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Level of Students' Argumentation Skills in Socio-Scientific Issues of Biodiversity Subject

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Abstract

Argumentation is one of the important skills that students need to master in facing the global challenges of the 21st century. Argumentation plays an important role in the learning process to build students' understanding, which will also develop their critical thinking skills. Argumentation skills are not just a process of gathering facts but also involve the coordination between evidence and theory. This study aims to analyze students' argumentation skills in social-scientific issues on the topic of biodiversity. The method used in this research is a descriptive method aimed at obtaining an overview of the quality of students' arguments. The subjects of the research are first-grade students at high schools in West Bandung. This study uses interviews and open-ended questions structured based on the Toulmin Argumentation Pattern: claim, data, warrant, and backing, which will then be analyzed using an assessment rubric. The results of this study indicate that students' argumentation levels are still at level 1, where the argumentation consists only of 'claims'. This is evidenced by the argumentation components most frequently expressed by students in the social-scientific issues learning on the topic of biodiversity.

Keyword: *argumentation, sosio-scientific issues, biodiversity*

INTRODUCTION

In the 21st century as the era of globalization, education should prepare the students to have skills in facing the future. The demand of people's mindset changes in the 21st century is to create education that can produce human resources. Human resources are expected to build social and economic order and be aware of national education. Besides, It is also likely huge changes in national education. Some abilities that students need to have are thinking critically, creatively, and innovatively, collaboration, and communication skills. The Roommates Scheme developed by P21 is explained by adding core subject 3R. In education context, 3R means collaboration and communication capabilities. The scheme developed by P21 clarified with the additional cores subject. 3R in the context of education, 3R stands for reading, writing,

and arithmetic to describe the function core subject 3R within the context of 21st-century skills, 3R translated into life and career skills, learning and innovation skills, and information media and technology skills.

In the process of science learning, argumentation skills, also known as argument-making skills, are necessary to develop concepts and practice thinking about concepts. The goal is for students to be able to remember concepts, facts, and other things related to the entire domain of science in their long-term memory. Argumentation is one type of paragraph presentation in writing that aims to convince or persuade the reader. In argumentative writing, the content can include reasons, explanations, proofs, or objective reviews accompanied by analogies, examples, and cause-and-effect relationships. The goal is for the reader to be convinced that the idea, concept, or opinion is true and proven. Toulmin (1958) developed a model from different aspects of argumentation that can be used to analyze the structure and complexity of what has been said or written. (Dawson & Venville, 2013; Osborne, Erduran, & Simon, 2004a). The Toulmin model (1958) begins with a claim, which is the conclusion, proposition, and demand about the issue that the debater wants to make. The next aspect of the Toulmin model is data, including some evidence provided by the debater to support the claim. Then there is the warrant, which involves explaining the relationship between the claim and the data. The next component is the backing, which is the basic assumption that supports the warrant, data, and claim. Another component is the qualifier, which provides conditions for a claim to be considered true. The final component is the rebuttal, which is the condition under which a claim can be rejected.

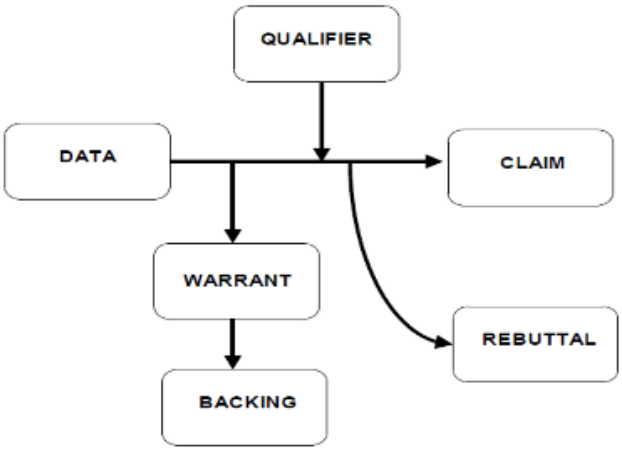

Figure 1 Toulmin Argumentation Pattern (Toulmin 2003)

Based on interviews with Biology teachers, the learning process for first-grade students' senior high school tend to be passive when discussing and only accepts the material presented. Thus, students' argumentative skills have not yet been well developed in science education, particularly in Biology. Based on this, students' argumentation skills must be practiced in the learning process. One of the efforts to improve students' argumentative skills is by implementing socio-scientific issues learning. This approach contains common social aspects that must be studied by students. (Siska, dkk 2020). Additionally, the controversial nature of socio-scientific issues can be linked to scientific concepts through students' argumentation skills in the learning process at school.

The controversial nature of socio-scientific issues can be linked to scientific concepts through students' argumentation skills in the learning process at school. Socio-scientific issues can meet the need for contextuality so that students can confront real problems in their environment to support the formation of knowledge, values, attitudes, decision-making, and problem-solving skills. (Subiantoro, Ariyanti, & Sulistyo, 2013). Sosio-scientific issues are effective in enhancing students' understanding of science in various contexts, argumentation skills, empathy, and moral reasoning. These science-related societal issues can be discussed through an argumentation process followed by the provision of evidence and justification to support the argumentation. (Dawson & Venville, 2013) follow the practice of Toulmin (1958) and Kuhn (2010) in using the term argumentation for the process of structured debate and discussion to provide reasons about problems and issues, including socio-scientific issues.

RESEARCH METHOD

The method used is the descriptive. Involved research subject is subject is thirty-two students from first-grade students' senior high school in West Bandung. The research instrument used in this study is interviews with biology teachers about the teaching process of biodiversity material and essay questions for students in the form of open-ended questions consisting of four items integrated with socio-scientific issues about efforts to preserve biodiversity. Here are the indicators of the questions displayed in the table below.

Table 1 Question Indicator of Argumention

Aspects of Argumentasion Skills	Argumentation components	Question Indicator	Outline
Use of facts and data in argumentation	Claim	Stating claims according to the issue	Providing arguments about land use change

Use information	Data	Including data to support the claim	explaining issues about environmental conservation and efforts to address them
Organizations of arguments	Warant	Explaining the relationship between data and claims	Providing arguments related to environmental conservation efforts for the preservation of biodiversity
Understanding of the issue Quality of argumentation	Backing	Providing justification to support the claim	Providing arguments related to the benefits of biodiversity conservation efforts

(Adapted from Toulmin Argumentation Pattern)

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To measure the level of students' argumentation, an argumentation sheet containing questions related to socio-scientific issues regarding efforts to preserve biodiversity was used. Starting with analyzing the emergence of argumentation components based on the Toulmin Argumentation Model, which consists of: claim, data, warrant, and backing. The following are the instruments used in the research.

Table 2 Assessment Rubric

Issues	**Question**	**Assessment Rubric**	**Score**
Management of the Bukit Betabuh Protected Forest area for the conservation of species such as Tigers and Sumatran Elephants, but in practice, parts of this area have been converted into plantation land. This condition also has a	Do you agree if the protected forest area is utilized as a plantation? Present your opinion and provide clear reasons based on data in the discourse!	Statement of agreement or disagreement	1
		Including data found in the discourse such as: a. status of protected forests, b. location and role of protected forests, c. the utilization dilemma faced by local communities, d. the environmental impact caused.	1
		Explaining the relationship between data and claims. Warrant can take the form of concepts such as the local community's	1

negative impact on the environment, such as the turbidity of clean water sources due to the loss of forest vegetation.		economy, employment, social stability, resource management, biodiversity conservation, environmental impact, social welfare, and even climate change that can occur as a result of land-use conversion.	
		Base the justification to support the claim. It contains additional clarification provided to explain the reasons the warrant applies.	1

Then, this pattern was developed into five levels based on the complexity of students' arguments. The determination of argumentation levels is based on Table 3. From this instrument, qualitative data on written arguments were obtained.

Table 3 Levels of Student Argumentation Skills Based on Argumentation Components

Level	Argumentation components	Criteria
1	Claim	Only providing true claims
2	Claim and data	Able to state claims and present accurate and correct data
3	Claim, Data, and Warrant	Able to state claims, present data, and explain the reasons used correctly.
4	Claim, Data, Warrant, Backing	Able to state claims, present data, and explain the reasons and supporting evidence used correctly.
5	Claim, Data, Warrant, Backing Qualifier, Rebuttal	Able to state claims, present data, explain reasons and supporting evidence, and demonstrate the quality of the conclusions used correctly.

(Source: Herlianti, 2014)

RESULT AND DISCUSSION

Students' argumentation skills are analyzed based on the completeness of argumentation indicators according to the framework proposed by Toulmin (2003) and then analyzed based on the components of argumentation according to the Toulmin Argumentation Pattern (TAP).

1.1 The Suitability of Score Acquisition and Student Argumentation Levels

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In this study, the research sample involved thirty-two students from first-grade students' senior high school in West Bandung. The results of the students' argumentation skill test yielded two forms of data: the first in the form of nominal data and the second in the form of the students' argumentation ability levels. The following is the data on the correspondence between the acquisition of scores and the levels of student argumentation shown in table below.

Tabel 4 The Suitability of Score Acquisition and Student Argumentation Levels

Student	Question 1		Question 2		Question 3		Question 4	
	Score	Level	Score	Level	Score	Level	Score	Level
E1	1	1	1	0	1	1	1	0
E2	2	2	1	1	3	1	2	1
E3	1	1	1	1	1	0	2	1
E4	3	2	1	1	1	1	1	1
E5	4	3	1	1	1	2	2	1
.E6	2	1	1	1	2	1	1	0
E7	3	3	1	1	2	1	3	1
E8	1	1	1	1	1	1	1	0
E9	2	2	1	1	1	0	1	1
E10	2	2	1	2	1	2	1	1
E11	2	3	1	2	1	1	1	0
E12	2	2	1	2	1	1	2	1
E13	3	2	2	1	1	1	3	1
E14	2	3	1	0	1	1	1	1
E15	3	3	1	2	1	2	3	1
E16	2	3	1	1	1	1	1	1
E17	1	1	1	0	1	0	1	0
E18	2	2	1	1	1	2	1	1
E19	2	2	1	3	1	2	1	1
E20	2	2	1	1	1	2	2	1
E21	1	1	1	0	1	2	2	0
E22	3	2	1	2	1	1	1	1
E23	2	2	1	1	1	1	1	0
E24	2	2	1	1	1	1	2	1
E25	3	2	1	1	1	1	3	1
E26	2	2	1	1	1	2	3	1
E27	3	2	1	0	1	0	1	0

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E28	2	2	1	1	1	0	1	0
E29	2	2	1	1	1	2	1	1
E30	2	2	1	2	1	2	2	1
E31	3	2	1	1	1	1	2	1
E32	2	2	1	2	1	2	1	1

Table 4 show the alignment between score acquisition and argumentation level varies for each question per student. The alignment of score acquisition and argumentation level tends to be as follows: if a student scores 1, they achieve level 1; if they score 2, they achieve level 2; if they score 3, they achieve level 3; and if they score 1, they achieve level 1. In Table 4, the alignment of score acquisition and level can be seen from the colors where the score matches the color of the level. For question number 1, the alignment between scores and levels was achieved by 21 students. For question number 2, the alignment between scores and levels was achieved by 18 students. For question number 3, the alignment between scores and levels was achieved by 13 students. And for question number 4, the alignment between scores and levels was achieved by 10 students.

1.2 Student's argumentation Skills

The students' argumentation skills have been calculated, and the results of the students' argumentation skills are presented in the table below.

Table 5. Data on students' argumentation skills acquisition

N	32
Rerata	26,44
Nilai Minimum	53,85
Nilai Maksimum	7,69
Standar Deviasi	16,34

1.3 Argumentation skills in Socio-scientific issue

The argumentation skills implemented in this research highlight the Socio-scientific issue of biodiversity, which has four interrelated basic components: claim, data, warrant, and backing, based on the Toulmin Argumentation Pattern. The indicators of argumentation captured in this issue are that students can state claims that are relevant to the problem, include data to support the claims, explain the relationship between the claims

and the data, and also provide justification to support the claims that have been made. The issue used is the dilemma of utilization in the management of the Bukit Bertabuh Protected Forest as the center of the Rimba Corridor.

Actually, argumentation skills have six aspects, namely four basic aspects and two additional aspects, which are qualifier and rebuttal. However, in this study, only four components are examined. The argumentation skill in each aspect was derived from test results, which were then coded based on the appearance of components by observing the number of students who stated those components. Table 6 presents the results of students' argumentation ability in each aspect.

Tabel 6.Recapitulation of the emergence of Student Argumentation components

Argumentation Components	**Question Number**				**Amount**
	1	**2**	**3**	**4**	
Claim	24	17	15	32	88
Data	1	3	1	1	6
Warrant	23	4	2	28	57
Backing	7	0	0	7	14
Qualifier	0	0	0	0	0
Rebuttal	0	0	0	0	0

The table show data on the occurrence of basic student argumentation components is presented. The ‘claim’ has the highest occurance compared to the other components and ‘data’ has the lowest occurence. The percentage of students at each level of argumentative skill is explained below in Figure 2.

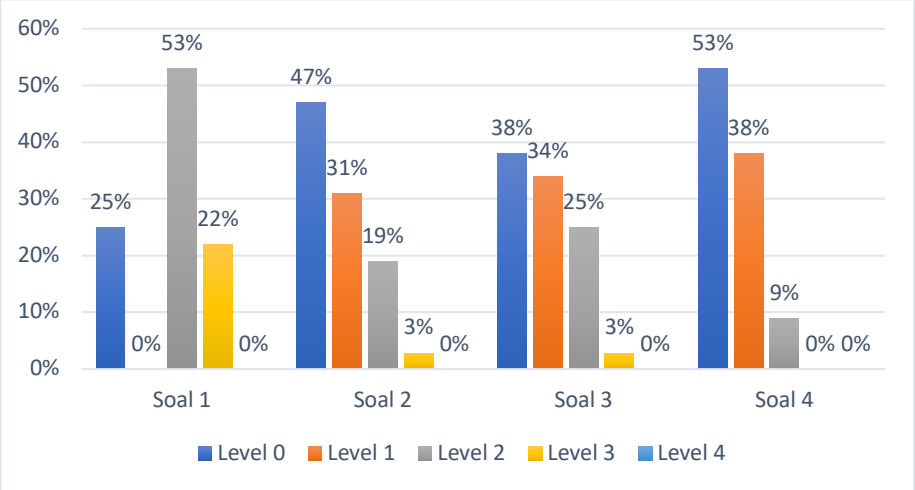

Figure 2. Level of Argumentation Skill

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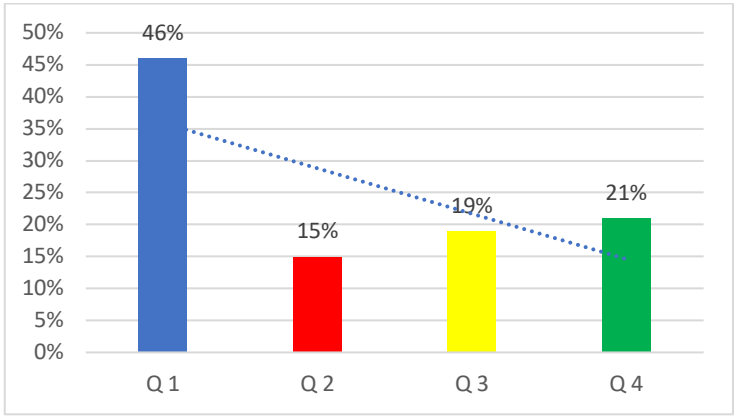
The results of the percentage of students' argumentation skills can be concluded that most students are only able to reach the first level. It is evident that the component of argumentation most frequently expressed by students is the claim. Meanwhile, the emergence of other argumentation components such as data, warrant, and backing is still not proportional to the claim. In line with the findings of Harianto's (2018) research, the level of argumentation quality most frequently achieved by students is the basic level (level one). The analysis of the argumentation quality descriptor patterns indicates that generally, students' arguments are limited to presenting claims related to a phenomenon and supporting those claims with the available data. Additionally, based on Nurdianti's (2021) findings, the rebuttal indicator also showed the lowest percentage because most of the arguments made still lacked elements of rebuttal and were unable to respond to other opinions well, even though they had claims, data, justification, and support.

Analysis of issues in biodiversity material to be applied in learning is conducted based on the characteristics of socio-scientific issues as proposed by (Ratcliffe & Grace, 2001). Socio-scientific issues on the topic of biodiversity are gathered based on issues that are published and reported periodically in the media, both print and digital. That means the issue becomes a phenomenon in society. Then the issue is also presented to students to elaborate on their knowledge and meet the basic competency requirements in the subject of biodiversity.

In this study, issues related to biodiversity in ecosystems that have occurred in Indonesia due to habitat loss, resulting in many species being endangered, are raised. For students' argumentative skills, the issue of biodiversity focusing on efforts to preserve biodiversity in Indonesia was used. Here is a recap of the percentage of students responding according to the given issue depicted below.



Caption:
Q1: Question number 1
Q2: Question number 2
Q3: Question number 3
Q4: Question number 4

Figure 3. Percentage of student argumentation achievement

Is the issue raised in capturing students' argumentative skill using the theme of conservation. This theme was chosen because it sufficiently represents and encompasses the entire issue, namely the issues of conservation, extinction, and in-situ preservation. The issue raised because critical thinking and argumentation require knowledge of concepts, this critical thinking is used to argue in other contexts on different concepts but can represent comprehensive issues.

The issue used is about the management of the Bukit Betabuh Protected Forest area for the conservation of species such as Tigers, Sumatran Elephants anf various bird species, but in practice, parts of this area have been converted into plantation land. This condition also has a negative impact on the environment, such as the turbidity of clean water sources due to the loss of forest vegetation. Students are required to present their answers with argumentative components, namely claim, data, warrant, and backing. For first question, approximately 46% of the students students can provide arguments regarding the possibility of the Bukit Betabuh Protected Forest being converted into plantation land. For second question, approximately 15% of students can provide arguments regarding the reasons for the conversion of protected forest land into conservation areas for tigers, Sumatran elephants, and many types of birds. For third question, approximately 19% of students can provide arguments regarding what efforts the government needs to undertake to address the conversion of protected forest land into plantation land. And for last question, approximately 21% students can provide arguments regarding the benefits of the Bukit Betabuh protected forest. According to Rahman (2018) shows that the quality of students' arguments in socio-scientific issues is still low. The low quality of arguments is because students are only able to make claims and rebuttals but find it difficult to provide reasoning. (data, warrant, dan backing). The difficulty in making arguments is based on the students' own understanding of the concepts..

After the recapitulation of the percentage of students answering according to the given issue is presented in Figure 4, the results of the students' scores answering according to the given issue on the argumentation skill questions will also be explained. The following presents the pretest scores of students answering according to the given issue on the argumentation ability questions in Figure 4.

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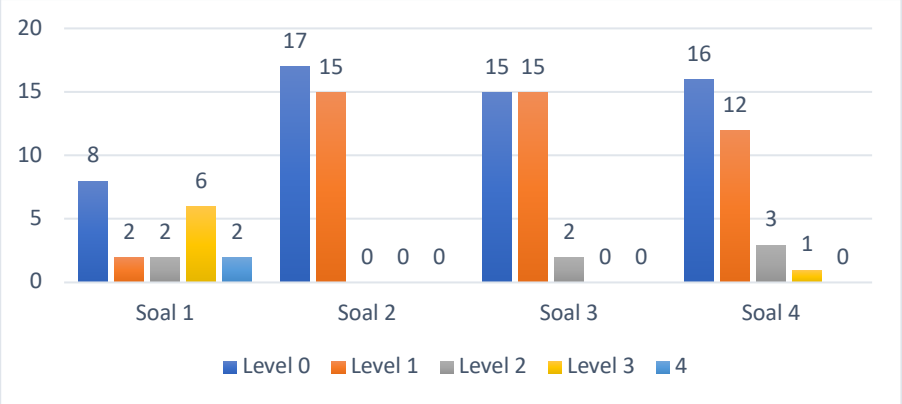

Figure 4 Student Scores on Socio-Scientific Issues

Limited knowledge or insight will make it difficult for students to provide scientific data, and even minimal understanding of biological concepts in learning can hinder students from providing scientific data to support a claim (Siska, 2020). According to Rini (2016), the quality of the arguments produced by students is still low, indicating that students can present arguments with a series of claims but have not yet been able to make rebuttals or present arguments accompanied by warrants and backing. This is relevant to the research by Cyntia, Dwiastuti, & Probosari (2016), which found that most students were unable to provide reasons accurately.

1.4 Interview with Biology Teacher

Beside using open-ended questions given to students to assess their argumentative skill in socio-scientific issues, this research also conducted interviews with biology teachers about the teaching processes applied in the classroom, particularly on the topic of biodiversity.

Table 7. The list of questions and interview teachers

No	Question	Answer
1	How do you conduct learning about biodiversity?	Studying biodiversity through one-way explanations from the teacher accompanied by observations in the school surroundings.
2	What approach or method do you often use in teaching this material?	Using a contextual approach namely the observation of biological biodiversity in the surrounding environment.

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3	Do you use specific learning media, such as videos, images, or props, to explain biodiversity?	Yes, sometime. Ussualy use media such as images to explain about biodiversity
4	How do you ensure that students can understand basic concepts such as species, ecosystems, and biodiversity?	Based on the results of the assessment or quiz
5	Do you provide real-life examples or case studies on biodiversity to help students better understand the material?	Not yet
6	How do you connect biodiversity material with students' daily lives?	Sometimes
7	What are your hopes for the development of biology education, particularly in the topic of biodiversity, in the future?	The background of the school is located in a highland area, making it suitable for cultivating vegetables and flowers.
8	Have you ever used socio-scientific issues in teaching biodiversity?	Not yet
9	Have you ever used socio-scientific issues in your biology class?	Not yet

The fact that classroom instruction does not prepare students to voice their viewpoints is another factor contributing to the poor level of argumentation skills among students. Students typically lack the knowledge necessary to formulate assertions, incorporate evidence, construct arguments and support, and comprehend other aspects of argumentation. Table 6 explains that the learning process does not always include case examples from students' daily life based on the findings of interviews with classroom teachers. This is regrettable because the educational setting can be used to investigate biodiversity-related topics. The school is situated in a highland area with cool air and many kinds of planted flower and agricultural fields.

CONCLUCION

Based on the analysis of the obtained data, it can be seen that students' argumentation skills are still at level 1, meaning students can only express a 'claim'. This is evidenced by the fact that the argumentation component 'claim' appears the most compared to data, warrant, or backing. This may be due to the fact that the implementation of learning using socio-scientific issues is something new for the students. Strengthened by the results of interviews with biology teachers, the students' ability to argue has not yet been facilitated, making them feel unfamiliar with it.

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