date:

Scores	Criteria for scoring
Very good (4)	All of the elements that make up the items in each stage are available with rich details and fully, appropriately and accurately planned and implemented. Another teacher can use this plan as it is.
Good (3)	More than half of the elements that make up the items in each stage have been fully, appropriately and accurately planned and partially implemented with rich details. Another teacher can use this criterion of the plan with minor changes.
Average (2)	Approximately half of the elements that make up the items in each stage are available with some details and are fully, appropriately and correctly planned (but not implemented). Other teachers can use this criterion of the plan with changes.
Poor (1)	Less than half of the elements that make up the items in each stage are available with some details and are fully, appropriately and correctly planned (but not implemented). Other teachers should re-plan this criterion of the lesson.
Not acceptable (0)	Basic elements of the lesson are not available (and are not implemented).

					Criteria	**Explanations**
					Pre-lesson preparation	
0	1	2	3	4	Concepts and/or skill to be covered in the lesson are comparable with the current science curriculum	
0	1	2	3	4	Lesson plan objective(s) are appropriate	
0	1	2	3	4	The big idea and the sub ideas are appropriate	
0	1	2	3	4	Concept map includes many concepts and relationships	
					Discussion on the research question to be investigated (Planning of the introductory activity)	
0	1	2	3	4	Introductory activity reveals students' prior knowledge about the lesson objective(s)	
0	1	2	3	4	Introductory activity increases students' interests in learning	
0	1	2	3	4	Introductory activity provides opportunities for students to discuss and ask questions	
0	1	2	3	4	Introductory activity draws students' attention and leads them to questions they are curious about	
0	1	2	3	4	Introductory activity initiates and sustains discussion among students	
0	1	2	3	4	Research questions expected from the students are sufficiently specified in the lesson plan together with alternative strategies to be realized if students do not express expected research questions	
0	1	2	3	4	Necessary materials are completely specified and provided	
					Testing/investigating research questions	
0	1	2	3	4	Students are guided to make experiments/research/observations appropriate with their research questions	
0	1	2	3	4	Activities planned for testing/investigating research questions are student-centered	

0	1	2	3	4	Important points to be considered during the testing/investigation of research questions are clearly specified with examples and applied accordingly	
Claims and evidences						
0	1	2	3	4	Planning and implementation of the lesson was clearly specified and sufficient enough to reveal how the teacher will enable students to construct claims and evidences based on data they obtained	
0	1	2	3	4	Planning and implementation of the lesson was clearly specified and sufficient enough to reveal how the teacher will enable students to establish the relationships among questions, claims, and evidences	
0	1	2	3	4	Planning and implementation of the lesson was clearly specified and sufficient enough to reveal how the teacher will enable students to develop persuasive arguments about their research questions	
Argumentation on the claims and evidences						
0	1	2	3	4	Sequence of the group presentations (about their claims and evidences) are appropriate for the subject matter and flow of the discussion	
0	1	2	3	4	Questions that will lead the argumentation on the claims and evidences are clearly specified in the lesson plan and asked accordingly during the lesson	
0	1	2	3	4	Questions and guidance that will encourage students to support/refute/develop counter arguments are clearly planned and sufficiently provided	
0	1	2	3	4	Procedures to be followed to enable students to come to a conclusion from the discussions are clearly planned and sufficiently enacted	
Comparison of the findings/observations with the literature						
0	1	2	3	4	Guidelines to relate students' findings with the literature are clearly planned and sufficiently enacted	
0	1	2	3	4	Students are directed to appropriate and reliable resources	
Providing opportunities to reflect on the change of the ideas						
0	1	2	3	4	Opportunities are provided to students to realize changes in their ideas about the subject matter	
0	1	2	3	4	Assessment and evaluation procedures of the lesson are clearly planned and sufficiently enacted	
0	1	2	3	4	Assessment and evaluation procedures of the lesson are appropriate for the subject matter	
Linking the lesson with Nature of Science and Nature of Scientific Inquiry						
0	1	2	3	4	At least one of the Nature of Science and Nature of Scientific Inquiry themes are explicitly covered	
0	1	2	3	4	Details of linking the lesson with Nature of Science and Nature of Scientific Inquiry (opportunities to be provided to students in each phase of the lesson) are clearly planned and sufficiently enacted	
Linking the lesson with the subsequent lesson						
0	1	2	3	4	Linking the lesson with the subsequent lesson is appropriate	
Additional lesson plan components						
0	1	2	3	4	Security measures are clearly planned and sufficiently enacted	
0	1	2	3	4	Time planned for each stage of the lesson are appropriate and time management is properly enacted during the lesson	

General evaluation						
0	1	2	3	4	Subject matter knowledge of the teacher/teacher candidate is sufficient	
0	1	2	3	4	Classroom management skills of the teacher/teacher candidate are sufficient	

*Answers to the items in this section are open-ended.		
General Evaluation	**Strengths**	**Weaknesses**
Implementation of the argumentation-based inquiry procedures		
Use of the Nature of Science and Nature of Scientific Inquiry Themes		
Total score		

Appendix 2. Argumentation-based Inquiry Rating Scale (Turkish)

Adı soyadı: Tarih:

Puan	Puanlama Kriterleri
Çok iyi (4)	İlgili maddeyi oluşturan unsurların tamamı zengin ayrıntılar ile birlikte mevcut, tam, uygun ve doğru bir şekilde planlanmış ve uygulanmıştır. Başka bir öğretmen bu planın ilgili maddesini değiştirmeden olduğu gibi kullanabilir.
İyi (3)	İlgili maddeyi oluşturan unsurların yarısından fazlası zengin ayrıntılar ile birlikte tam, uygun ve doğru bir şekilde planlanmış ve kısmen uygulanmıştır. Başka bir öğretmen bu planının ilgili maddesini küçük değişikliklerle kullanabilir.
Orta (2)	İlgili maddeyi oluşturan unsurların yaklaşık yarısı bazı ayrıntılar ile birlikte mevcut tam, uygun ve doğru bir şekilde planlanmış ancak uygulanamamıştır. Başka bir öğretmen bu planının ilgili maddesini değişiklikler yaparak kullanabilir.
Zayıf (1)	İlgili maddeyi oluşturan unsurların yarısından azı küçük detaylar ile birlikte mevcut, tam, uygun ve doğrudur. Başka bir öğretmenler bu planının ilgili maddesini yeniden planlamadır.
Uygun değil / Kabul edilemez (0)	İlgili maddenin temel unsurları mevcut değil. Açıklamalar uygun değil.

Kriterler						Açıklamalar
Ders Öncesi Hazırlık						
0	1	2	3	4	Ders için seçilen kavramlar ve /veya beceriler MEB güncel Fen Bilimleri Dersi programına uygundur.	
0	1	2	3	4	Ders planı uygun kazanım/lar içermektedir.	
0	1	2	3	4	Planlanan ders için hazırlanan büyük düşünce ve alt düşünceler uygundur.	
0	1	2	3	4	Oluşturulan kavram haritası konu ile ilgili birçok kavramı ve kavramlar arasındaki ilişkiyi içermektedir.	
Araştırılacak Soru Üzerinde Uzlaşma						
0	1	2	3	4	Giriş etkinliği öğrencilerin kazanım/lara yönelik önbilgilerini ortaya çıkarır bir şekilde planlanmış ve uygulanmıştır.	
0	1	2	3	4	Giriş etkinliği öğrencilerin öğrenmeye olan ilgilerini artıracak şekilde planlanmış ve uygulanmıştır.	
0	1	2	3	4	Giriş etkinliği öğrencilerin tartışmaları ve soru sormaları için fırsat/lar sunacak şekilde planlanmış ve uygulanmıştır.	
0	1	2	3	4	Giriş etkinliği dikkat çekicidir ve öğrencileri merak ettikleri sorulara götürecek şekilde planlanmış ve uygulanmıştır	
0	1	2	3	4	Giriş etkinliği tartışma başlatacak ve devam ettirecek sorular içerecek seklide planlanmış ve uygulanmıştır.	
0	1	2	3	4	Öğrencilerden beklenen araştırma soruları ders planında yeterince belirtilmiş ve beklenilen araştırma sorularının öğrencilerden gelmemesi durumunda yapılabilecekler planlanmıştır.	
0	1	2	3	4	Öğrencilerin ihtiyaç duyabileceği malzemeler eksiksiz olarak belirtilmiş ve temin edilmiştir.	
Öğrencilerin araştırma sorularını test etmesi/ araştırması/deney (etkinlik) yapması						
0	1	2	3	4	Öğrenciler araştırma sorularına uygun deneyler/araştırmalar/gözlemler yapmaları için yönlendirilmiştir	
0	1	2	3	4	Öğrencilerin araştırma sorularını test etmesi için yapılması planlanan öğrenme aktiviteleri öğrenci merkezlidir.	
0	1	2	3	4	Deneyler/araştırmalar/gözlemler esnasında nelere dikkat edilmesi gerektiği açıkça örnek/ler ile belirtilmiştir ve uygulanmıştır.	
İddia ve delil üretme						
0	1	2	3	4	Öğrencilerin elde ettikleri verilerden yola çıkarak deliller ve iddialar oluşturmalarının nasıl sağlanacağı örnek/ler ile ders planında belirtilmiş ve uygulanmıştır.	
0	1	2	3	4	Öğrencilerin soru-iddia-delil arasındaki ilişkiyi kurmalarının nasıl sağlanacağı örnek/ler ile ders planında belirtilmiş ve ders uygulamasında sağlanmıştır.	

0	1	2	3	4	Öğrencilerin araştırma sorularına yönelik ikna edici bir argüman oluşturmalarının nasıl sağlanacağı planda belirtilmiş ve uygulanmıştır.	
Argümanların savunulması ve uzlaşma süreci (İddia ve delillerin savunulduğu tartışma)						
0	1	2	3	4	Argümanların savunulduğu tartışma sürecinde, öğrenci gruplarının konuya ve tartışmanın akışına uygun sıraya göre iddia ve delillerini sunması hem planlanmış hem de uygulanmıştır.	
0	1	2	3	4	Tartışmayı yönlendiren öğretmen soruları açıkça planda belirtilmiş ve uygulamada sorulmuştur.	
0	1	2	3	4	Öğrencileri, sunulan argümana karşı destekleme/çürütme/karşı argüman oluşturma konusunda teşvik edecek sorular ve yönlendirmeler planlanmış ve uygulanmıştır.	
0	1	2	3	4	Bu aşamada yapılan tartışmalardan öğrencilerin bir sonuca varmasının nasıl sağlanacağı planda belirtilmiş ve uygulanmıştır.	
Bulduklarının okudukları ile karşılaştırılması						
0	1	2	3	4	Öğrencilerin buldukları sonuçlar ile alanyazındaki bulguları ilişkilendirebilmeleri için yönlendirmeler planlanmış ve uygulanmıştır.	
0	1	2	3	4	Öğrenciler konu ile uygun güvenilir kaynaklara yönlendirilmiştir	
Fikirlerin nasıl değiştiğini yansıtmak için fırsatlar sağlama						
0	1	2	3	4	Öğrencilerin araştırma boyunca dersin konusuna dair düşüncelerindeki değişim fark ettirilmiştir	
0	1	2	3	4	Öğrencilerin dersi anlayıp anlamadıklarının nasıl değerlendirileceği açık bir şekilde ders planında belirtilmiş ve derste uygulanmıştır.	
0	1	2	3	4	Yapılan ölçme ve değerlendirme etkinliği konuya uygundur.	
Bilimin/bilimsel sorgulamanın doğası ile ilişki kurma						
0	1	2	3	4	Ders boyunca bilimin/bilimsel sorgulamanın doğası temalarından en az birine açık bir şekilde planda yer verilmiş ve derste uygulanmıştır.	
0	1	2	3	4	Bilimin/ bilimsel sorgulamanın doğası ile ilişki kurma ve nasıl vurgu yapılabileceği adına dersin hangi aşamasında öğrenciye ne tür fırsatlar sunulacağı örneklerle planda belirtilmiş ve derste uygulanmıştır.	
Bir sonraki derse geçiş						
0	1	2	3	4	Bir sonraki konuya geçiş uygun bir şekilde planda belirtilmiş ve derste uygulanmıştır.	
İlave Ders Planı Bileşenleri						
0	1	2	3	4	Gerekli güvenlik önlemleri planda belirtilmiş ve derste uygulanmıştır.	
0	1	2	3	4	Ders planı aşamalarının her biri için belirlenen süre uygun bir şekilde planlanmış ve uygulamada zaman yönetimi sağlanmıştır	
Genel değerlendirme						
0	1	2	3	4	Öğretmen/öğretmen adayı yeterli konu alan bilgisine sahiptir, bunu dersi planına ve uygulamaya yansıtmaktadır.	
0	1	2	3	4	Öğretmen/öğretmen adayı sınıf yönetimi açısından öğrencileri ve süreci yönetebilmektedir	

***Bu bölümdeki maddelere verilecek cevaplar açık uçludur.**		
Genel Ders Değerlendirmesi	**Güçlü yönleri**	**Zayıf yönleri**
Öğretmen adayının argümantasyon tabanlı bilim öğrenme sürecini uygulaması ve yönetmesi ile ilgili genel değerlendirme		
Öğretmen adayının planladığı dersi uygularken bilimin/bilimsel sorgulamanın doğası temalarını kullanımını ile ilgili genel değerlendirme		
Değerlendirme Sonucu Alınan Toplam Puan		

Appendix 3. Lesson Plan Template for Argumentation-based Inquiry (English)

Group members		
Name of the group member who implement the lesson	**Date:**	
Name of the unit:		
Grade level		
Duration		
Subject		
Objectives (science): Please consult current Science Curriculum for determining objectives		
Objectives (Nature of science/ Nature of scientific inquiry): Please write objectives related to Nature of Science/Nature of Scientific Inquiry themes.		
The big idea and sub-ideas of the unit Write the sub-idea of the unit that will guide you in this lesson in bold*	**The big idea of the unit:** **Sub-ideas of the unit:**	
Concepts:		
Skills (e.g., Science Process Skills, Life Skills, Engineering and Design Skills, etc.)**		
Teaching methods and techniques Note: This course will be planned based on Argumentation Based Inquiry Approach. Please indicate the teaching methods and techniques you will utilize during the lesson.		
Nature of Science/Nature of Scientific Inquiry themes that will be addressed during the lesson: (<u>You need to address at least one of Nature of Science/Nature of Scientific Inquiry themes</u>)	☐ Tentativeness of scientific knowledge ☐ Science is empirical based ☐ Subjectivity and theory-laden of scientific knowledge ☐ Creativity and imagination ☐ Socio-cultural embeddedness ☐ Science is based on observation and inferences ☐ Scientific theories and Laws	☐ Scientific investigations all begin with a question and do not necessarily test a hypothesis; ☐ There is no single set or sequence of steps followed in all investigations; ☐ Inquiry procedures are guided by the question asked; ☐ All scientists performing the same procedures may not get the same results; ☐ Inquiry procedures can influence results; ☐ Research conclusions must be consistent with the data collected; ☐ Scientific data are not the same as scientific evidence; ☐ Explanations are developed from a combination of collected data and what is already known
Safety precautions:		

Pre-lesson preparation: (Constructing the concept map and determination of the big idea and the sub-ideas) *** *** *Please attach the concept map to your lesson plan as Appendix 1* Please explain the way you followed for determining the big idea and the sub-ideas	
1. **Discussion on the research question to be investigated (Planning of the introductory activity)**	**Duration:** *Please indicate how much time you plan to spend for this section of the lesson plan
What can I do to prepare the learning environment and get students' attention?	
What are the questions that will start and continue the introductory discussion?	
What are the research questions expected from students?	
What can I do if I do not receive the research questions I expect from students?	
What are the materials students might need to answer their research questions?	
2. Testing/investigating research questions	**Duration:** *Please indicate how much time you plan to spend for this section of the lesson plan
How can I guide students to make experiments/research/observations appropriate with their research questions?	
What should I pay attention to while students test/investigate their research questions?	
3. Claims and evidences	**Duration:** *Please indicate how much time you plan to spend for this section of the lesson plan
How can I get students to create evidence and claims based on the data they have obtained? How can I direct students to establish the relationship between question-claim-evidence?	
4. Argumentation on the claims and evidences	**Duration:** *Please indicate how much time you plan to spend for this section of the lesson plan
How should I lead the discussion? (e.g., What can I ask during the discussion? How should I end the discussion? etc.)	
What are the topics (concepts, relationships between concepts, events,	

phenomena etc.) that should theoretically addressed in this course? (*Please explain them as you plan to address in the lesson)	
5.Comparison of the findings/observations with the literature How can I get students to compare their results with findings in the literature? What are the resources that I especially expect students to read? How can I direct students on this issue? * Please clearly specify the reference/links of the resources.	
6.Providing opportunities to reflect on the change of the ideas How can I direct students to realize changes in their ideas about the subject matter?	
7. Assessment & Evaluation How can I assess and evaluate students for this lesson? Which measuring tools can I use? What might my questions in these measurement tools be? *Please pay attention to use alternative assessment and evaluation tools such as concept map, fish bone, etc.	
8. Linking the lesson with Nature of Science and Nature of Scientific Inquiry Please clearly specify the stages that you will link the lesson with Nature of Science and Nature of Scientific Inquiry. Please clearly explain how you plan to link the lesson with Nature of Science and Nature of Scientific Inquiry.	
9. Linking the lesson with the subsequent lesson How can I link the lesson with the subsequent lesson? * You can leave this section blank if a new unit starts after this lesson.	

***a. Science Process Skills:** Include skills such as observing, measuring, classifying, recording data, making hypotheses, using and modeling data, changing and controlling variables, and conducting experiments etc. that scientists use during their studies.

***b. Life Skills:** Include skills such as analytical thinking, decision-making, creativity, entrepreneurship, communication and teamwork, etc. that are used for accessing and using scientific knowledge.

*** c. * Engineering and Design Skills:** Include innovative thinking skills.

*** Big idea and sub-ideas:** Big idea is the basic idea that forms and reflects the roof of the unit and subject. The process / activities that will take place throughout the unit are planned around the big idea. It should cover the whole unit and reflect the goal we want to achieve at the end of the unit.

Sub-idea is the basic idea of each activity (the lesson you plan for 2 lesson hours) that we will do to reach the big idea. Determine how many lesson activities are needed to reach the big idea. Each lesson activity should target a sub-idea/sub-ideas. The sub idea(s) that you have identified should lead us to the big idea at the end of the unit.

Features of big idea:

- It should cover the whole topic/unit and emphasize the main point.
- It should be clear, understandable, meaningful and express a judgment that consists of a few words
- Should reflect the goal we want to achieve at the end of the unit

Features of sub-idea:

- Should be determined for each activity to be held throughout the unit
- Should be basically linked to the big idea of the unit but more specific when compared to the big idea
- Should be clear, understandable, meaningful and express a judgment that consists of a few words
- Should guide the teacher in planning their activities.

Example:

Unit: Force and Motion

Big idea: Matters move under the effect of force.

Sub ideas: 1- **If the object has a bigger density than a liquid, it floats; if it is not, it sinks**

2- Gases and liquids exert buoyancy**.**

3- Force causes pressure.

Note: See Yesildag-Hasançebi and Akbay (2017) for further details.[†]

[†]Yesildag-Hasancebi, F., & Akbay, Y. (2017). The role of big ıdea in argumentation based science ınquiry classrooms. In Hand, B., Norton-Meier, L., Jang, Jy. (eds), *More voices from the classroom* (pp. 35-44). SensePublishers. https://doi.org/10.1007/978-94-6351-095-0_3

Appendix 4. Lesson Plan Template for Argumentation-based Inquiry (Turkish)

Grup Elemanlarının Adı Soyadı		
Dersi Uygulayan Grup Elemanı	**Tarih:**	
Ünitenin Adı:		
Dersin Sınıf Seviyesi		
Dersin Süresi		
Konu:		
Kazanımlar: Fen kazanımı için fen öğretim programından yararlanınız. **Bilimin/bilimsel sorgulamanın doğası kazanımı:** Planladığınız derste yer alacak bilimin /bilimsel sorgulamanın temasına yönelik kazanım yazınız		
Dersin büyük düşüncesi ve alt düşünceleri Yazdığınız alt düşüncelerden bu ders ile ilgili olan (sizi yönlendirecek olan) alt düşünceyi koyu renk yaparak belirtiniz.*	**Büyük düşünce:** **Alt düşünceler:** **1.** **2.**	
Kavramlar:		
Beceriler (BSB -Yaşam becerileri) Bu ders içerisinde öğrencilerin kazanabileceği Bilimsel Süreç Becerileri ve Yaşam Becerileri nelerdir?*		
Yöntem ve Teknikler Bu ders <u>Argümantasyon Tabanlı Bilim Öğrenme yaklaşımı</u> esas alınarak planlanacaktır. Süreçte kullanmak istediğiniz teknikler varsa belirtiniz. Ayrıcaders planınızın <u>Bilimin Doğası</u> temalarını içinde barındırmasına dikkat ettiniz.		
Derste Değinilebilecek Bilimin/Bilimsel Sorgulamanın Doğası Temaları: Bu derste bilimin ve bilimsel sorgulamanın doğası temalarından hangisi/hangilerine dikkat çekebilirim?	☐ Bilimsel bilginin değişebilirliği ☐ Bilimsel bilginin deneysel yapısı ☐ Bilimsel bilginin öznel yapısı ☐ Bilimsel bilginin bilim insanının yaratıcılığını ve hayal gücünü içermesi	☐ Bütün bilimsel araştırmalar bir soru ile başlar, ancak mutlaka bir hipotez ile test edilmesi gerekmez. ☐ Tek bir bilimsel yöntem yoktur. ☐ Sorgulama sürecine, sorulan sorular yön verir. ☐ Bilim insanları aynı prosedürleri uygulasalar bile aynı sonuçlara ulaşamayabilirler.

(<u>En az bir tane bilimin/bilimsel sorgulamanın doğası temasını dersinize dahil etmelisiniz</u>)	□ Bilimsel bilginin sosyal ve kültürel yapısı □ Bilimsel bilginin gözlem ve çıkarımlara dayanması □ Teoriler ve kanunlar arasındaki farklar	□Sorgulama süreçleri elde edilen sonuçları etkileyebilir. □Araştırma sonuçları toplanan veriler ile tutarlı olmalıdır. □ Bilimsel veriler ile bilimsel deliller birbirinden farklıdır. □Açıklamalar, toplanan veriler ve var olan bilgiler (ön bilgiler) ışığında geliştirilir.
Güvenlik önlemleri: **(**Deneyler esnasında ne tür güvenlik önlemleri almalıyız?)		
Ders öncesi hazırlık: (Kavram haritası yapılması ve büyük düşüncenin belirlenmesi) Büyük ve alt düşünce belirlemede izlediğiniz yolu aktarınız. * Kavram haritanızı EK-1 olarak ekleyiniz.		
1. **Araştırılacak Soru Üzerinde Uzlaşma**	**Süre:** *Bu bölümü kaç dakikada gerçekleştirmeyi planladığınızı yazınız.	
Ortamı hazırlama ve dikkat çekme için ne yapabilirim?		
Giriş tartışmasını başlatacak ve devam ettirecek sorular neler olabilir? Bu süreçte öğrencilere sormayı planladığınız soruları yazınız.		
Öğrencilerden beklenen araştırma soruları nelerdir?		
Beklediğim araştırma soruları öğrencilerden gelmezse ne yapabilirim?		
Öğrencilerin araştırma sorularına cevap bulmak için ihtiyaç duyabileceği malzemeler nelerdir?		
2. Araştırma Sorularını Test Etme/Araştırma/Deney Yapma	**Süre:** *Bu bölümü kaç dakikada gerçekleştirmeyi planladığınızı yazınız.	
Soruları test ettirebilmek için ne yapabilirim? Öğrencileri araştırma sorularına uygun deneylere nasıl yönlendirebilirim?		
Deneyler/gözlemler/araştırmalar esnasında nelere dikkat etmeliyim?		
3. İddia ve Delil Üretme	**Süre:** *Bu bölümü kaç dakikada gerçekleştirmeyi planladığınızı yazınız.	

Öğrencilerin elde ettikleri verilerden yola çıkarak deliller ve iddialar oluşturmalarını nasıl sağlarım? Öğrencilerin soru-iddia- delil arasındaki ilişkiyi kurmalarını sağlamak için onları nasıl yönlendirebilirim?	
4. Argümanların Savunulması ve Uzlaşma Süreci (İddia ve Delillerin Savunulduğu Tartışma)	**Süre:** *Bu bölümü kaç dakikada gerçekleştirmeyi planladığınızı yazınız
Tartışmayı nasıl yönlendirmeliyim? Hangi soruları sorabilirim? Tartışmayı nasıl sonlandırırım?	
Teorik olarak bu derste değinilmesi gereken konular (kavramlar, kavramlar arası ilişkiler, olaylar, olgular vb.) neler olmalı? (Konu ile ilgili teorik bilgiyi ders planının bu bölümünde yazabilirsiniz)	
5.Bulduklarımın Okuduklarım ile Karşılaştırılması (Uzmanların konu hakkında ne söylediğini belirleme) Öğrencilerin buldukları sonuçlar ile bilimsel sonuçları karşılaştırmalarını nasıl sağlarım? Özellikle öğrencilerin okumasını beklediğimiz metinler neler olabilir? Bu konuda öğrencileri nasıl yönlendirmeliyim? * Okuma örneklerine ait referans/link açık bir şekilde belirtilmelidir.	
6. Öğrencilerin Fikirlerinin Nasıl Değiştiğini Yansıtmak İçin Fırsatlar Sağlama Öğrencilerin araştırma boyunca dersin konusuna dair düşüncelerindeki değişimi onlara nasıl fark ettiririm?	
7. Ölçme-Değerlendirme Öğrencilerin dersi anlayıp anlamadıklarını nasıl değerlendiririm? Hangi ölçme araçlarını kullanabilirim? Bu ölçme araçlarındaki sorularım neler olabilir? *Özellikle alternatif ölçme değerlendirme araçlarını (kavram haritası, anlam çözümleme tablosu, balık kılçığı vb.) kullanmaya özen gösteriniz	

8. Bilimin/Bilimsel Sorgulamanın Doğası ile İlişki Kurma Bilimin/bilimsel sorgulamanın doğası ile ilişki kurma adına dersin **hangi aşamasında** ne tür fırsatlar olabilir? Derste Bilimin/bilimsel sorgulamanın doğası temalarından hangisine/ hangilerine **nasıl** vurgu yapabilirim	
9. Bir Sonraki Derse Geçiş Bir sonraki konuya/derse geçişi nasıl sağlarım? Öğrencileri nasıl yönlendiririm? *Planladığınız dersten sonra yeni bir ünite başlıyorsa bu bölümü boş bırakabilirsiniz	

***a. Bilimsel Süreç Becerileri:** Bu alan; gözlem yapma, ölçme, sınıflama, verileri kaydetme, hipotez kurma, verileri kullanma ve model oluşturma, değişkenleri değiştirme ve kontrol etme, deney yapma gibi bilim insanlarının çalışmaları sırasında kullandıkları becerileri kapsamaktadır.

***b. Yaşam Becerileri:** Bu alan; bilimsel bilgiye ulaşılması ve bilimsel bilginin kullanılmasına ilişkin analitik düşünme, karar verme, yaratıcılık, girişimcilik, iletişim ve takım çalışması gibi temel yaşam becerilerini kapsamaktadır.

*__Mühendislik ve Tasarım Becerileri__: Bu alan yenilikçi (İnovatif) düşünme becerisini kapsamaktadır.

*__Büyük düşünce ve alt düşünceler:__ Büyük düşünce ünite ve konunun çatısını oluşturan ve onu yansıtan temel düşüncedir. Ünite boyunca gerçekleşecek süreç/etkinlikler büyük düşünce etrafında planlanır. Tüm üniteyi kapsamalı ve ünite sonunda ulaşmak istediğimiz hedefi yansıtmalıdır. Alt düşünce ise büyük düşünceye ulaşmamız için yapacağımız her bir etkinliğin (2 ders saati için planladığınız dersin) temel düşüncesidir. Büyük düşünceye ulaşmak için kaç ders etkinliği gerekiyorsa her biri için bir düşünce belirleyiniz (Yani bir ünite kaç aşamada işlenecekse her bir aşamanın hedeflediği bir düşünce olmalıdır). Belirlediğiniz bu alt düşünceler ünite sonunda bizi büyük düşünceye ulaştırmalıdır. (Yeşildağ-Hasançebi & Akbay, 2017) Aşağıdaki örneği inceleyiniz.

Not: Hazırladığınız ders planı ünite bazında belirlenen alt düşüncelerden hangisi ile ilgili ise onu koyu renk yaparak belirtiniz. Diğer alt düşünceleri planlamak zorunda değilsiniz.

Büyük düşüncenin özellikleri

- Tüm konuyu/üniteyi kapsamalı ve temel noktaya vurgu yapmalıdır.
- Açık, anlaşılır, anlamlı olmalı ve birkaç kelimeden oluşan bir yargı bildirmelidir.
- Ünite sonunda ulaşmak istediğimiz hedefi yansıtmalıdır.

Alt düşüncenin özellikleri

- Ünite boyunca yapılacak her etkinlik için belirlenir.
- Temelde büyük düşünceye bağlıdır ama daha özeldir.
- Açık, anlaşılır, anlamlı olmalı ve birkaç kelimeden oluşan bir yargı bildirmelidir.
- Öğretmenin etkinliklerini planlamada ona yol gösterir.

Büyük düşünce ve alt düşüncenin özellikleri ve bir fizik ünitesi için örnek aşağıda sunulmuştur (Yeşildağ-Hasançebi & Akbay, 2017)

Örnek: **Fizik ünitesi:** Kuvvet ve Hareket Ünitesi

Büyük düşünce: Maddeler kuvvetin etkisiyle hareket eder.

Alt Düşünceler: 1) **Cisim; sıvı içinde yoğunsa batar değilse yüzer**

2) Gazlar ve sıvılar kaldırma kuvveti uygular.

3) Kuvvet basınca neden olur

Yesildag-Hasancebi, F., & Akbay, Y. (2017). The role of big idea in argumentation-based science ınquiry classrooms. Ed. Hand, B., Norton-Meier, L., Jang, Jy. (eds), *More voices from the classroom* (pp. 35-44). Sense Publishers. https://doi.org/10.1007/978-94-6351-095-0_3