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Profile of Learners' Argumentation Ability on Socio-Scientific Issues

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Abstract: This study aims to determine the profile of students' argumentation skills at MTs Idrisiyyah, Tasikmalaya Regency, in the context of Socio-Scientific Issues (SSI), which includes issues related to science and society based on the components of scientific argumentation from the Toulmin model. The study used a quantitative descriptive method; as many as 63 Grade VIII learners participated. The results of the analysis showed that the ability to claim was excellent (86%), but argumentation support such as data (64%), warrant (32%), qualifier (30%), and backing (27%) was still low. This finding indicates that although learners can convey claims well, they have difficulty supporting these claims with strong data and arguments. The results of this study are expected to be a reference for educators in designing more effective learning strategies related to the development of argumentation skills in the context of SSI.

Keywords: Argumentation Skills; Socio-Scientific Issues; 21st Century Skills.

Introduction

Science education in the age of information and technology plays a crucial role. In the 21st century, science education plays an important role in creating quality human resources, both in terms of soft skills and hard skills, as well as adaptability. With a deep understanding of science concepts and the utilization of technology, students are directed to be able to solve problems encountered in everyday life [1]. By implementing inquiry-based learning approaches and collaborative projects and integrating technology into the learning process, science education can more effectively prepare students with 21st-century skills. This will produce a generation that possesses scientific knowledge and the critical thinking skills and argumentation abilities needed to contribute positively in an ever-changing society. With these skills, they are expected to be able to excel and compete to face all the challenges in the increasingly complex and modern millennial era [2].

Argumentation skills in science education can be understood as the ability to express opinions and provide evidence and relevant reasons in the context of scientific discussions. The importance of this skill lies in its contribution to constructive scientific discussions, where learners not only learn scientific facts but also how to apply that knowledge in a social context. Argumentation skills are important in developing learners' thinking, communication, and problem-solving [3].

The scientific argumentation model often used in science education is the Toulmin model, which consists of several main elements, as shown in Figure 1. The first element is the claim, the proposed statement, or the conclusion. Second, evidence is data or information that supports the claim. Third, a warrant explains how the evidence supports the claim. As the fourth element, backing is an additional argument or other evidence that strengthens the warrant. In addition, rebuttal refers to exceptions or situations where the claim does not apply. Finally, the qualifier indicates the extent to which the claim can be considered certain [4], [5], [6].

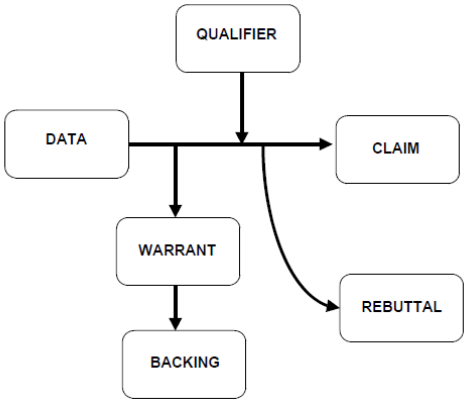

Figure 1. Components of Scientific Argumentation According to Toulmin [4]

Socio-scientific issues (SSIs) cover issues between science and society, such as climate change, health, and the ethics of technology. SSIs serve as a relevant context for honing learners' argumentation skills, as these issues are often controversial and require critical thinking and in-depth discussion. SSI-oriented learning can increase student engagement in the learning process and strengthen their science literacy [7]. SSI allows students to explore diverse viewpoints and improve their argumentation skills [8]. Despite its importance, SSI-based argumentation teaching often faces challenges. Lack of learning resources, limited classroom time, and inadequate teacher skills in facilitating SSI-based discussions can hinder the development of learners' argumentation skills.

Some research has also been conducted, which shows that the argumentation skills of high school students in grade XI in Oman are in the low category [9].]. In another study, it was mentioned that to improve students' argumentation

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skills, it is recommended to innovate strategies in learning and integrate socio-scientific problems or issues in learning activities [10]. While much research has been done previously, most has focused on different contexts, such as higher education or specific disciplines. Research on SSI at the junior secondary school level is still very limited. MTs Idrisiyyah is a school that integrates general curriculum and religious education and has a vision to improve the quality of teaching and equip students with critical thinking skills, which aligns with this research to develop scientific argumentation skills. Therefore, this study aims to fill the gap by developing students' argumentation skills at MTs Idrisiyyah.

Understanding the argumentation skill profile of learners at MTs Idrisiyyah is essential to evaluate the extent to which they can argue scientifically in the context of SSI. The results of this study are expected to provide insight into the importance of developing more efficient SSI-based learning methods. According to Toulmin's model, this study aims to analyze the profile of argumentation skills possessed by students in the context of SSI based on the components of the scientific argument. This research is expected to contribute to improving the quality of science learning and producing students who are more sensitive to social and environmental issues.

Research Methods

This research uses a quantitative descriptive method to produce a description or description related to the components of students' argumentation skills. The data was collected by completing essay questions on socio-scientific issues (SSI) related to the elements of scientific argumentation according to Toulmin (claim, data, warrant, qualifier, and backing).

This research was conducted at MTs Idrisiyyah Tasikmalaya Regency. The population in this study consisted of all students in MTs Idrisiyyah Tasikmalaya Regency, with a total of 250 students. At the same time, the research sample was all VIII grade students, totaling 63 people who were determined by purposive sampling technique. The determination of the sample is based on the consideration that students in grade VIII are considered to have basic and adequate science skills to measure the ability of scientific argumentation.

The instrument used in this study is a test in the form of essay questions related to Socio-Scientific Issues (SSI) with 10 questions. Each question measures students' ability to understand the components of scientific argumentation according to Toulmin's pattern [11], as shown in Table 1 below.

Table 1. Indicators of Argumentation Skills

No	Indicator	Description
1	claim	Learners can convey opinions or statements and are accepted by the audience.
2	data	Learners can present facts or evidence that support and strengthen the argument.
3	warrant	Learners can express logical and general statements and hypotheses, linking claims and the data or evidence that supports them.
4	qualifier	Learners can provide additional statements that clarify or strengthen certain claims so that they become more convincing and easily accepted by the audience.
5	backing	Learners can provide additional statements that strengthen the warrant in the argument. This support is not intended to prove the main point being discussed but rather focuses on strengthening the validity or truth of the warrant. This helps to give the argument a firmer foundation.

The data collection procedure was done by compiling the instrument and distributing it to students directly in the classroom. Each learner's answer is given an occurrence score for each indicator of scientific argumentation ability and then converted into a percentage for each component of scientific argumentation. Percentage (%) is calculated using the following formula.

$$\text{Percentage} = \frac{\text{number of scores obtained}}{\text{maximum score}} \text{ x } 100$$

Table 2. Criteria for each indicator of scientific argumentation ability

Average score (%)	Criteria
< 55	Low
55 – 70	Simply
71 – 85	Good
> 85	Very Good

Adapted from [12]

Results and Discussion

Scientific argumentation is an essential skill that students need to master as a foundation for thinking, communicating, and acting like a scientist [13]. Scientific argumentation has an important role in improving the ability to think critically, solve problems, and compose arguments based on scientific logic so that other parties can accept them [14]. However, not all students can convey their arguments verbally, because some are more comfortable expressing them in writing [15].

From a total of 63 students who participated in this study, based on the results of the TAP analysis, students' argumentation has claims and data, warrants, and some qualifiers and backing. Based on the test analysis carried out on class VIII students, the percentage of each indicator of scientific argumentation ability is obtained as shown in the following bar chart.

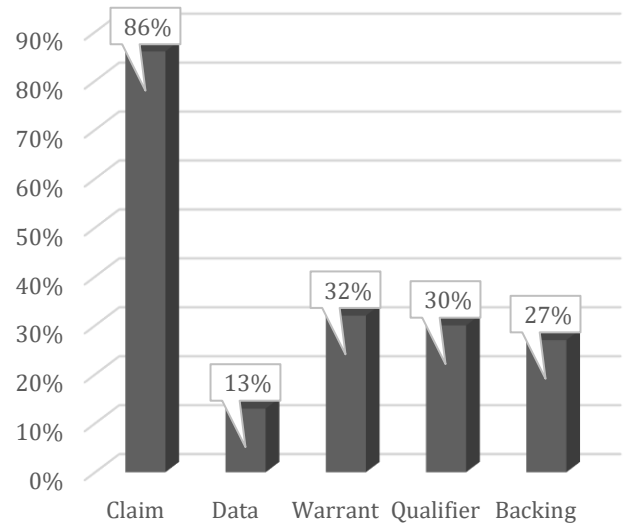
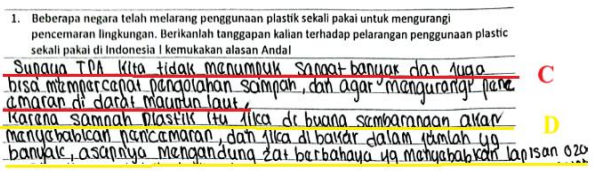


Figure 2. Percentage of Scientific Argumentation Ability per Component

Based on the graph in Figure 2, it is clear that the difference in argumentation skills possessed by students for each indicator of Toulmin's pattern ability, the percentage of students showing the ability to claim with a very good category is 86% compared to other indicators where claim shows that students have been able to convey arguments or opinions on the questions given. Learners generally only focus on providing statements (claims) as the basis for the solution of the problem without any supporting evidence or data [16], [17]. The second indicator, namely Data (data), shows the results of 64%; this indicates that learners can convey their opinions with data support in the form of facts, evidence, or relevant reasons to support their claims, which are still classified as adequate. For example, in Figure 3, learners can provide claims based on data related to Socio-Scientific Issues. Regarding the implementation of regulations prohibiting the use of single-use plastics if implemented in Indonesia, the percentage of learners who provide claims supported by data is still relatively adequate, and most learners can provide claims without data support.

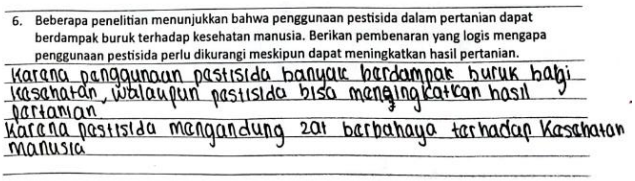

1. Beberapa negara telah melarang penggunaan plastik sekali pakai untuk mengurangi pencemaran lingkungan. Berikanlah tanggapan kalian terhadap pelarangan penggunaan plastic sekali pakai di Indonesia ! kemukakan alasan Anda!

Supaya TPA kita tidak menumpuk sampah banyak dan juga bisa mempercepat pengolahan sampah, dan agar mengurangi pence amaran di darat maupun laut. C

Karena sampah plastik itu jika di buang sembarangan akan menyebabkan pencemaran, dan jika di bakar dalam jumlah yg banyak, asapnya mengandung zat berbahaya yg menyebabkan lapisan ozo D

Gambar 3. Learners' answers on the aspects of claim and data

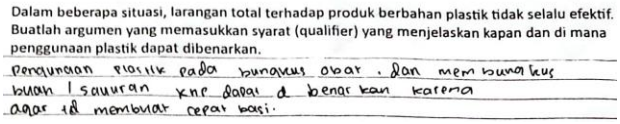
The justification indicator (warrant) shows an average percentage of 32% with a low category; the answers of students in Figure 4 are related to the use of pesticides that need to be reduced because they are bad for health even though they can increase agricultural yields, this gives an idea of students who can provide warrant or justification in the form of logical statements used to support their claims very little.


6. Beberapa penelitian menunjukkan bahwa penggunaan pestisida dalam pertanian dapat berdampak buruk terhadap kesehatan manusia. Berikan pembenaran yang logis mengapa penggunaan pestisida perlu dikurangi meskipun dapat meningkatkan hasil pertanian.

Karena penggunaan pestisida banyak berdampak buruk bagi kesehatan, walaupun pestisida bisa meningkatkan hasil pertanian

Karena pestisida mengandung zat berbahaya terhadap kesehatan manusia

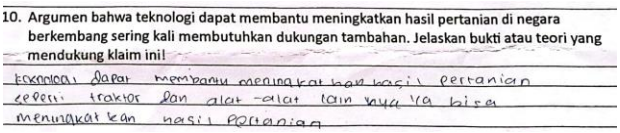
Figure 4. Learners' Answers on the Warrant Aspect


Dalam beberapa situasi, larangan total terhadap produk berbahan plastik tidak selalu efektif. Buatlah argumen yang memasukkan syarat (qualifier) yang menjelaskan kapan dan di mana penggunaan plastik dapat dibenarkan.

Penggunaan plastik pada bungkus obat. dan membungkus buah / sayuran krn dapat di benarkan karena agar tdk membuat cepat basi.

Figure 5. Learners' Answers Qualifier Aspect

Figure 5 shows learners' answers on the qualifier indicator, where learners can provide additional statements related to the use of plastics that can be justified when the regulation on the prohibition of single-use plastics is implemented. The qualifier indicator, which shows an average score of 30%, proves that learners who can provide additional statements to support data and claims to make their statements more acceptable are still low. In the research conducted, it was found that the percentage of qualifiers was low, with some not including qualifiers at all in their arguments; this is because learners are accustomed to memorizing rather than understanding concepts in detail [18], so learners do not provide clear boundaries to their claims, which contributes to weak and less convincing arguments.


10. Argumen bahwa teknologi dapat membantu meningkatkan hasil pertanian di negara berkembang sering kali membutuhkan dukungan tambahan. Jelaskan bukti atau teori yang mendukung klaim ini!

teknologi dapat membantu meningkatkan hasil pertanian seperti traktor dan alat-alat lain yang ia bisa meningkatkan hasil pertanian

Figure 6. Learners' Answers on the Backing Aspect

Figure 6 shows learners' answers on the backing indicator, supported by supporting statements for the claims. The research indicates that backing is rarely found in learners' answers, with a percentage of 27%. When learners do not include backing, their arguments weaken and are not supported by adequate evidence or references. This shows the difficulty for learners in formulating more complex and thorough arguments. The ability to support argumentation is closely related to concept mastery [10]. So, learners' low backing ability can indicate that they have not mastered questions related to socio-scientific issues (SSI).

Overall, the low frequency of using warrant, qualifier, and backing indicators indicates that learners must improve their argumentation skills to construct more complete and convincing arguments. This also shows the need for more effective teaching methods to assist learners in optimally utilizing these indicators in the argumentation process.

Students' low scientific argumentation ability can be influenced by several factors, such as the lack of experience and opportunity for students to argue and the lack of understanding and mastery of material concepts. Training the ability and courage of students in argumentation requires a long and sustainable time so that students are trained and brave enough to express their opinions with the relevance of data or scientific evidence that can support students' statements. Therefore, teachers' learning process plays an

important role in helping students develop scientific argumentation skills [19]. Lack of understanding and mastery of Socio Scientific Issues (SSI) can affect argumentation skills in providing evidence, data, and theories supporting their opinions. Students' understanding of the material and their activeness during the learning process are important factors that affect their argumentation skills. Students who are less active in learning tend to be less trained to present arguments scientifically. In addition, low argumentation skills are also influenced by learning methods that do not provide space for students to develop their argumentation skills [20].

Learners' low argumentation skills indicate a major challenge in helping them master 21st-century skills, such as critical thinking, communication, teamwork, and creative innovation. Critical thinking and communication skills are integrated, as are argumentation skills [21]. Argumentation is a skill that learners must possess to apply knowledge in everyday life. Argumentation-based learning can encourage learners to actively present relevant evidence, data, and theories to strengthen their opinions on a problem. Understanding scientific argumentation needs to be trained in the learning process, such as applying learning models to improve students' argumentation skills.

One of the learning models that can be applied to improve students' argumentation skills is the Argument-Driven Inquiry (ADI) learning model, which has been previously researched to be effective in enhancing students' argumentation skills, the quality of scientific argumentation skills of students taught using the ADI learning model shows the best results among the three classes studied [22]. Another study showed that the experimental class that applied the ADI model had better argumentation skills among eighth-grade junior high school students in Bandar Lampung in understanding scientific concepts. [23].

Conclusion

The results showed that the scientific argumentation ability of students regarding Socio-scientific Issues (SSI) conducted in class VIII MTs Idrisiyyah Tasikmalaya Regency was still relatively low. The profile of argumentation skills based on Toulmin indicators shows the ability of students to convey claims is very good, but in other indicators, such as statements accompanied by data, warrant, qualifier, and backing, are still relatively low. Teachers are expected to design learning lessons that support the development of scientific argumentation skills.

Author's Contributions

Siva Fauziah: Writing; Diana Hernawati: Proofreading; Rahmat Rizal: Proofreading; Liah Badriah: Proofreading

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