

# Arguing Skillfully with Argument-Driven Inquiry Science Textbooks

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Abstract. Argumentation skills have an important role in 21st-century learning because it can facilitate constructing the relationship between theory and understanding the concept of science. The development of textbooks based on argumentation skills can bridge science theories and ideas, especially with the Covid-19 pandemic, limiting social contact between communities and students so that they have to work and study from home. Textbooks can be a solution to assist students to learn independently. This study aims to determine the characteristics, practicality, and effectiveness of the developed argument-driven inquiry textbook (ADI). The research was conducted at MTsN 6 Ponorogo using the research and development (R&D) method. Testing the practicality and effectiveness of textbooks was carried out using a randomized control group pretest-posttest design. The number of research samples consisted of 124 students taken through random sampling techniques divided into experimental and control classes. Data were obtained from questionnaires, and argumentation skills tests were analyzed using quantitative descriptive and qualitative descriptive to determine practicality, and inferential statistics (t-test) to evaluate the effectiveness of the textbooks being developed. The results showed that ADI-based textbooks: 1) have the characteristics of being able to encourage students to argue critically and be able to construct students' logic and creativity in relating environmental problems, scientific concepts, and scientific paradigms through multidisciplinary integration; 2) has a practicality level of 84%, which means that the contents of the book are very good at motivating students to learn, relevant to the material, and easy to understand from the material and language aspects; 3) effective in improving students' argumentative skills is better than classes that are not based on ADI (a = 0.05) with an increase in the moderate category (N-Gain = 47.17%).

Keywords: Textbooks, Argument-Driven Inquiry, Argumentation Skills.

## Introduction

Argumentation skills have an important role in 21st-century learning. With argumentation, students can explore their activities by asking, observing, seeking information, and associating. The ability to argue is the foundation of logical and critical thinking skills by explaining a question (Hadiwidodo, et al., 2017; Kirana, et al., 2018). Learning that involves argumentation is carried out by increasing the ability to justify claims, providing an explanation, and communicating the student's perspective on something by giving tendencies in the form of evidence and relevant justification (Agustina, et al., 2020; Grooms, et al., 2014; Lee, et al., 2013; Sampson & Walker, 2012). Students

carry out this activity in the learning process: asking, observing, looking for information, and associating.

In each of the argumentation-oriented learning activities, students can develop argumentation skills through exploring the core concepts of science, studying theories, applying laws and their models. Content and scientific concepts are used to verify and construct valid arguments (Hofer, 2015; Miaturrohmah & Fadly, 2020; Passmore & Svoboda, 2012; Sampson & Walker, 2012). Argumentation skills are part of the scientific process and a foundation for logical, critical, reasoning thinking skills. These skills can form cognitive abilities and be able to construct relationships between theory and understanding scientific concepts through various opinions/claims with tendencies and decisions along with solutions as alternatives to the risks offered by students (Edmondston, et al., 2010; Evagorou, et al., 2012; Henderson, et al., 2015).

Six aspects need to be considered to see a person's ability to argue, namely claim, ground, warrant, backing, qualifier, and rebuttal (Osborne, et al., 2004; Sandhy, 2018; Von Aufschnaiter, et al., 2008). However, four aspects are considered the most important which are then used as indicators of argumentation skills, namely claims (being able to make statements that are raised and believed to be true), ground (being able to submit hypothetical data supported by accurate theory), warrant (a link between what is conveyed with previous scientific data or reasons), and backing (there is support for statements, data, and justifications that have been stated previously).

The success of learning is influenced by the textbooks used because textbooks are useful as a bridge for students to achieve learning goals (Hadiwidodo, et al., 2017; Muqodas, et al., 2015). Textbooks include at least five essential elements: titles, basic competencies or subject matter, supporting information, exercises, and assessments or evaluations (Muqodas, et al., 2015; Yulianti, 2017). Making textbooks needs to pay attention to four essential aspects: aspects of the content or material being taught, aspects of material presentation, aspects of language, and aspects of graphics or design (Muqodas, et al., 2015; Yulianti, 2017).

In its mechanism, textbooks' function can encourage argumentation skills through authorship's systematic development in the learning process. This systematic writing can encourage students to improve their abilities related to developing argumentation skills. These main aspects include communicating claims and providing theoretical/tendency support in verifying knowledge and work procedures. On the other hand, communicating claims and verification requires understanding based on theory and law and offering context-based solutions according to the risk of decisions (Seah & Yore, 2017). Learning by emphasizing argumentation through writing facilitated by textbooks can make students more active by connecting their ideas with evidence, which then will be used to validate the ideas they put forward (Marhamah, et al., 2017).

Argument-driven inquiry (ADI) based textbooks can support students to argue, besides that it also provides opportunities for students to develop ideas in obtaining data, using data, and answering questions critically and logically through a writing approach related to the content, concepts, language science (Grooms, et al., 2014; Marhamah, et al., 2017; Sampson & Walker, 2012). ADI-based textbooks have differences that can be considered as uniqueness or novelty, namely "scientific investigation" which aims to invite students to explore or investigate the symptoms of science, "causality" aims to invite students to think critically and logically, "let's analyze" aims to invite students to argue, "conceptual analysis" aims to train students to argue by answering questions, "comment room" aims to train students to argue according to indicators of argumentation skills, and "diagnostic argumentation" as a tool to measure how much argumentation skills students.

Based on surveys and unstructured interviews with some science students and teachers, the field's facts show that students' argumentative science learning skills have

not yet reached the expected level. In learning, teachers must focus on providing facilities to support the development of a culture of argumentation in students. This development can include the transfer of teacher knowledge in the learning process and creating interactions that support good communication between teachers and students by prioritizing argumentation (Amielia, et al., 2018; Diniya & Rusdiana, 2018; Fadly, 2017b, 2020). In this case, the teacher has not entirely carried out learning according to student characteristics and teaching techniques as expected to develop learning priorities that lead to argumentation skills (Jönsson, 2016; Osborne, et al., 2004). Therefore, ADI-based textbooks are needed to bridge the realization of learning that leads to argumentation skills.

### Method

This study uses research and development (R&D) to produce a product with specific characteristics and then test its effectiveness (Fraenkel, 2012; Plomp & Nieveen, 2013). The resulting product is a textbook oriented to ADI principles. This study uses the Borg and Gall model and is summarized into five stages consisting of (1) product draft, (2) validation, (3) prototyping, (4) limited testing, and (5) final product. In contrast, it testedthe practicality and effectiveness of textbooks using randomized control group pretest-posttest design (Fraenkel, 2012).

This study aims to determine the characteristics, practicality, and effectiveness of the ADI-based textbooks developed. The number of research samples consisted of 124 students taken through random sampling techniques divided into experimental and control classes. Experts have validated the instrument used in this study both in content and construct. Practical data collection techniques use student response questionnaires while using the argumentation skills test in multiple-choice tests, which has been tested for validity and reliability using the SPSS program. Practical data analysis techniques using descriptive quantitative and qualitative. The criteria for the level of practicality of development can be seen in Table 1.

Percentage	Practicality criteria
80-100	Very practical
66-79	Practical
56-65	Practically enough
40-55	Less practical
30-39	It's not practical
(Arikunto, 2019)	

**Table 1.** Guidelines for assessing the practicality of product development

The textbook developed was analyzed using the N-Gain test and inferential statistical two-tailed t-test and one-tailed t-test. Requirements for passing hypothesis testing must be tested for normality and homogeneity. Data is normally distributed if p>0.05 and homogeneous if p>0.05 (Wiyono, 2013). Hypothesis testing used the independent sample t-test (t two-tailed) at a significance level of 0.05 with the H0 test decision rejected if p<0.05 and the one-tailed t-test with the H<sub>0</sub> test decision rejected if to  $<t_{av}$ . Besides, a test was also conducted to determine the improvement of argumentation skills using the N-gain test. The results of the N-gain calculation are interpreted using the gain index (Meltzer, 2002).

### **Results and Discussion**

Development research can mean the process of making new products or improving existing products. This research includes product improvement, namely textbooks that have been widely used but refined or modified with the use of ADI principles in textbooks so that they are different from textbooks in general. Before entering the product-making stage, first, go through the analysis of student characteristics. In general, MTs students' characteristics are that they can think abstractly and idealistically, in the sense that they can process information related to objects, principles, and concepts, which cannot physically appear.

After knowing students' characteristics, it is necessary to conduct a needs analysis regarding product development. ADI-based textbooks need to be developed because the use of textbooks is deemed unable to support students' argumentation skills. After all, the presentation of textbooks is still global in increasing student competence. Hence, there is a need for development that leads to student involvement or activities that are oriented towards improving argumentation skills needed in 21<sup>st</sup>-century education.

#### **Product Development**

ADI-based textbooks are different from books in general. This difference is raised by the inculturation of ADI's fundamental principles of learning, a learning model that has been researched that can improve students' argumentation skills. The author includes ADI principles in the form of unique features. The features in question include a comment room, scientific investigation, causality, conceptual analysis, let's analyze, and let's argue. The making of these features is based on a statement which states that the ability of scientific argumentation can develop because students are trained to answer contextual problems through investigation, development, and presentation of works and discussions that are applied using a scientific approach (Bathgate, et al., 2015; Larrain, et al., 2014; Mubarok, et al., 2016).

Students who have scientific arguments submit hypothesis data by including evidence supported by accurate theories (Kaya, 2013; Nababan, et al., 2019). Therefore, the "Science Investigation" feature is presented as shown in Figure 1.



Figure 1. Science investigation feature

The "Science Investigation" feature presents questions that invite students to explore or investigate what happens to science symptomsto train students to answer questions that may arise about a problem by expressing an argument related to the issue raised. This feature's advantage is in the form of queries that have been adjusted to the indicators of argumentation skills, namely claim, ground, warrant, and backing. Investigation activity refers to a problem that is being studied. The implementation of these activities can be through object observation, gathering and analyzing information, and making conclusions (Fadly, 2017a; Miaturrohmah & Fadly, 2020; Nursamsu, et al., 2020; Osborne, et al., 2004).This feature also invites students to think critically by investigating and finding everything related to scientific phenomena.

Students who have argumentation skills can present conclusions based on information or reasons (Holmqvist & Olander, 2017; Kirana, et al., 2018; Lin, et al., 2017; Viyanti, et al., 2016). Hence the "Causality" feature is presented as shown in Figure 2.



Figure 2. Causality feature

The "causality" feature contains a contextual illustration of a phenomenon as well as directions for students to look for one of the causes or effects of this phenomenon with the aim of training critical and logical thinking skills because critical and logical thinking is the foundation of scientific argumentation skills. The advantage of this feature is that it presents a contextual phenomenon with a causal pattern. The pattern of giving a cause and effect is packaged in an argument by referring to four indicators of argumentation skills (claim, ground, warrant, backing).

The involvement of argumentation in learning has a significant impact on learning outcomes and knowledge (Farida & Gusniarti, 2014; Tarigan & Rochintaniawati, 2015; Zhu, et al., 2017). The argumentation model's application improves written argumentation (Hong, et al., 2013; Nuryandi & Rusdiana, 2015; Rahayu, et al., 2018). Based on the above statement, it is necessary to have an argument process, both written and oral, to form students' argumentation skills. Therefore, the "let's analyze" feature is presented as an effort to develop the argument.



Figure 3. Let's analyze feature

The "let's analyze" feature presents contextual phenomena and orders for students to present arguments about the phenomena raised. The purpose of this feature is that students are trained to express arguments such as the conceptual analysis feature and comment space. This feature's advantage is that it presents contextual phenomena in problems because presenting problems can challenge students to think (Fadly, 2017c; Khishfe, 2014; Nurhadi, et al., 2004).

Argumentation skills can develop well if students can interpret concepts well (Farida & Gusniarti, 2014; Siswanto, et al., 2014). Based on this statement, a "conceptual analysis" feature is created as shown in Figure 4.



Figure 4. Conceptual analysis feature

The "conceptual analysis" feature presents illustrations in scientific arguments that contain the factors and impacts of the situations described. Presentation of arguments based on reliable data and information is then given a concept that underlies this relationship to train students to involve the concept in every lesson. This feature's advantage is that it uses contextual discussions accompanied by data because students who have argumentation skills can construct answers by scientific concepts (Amielia, et al., 2018; Siswanto, et al., 2014).

The ability to communicate, reasoning skills, and the ability to argue using evidence can characterize argumentation (Nuryandi & Rusdiana, 2015). Therefore, the "let's argue" feature is presented, as shown in Figure 5.



Figure 5. Let's argue feature

The "let's argue" feature contains illustrations and questions that have been adjusted to the argumentation skill indicators. This feature aims to train students to argue scientifically through statements and proofs according to the concept. This feature's advantage is that it presents questions adjusted to the indicators of argumentation skills, namely claims, ground, warrant, and backing. Training students to be skilled in obtaining and processing information can be done by teaching students to find various facts, build concepts, and new values necessary for their life (Kustijono, 2012; Siswanto, et al., 2014).

The activity of expressing comments, ideas, and thoughts results from argumentative discussion activities (Fadly, 2017c; Tarigan & Rochintaniawati, 2015; Von Aufschnaiter, et al., 2008). Argumentative discussion activities are proven to develop good argumentative skills (Nuryandi & Rusdiana, 2015). Interpreting, criticizing, and revising an argument can be interpreted as building socio-cultural activities through arguments (Farida & Gusniarti, 2014; Rahmasiwi, et al., 2018). Then the "comments space" feature is presented as shown in Figure 6.



Figure 6. Conceptual analysis feature

The "comment room" feature presents a contextual phenomenon, and a response is given related to this phenomenon. The responses expressed are adjusted to the indicators of argumentation skills, namely claim, ground, warrant, and backing, to train students to put forward a correct argument. The advantage of this feature is the phenomenon raised in the form of contextual facts and providing comments in scientific arguments according to indicators. Through this, students are expected to get an overview of scientific argumentation.

Scientific argumentation can develop because students are trained to answer contextual problems through investigation, development, and presentation of works and discussions that are applied using a scientific approach (Mubarok, et al., 2016). The feature "Diagnostic argument" presents questions that have been adjusted with 4 indicators of argumentation skills (claim, ground, warrant, backing). The questions presented are HOTs questions that affect students' skills in solving complex problems (Khaldun, et al., 2019). The purpose of diagnostic argumentation is to evaluate how far the students' argumentation skills are.



Figure 7. Diagnostic argumentation feature

#### Textbook practicality in learning

The practical textbook trial was conducted at MTsN 6 Ponorogo with a sample VII-B consisting of 29 students. The test was conducted by using textbooks during the learning process on environmental pollution material. After completing the learning using the textbook, the practicality data was taken using a student response questionnaire. The results of student responses related to the practicality of textbooks can be seen in Fig. 8.



Figure 8. Student responses about textbook practicality

Figure 8 shows the responses of students while using ADI-based textbooks. Based on the percentage acquisition in each practical aspect. It is known that textbooks have been able to provide interest and enthusiasm for students to learn, textbooks have also been able to present material that is by the expectations and needs of students, besides that textbooks can provide convenience to readers through the ease of students in learning, read and understand books in terms of shape and size of letters, word order, and book instructions.

Textbooks can provide interest in the sense that they can motivate students to learn. This ability is seen when the learning process takes place. Students are enthusiastic about learning, which is shown by students' ability to respond to questions. Besides, textbooks can focus students' attention, indicated by the number of students who take notes on their respective books or underline essential statements in the book. Students' enthusiasm for learning is shown by the ability to focus attention by listening to and observing what the teacher says about ongoing learning (Bayir, et al., 2014; Irachmat, 2015).

Students' interest in learning by focusing on the teacher is a manifestation of student motivation to learn during the learning process. Someone who has high motivation for an activity will pay more attention than someone low in motivation (Irachmat, 2015; Silalahi, 2018). Besides, something that someone is interested in will attract more attention. Seeing students' responses who focus on the teacher during the learning process can be said that textbooks can motivate students to learn to argue. Students who have motivation and enthusiasm in learning are more able to absorb learning material, are more able to concentrate, and be active in learning so that students are better able to argue in writing and orally according to the teacher's direction.

Apart from going through textbooks, other factors can make students active in learning, namely, by creating a learning environment that makes students understand what is being done (Tarigan & Rochintaniawati, 2015). Through a specially designed learning environment, for example, designed so that students have argumentative skills, it can be done by teaching methods of teachers who often condition students to argue (de Sá Ibraim & Justi, 2016; Nuryandi & Rusdiana, 2015; Tarigan & Rochintaniawati, 2015). Textbooks are said to be practical in terms of material seen from the presentation of material relevant to the needs of 7<sup>th</sup>-grade students of MTs. The production of material and questions is easy for students to understand. Besides that, students also do not entirely need others' help in using textbooks because, in essence, textbooks are used by students to learn independently with educators' guidance (Prastowo, 2011).

When the learning process takes place, students can understand the material well. This is shown by students' ability to work on features in the book whose presentation is always associated with natural science phenomena, such as features of scientific investigations, let's argue, causality, and diagnostic arguments. Scientific argumentation equips students to answer and explain science phenomena that occur based on everyday life based on concepts (Octasari, et al., 2019; Sukmawati, 2017; Zimmerman, 2007). So it can be said that students' ability to fill in exercises on these features can form scientific argumentation skills.

Student activities working on the textbook features have more or less embodied the involvement of arguments in the learning process. The involvement of argumentation in the learning process has a significant effect on the amount of knowledge. Besides, the involvement of arguments in the learning process can invite students to think critically to respond to a problem with logical reasons based on supporting concepts and theories. Indirectly, this will expand students' knowledge to answer questions from various features in the book and explanations and reasons for students choosing these answers.

In addition to inviting students to think critically and logically, argumentation in learning also makes students more active because they can collaborate with friends. Active student activities, both individually and in groups, can improve and practice their ability to argue (Khishfe, 2012; Ozdem, et al., 2013; Rahayu, et al., 2018). In addition to being assisted by ADI-based textbooks, students are also required to take an active role in participating in learning, especially in the process of training and developing argumentation skills. Collaboration is beneficial in practice and realizing argumentation skills (Viyanti, et al., 2016).

The practicality of textbooks in terms of language is known from students' good responses to book design, easy-to-read type and size of letters, the absence of words that make it difficult for students, and the ease with which students understand instructions and language in books. The language used is an interactive language tounderstand what is being discussed in the book indirectly easily. The communicative writing style can help convey messages to students effectively (Prastowo, 2011).

Students easily understand the language in books shows that textbooks are interactive and innovative books. The development of mature textbooks rich in innovation will attract students to learn (Prastowo, 2011). This can be done with the efforts of educators to build their creativity to develop innovative textbooks. The existence of innovative textbooks made by each educator will make the learning process run more meaningful to attract students' interest in learning effectively. To realize interesting, effective, and efficient learning, not only through textbooks, but an educator must also create learning activities that are not boring and tedious (Berne, 2014; Viyanti, et al., 2016). These meaningful and comprehensive lessons can help improve argumentation skills (Pritasari & Jumadi, 2018).

The above shows that ADI-based textbooks help improve students' argumentation skills on environmental pollution with activities that train students to express arguments. Scientific argumentation can develop because students are trained to answer contextual problems through investigation, development, and presentation of works and discussions that are applied using a scientific approach (Mubarok, et al., 2016; Nuryandi & Rusdiana, 2015; Vieira, et al., 2015). The level of practicality of the textbook as a whole is shown in the following Table 2.

**Table 2.** Distribution of the frequency of student responses

Student statement	Percentage	The level of practicality
Score 3 and 4	84	Practical
Score 2 and 1	16	It's not practical

Based on these data, it is known that the results of student responses related to the practicality of ADI-based textbook products can mostly be said to be practical. This means that textbooks are very good at motivating students to learn, relevant to the material, and easy to understand from the material and language aspects.

#### **Textbook effectiveness in learning**

Effectiveness data obtained from the argumentation skills test in the experimental and control class in the form of a pretest and posttest. The results of the students' pretest and posttest were analyzed using the t-test. The two-tailed t-test showed that sign (p) <0.05, which means a significant difference in values between the experimental class and the control. After knowing that there were differences between the two classes, a further test was carried out, namely the one-tailed t-test, so that it was known which was the treatment that showed more improvement between the two. The data processing results obtained t<sub>0</sub> of -4,345, which means smaller than t<sub>count</sub>, which means H<sub>0</sub> is rejected, so it can be said that the improvement in the experimental class is better than the control class. Through these two tests, it can be interpreted that ADI-based textbooks effectively improve students' argumentation skills.

Textbooks-based ADI helps students realize conceptual understanding and the ability of scientific argumentation orally or in writing with indicators in the form of claims, ground, warrant, and backing (Gray & Kang, 2014; Sandhy, 2018). The data analysis results showed an increase in students' argumentation skills in the experimental and control classes, calculated through the N-gain per-indicator shown in Figure 9.





These data indicate that students have high abilities in expressing support for statements, reasons, or data and linkages between something (backing). However, students' ability to express the relationship between statements or data (warrant) is not maximal, and students are not yet proficient in determining the relationship between claims and ground. In comparison, justification and support must be based on accurate concepts and theories and provide tendencies in the form of evidence and relevant explanation (Nuryandi & Rusdiana, 2015; Osborne, et al., 2004; Rahayu, et al., 2018; Sandhy, 2018).

Argumentation skills can improve cognitive abilities, especially in understanding through student activity in individuals and groups in meaningful and comprehensive learning that will stimulate the development of these skills (Pritasari & Jumadi, 2018; Rahayu, et al., 2018; Siswanto, et al., 2014). Argumentation skills on the backing indicator with a very high score may be due to the ease with which students estimate answers to questions. Spontaneous estimation through reasoning is beneficial for students in

answering questions on the indicator instrument presented. This process involves thinking critically, logically, reason and requires content knowledge to find the desired answer (Evagorou, et al., 2012). Textbooks with the "Causality" feature contain discussion and analysis of a clear and logical cause or effect of an event aimed at training critical and logical thinking skills because critical and logical thinking is the foundation of scientific argumentation skills (Evagorou, et al., 2012).

The process of reasoning involves a critical and logical thinking process to find the desired answer. Textbooks with the "Causality" feature contain clear and logical discussion and analysis of cause or effect from an event. This feature's testtrains critical and logical thinking skills because critical and logical thinking is the foundation of scientific argumentation skills.



Figure 10. Causality feature

Based on students' answers in Figure 10, it can be seen that students can reason by involving critical and logical thinking processes so that students can answer the connectedness of the phenomena described. Besides that, students can also provide support in the form of a result of the phenomenon. Argumentation is an essential ability in developing a democratic society to help individuals judge many opinions and make the right decisions (Osborne, et al., 2004). The ability to communicate, reasoning skills, and the ability to argue using evidence can characterize argumentation (Nuryandi & Rusdiana, 2015; Von Aufschnaiter, et al., 2008). Therefore, the textbook presents "let's argue" and "let's analyze" features that contain illustrations and questions adjusted to the indicators of argumentation skills to train students to be ready to argue scientifically by reasoning through statements proof according to the concept.



Figure 11. Let's argue feature

Students' answers to these features indicate that students can provide statements related to phenomena very well.Students can provide reasons according to the concept and the relationship between statements and reasons in the form of signs or features that water pollution has occurred in the phenomenon in question.

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Figure 12. Let's analyze feature

Based on student answers as exemplified in Figure 12, it shows that students can adequately analyze the phenomena described by the argumentation skills indicators, which consist of presenting statements, reasons, justification in the form of pollution indicators, and providing support suggestions and recommendations to overcome pollution. Good analytical thinking skills can make it easier for students to connect one concept to another and make it easier for students to face students' situations (Hasan & Jalil, 2016; Rahayu, et al., 2018).

The backing aspect can also be interpreted as providing support for statements and reasons made. This support can be in the form of rebuttal or criticism. The presentation of the "comment room" feature helps students make presentations, interpretations, criticize and revise an argument to build socio-cultural activities and scientific practice to make appropriate decisions (Farida & Gusniarti, 2014; Osborne, et al., 2004). Meanwhile, the warrant indicator has a low level of the four indicators. This may occur due to the lack of books as learning media and references that specifically direct students to have argumentation skills. Students who have argumentation skills can construct answers according to the concept of science (Amielia, et al., 2018). ADI-based textbooks attempt to optimize argumentation based on concepts, including warrant aspects, namely by bringing up the "Conceptual Analysis" feature that presents contextual problems and includes solutions to overcome these problems. Learning that applies an Inquiry-driven approach (Sampson & Walker, 2012) modified by increasing the transfer of learning and maintaining a situation that supports personal communication (Hong, et al., 2013; Logan & Skamp, 2013), and improving their arguments and involving them in science learning can bring about new, more meaningful learning innovations and strategies (Chen, et.al., 2016).

Student involvement in argumentation discussions will affect students' understanding of science (Evagorou, et al., 2012; Nuryandi & Rusdiana, 2015). This can be done by applying argumentative discussion learning by prioritizing science concepts and content. Students who are trained to argue in the learning process are better able to make arguments rationally. To argue rationally means to do a thinking process to show a claim or opinion accompanied by evidence that can be justified based on an accurate theory or

concept. Students' conceptions and theories are obtained from literacy activities in books, and investigative and simulation activities carried out by students. This statement indicates that the presentation of the report, reason, and support must accurately refer to the concept of science. The use of scientific concepts can be done with learning habits that pay attention to concepts' suitability (Fadly, 2017a; Miaturrohmah & Fadly, 2020; Wiyarsi & Çalik, 2019; Wu & Tsai, 2011). ADI-based textbooks are effective in improving argumentation skills with activities that train students to argue. Scientific argumentation can be increased because of the developed textbooks. Students are also trained to answer contextual problems through investigation, development, and presentation of work and the conditioning of discussion activities using a scientific approach.

### Conclusion

The ADI-based textbook developed has the following characteristics: 1) through the features let's argue, causality, let's analyze, and character reinforcement can encourage students to think critically and logically in expressing arguments while still paying attention to the boundaries of opinion and offering relevant solutions; 2) through the let's science investigation feature, conceptual analysis, Islamic items, and diagnostic argumentation can construct students' logic and creativity in linking environmental problems, scientific concepts and scientific paradigms to form high-level argumentation skills that involve multi-disciplinary integration. The results showed that the ADI-based textbooks developed had a practicality level of 84%, which means that the books' contents were very good at motivating students to learn.

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