Student argumentation skills' analysis on the discussion of socio-scientific issues in the concept of viruses

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ABSTRACT

This study aimed to analyze the argumentation skills of students in learning through discussion of socio-scientific issues with the concept of viruses. This research is descriptive which describes the quality of oral and written arguments. The research was conducted in class of X MIPA at SMAN Jakarta. There were 34 students involved in this study. The method of analysis to determine the pattern of arguments used is the Toulmin Analysis. The analysis of collaborative oral arguments in class used Erduran's analysis framework. Meanwhile, the quality of individual written argumentation was Dawson and Venville's analysis. The results showed that the quality of students' oral arguments reached level 5. This means that students have been able to make a claim accompanied by a warrant and rebuttal quite well. The quality of the students' written arguments reaches levels 2 and 3. This means that students' arguments consist of arguments in the form of claims (claims) accompanied by guarantors of claims (warrants) and evidence (data) and rebuttals that are still weak.. The augmentation process verbally and collaboratively in class has reached the highest level, but individually and in writing it is still at a moderate level.

Keywords: discussion, socio-scientific issues, oral argumentation, written argumentation

INTRODUCTION

In the 2013 curriculum consist of Graduate Competency Standards (SKL), integrated character education, accommodate all schools of philosophy, and develop the ability to reason, communicate, and create (Zaini 2014; Rachmawati & Diningsih, 2021). One aspect that is considered important is the ability of students to communicate. The communication of students is expected not only to contain conversations or ordinary sentences but also to contain the value of facts/data or arguments.

Students' skills in argumentation are one of the most important components today because they can improve and develop critical thinking skills. Argumentation can be used to deal with various problems and knowledge issues that exist in everyday life. Arguments are very important for developing students' reasoning by developing activities to ask, find, and determine answers to curiosity in everyday life (Dawson & Venville, 2009 in Herlanti, 2014; Rahman, 2020). The argumentation process is used to analyze information about a topic so that students are accustomed to first analyzing an information before it is accepted as a whole. Some research results also show an increase in the performance and learning outcomes of science students who use argumentation in their learning

Natural Sciences including biology is very closely related to the issue of knowledge that exists in everyday life in the social environment or what is called socio-scientific issues (SSI). SSI tend to be studied from various points of view so as to be able to give rise to different answers. The application of socioscientific issues in the classroom involves scientific topics that require students to engage in dialogue, discussion, and debate (Zeidler, 2009; Rifa'i & Subiantoro, 2022). Thus, students' scientific literacy and critical thinking skills can grow and improve (Kristiana et.al., 2019). The most important of these approaches is the Science-Technology-Society (Sadler, 2011). Students can express

their ideas or arguments to solve science issues in the social environment as a manifestation of the active learning process in the classroom (Defni et al., 2022). Thus, the method of discussing socioscientific issues can also improve students' scientific reasoning abilities, especially probabilistic reasoning (Mazfufah et al., 2017; Amalia et al., 2018; Istiana et al., 2019). The results of other studies also show an increase in students' scientific arguments when using socio scientific issues learning strategies (Siska et al., 2020; Martini et al., 2021).

Biological material that presents many socio-scientific issues, one of which is the concept of viruses. The concept of the virus is conceptual and contextual (related to facts and everyday phenomena) so that learning on these concepts can increase the involvement of students to express opinions. Various cases and events related to the virus concept (which is closely related to the social environment and raises many social issues) will increase students' knowledge and improve the quality of discourse (supporting the knowledge that students already have). Thus, expressing arguments by discussing socio-scientific issues on the concept of viruses can be used as a benchmark in the development and realization of students' argumentation skills. In addition, the ability to evaluate students' scientific information can increase (Rahayu, 2015).

Several studies related to the analysis of argumentation skills have already been studied, but the packaging of arguments in discussion of socioscientific issues, especially those related to

biological (virus) concepts, is an interesting new subject to raise. This research will map out the study of socioscientific issues in three themes, namely: The first meeting regarding the departure of Indonesian athletes to participate in the Rio Olympics related to the rise of the Zika virus. The second meeting raised socioscientific issues regarding the use of pig enzymes as vaccine manufacturing materials. The third meeting raised socioscientific issues regarding localization for HIV/AIDS sufferers. The existing pattern of argumentation will show how active the discussion in the learning takes place. Thus, it will also be known to what extent the quality of the discussion of these socioscientific issues, to what level the quality of the argumentation skills can be achieved.

METHOD

The research is descriptive in nature which describes the quality of oral and written arguments. The research was conducted in class X MIPA SMAN in Jakarta. There were 34 students involved in this study. The implementation of learning was carried out in 3 meetings (Table 1). The method of analysis to determine the pattern of arguments used Toulmin analysis. The analysis used to determine the quality of the students' oral arguments is Erduran Analysis (Table 2). Meanwhile, the quality of written argumentation uses Dawson and Venville analysis (Dawson & Venville, 2009 in Herlanti, 2014). Toulmin's Argument Framework shows that the statements that make up an argument have different functions.

Table 1. Discussion of socio-scientific issues at 3 virus concept learning meetings.

	1st Meetings	2nd Meetings	3rd Meetings	Information
Topic/ Theme of discussion	The topic of discussion about "The government bans athletes in their country from participating in the 2016 Rio Olympics in Brazil"	"Do you agree with the use of pork enzymes as vaccine ingredients?"	"Localization for People with HIV/AIDS",	Each meeting is held for 3 x 45 Minutes

Preliminary Stage	Opening, apperception and delivering indicators, motivation and material coverage	Opening, apperception and delivery of indicators, motivation and material coverage	Opening, apperception and delivery of indicators, motivation and material coverage	5 minutes
Main Stage	Concept formation, polemic, exploration, action, and conclusion stages	Concept formation, polemic, exploration, action, and conclusion stages	Concept formation, polemic, exploration, action, and conclusion stages	90 Minutes
Closing Stage	Reflection, informing the next lesson plan, instructing to find information, and writing down the essence of the lesson	Reflection, informing the next lesson plan, instructing to find information, and writing down the essence of the lesson	Reflection, informing the next lesson plan, instructing to find information, and writing down the essence of the lesson	5 Minutes
LKS Topic/ Theme	Fear of Zika Virus, Country Bans Athletes from Participating in Rio 2016 Olympics	Doubts of Pig Enzymes for Vaccines.	Localization for HIV/AIDS sufferers.	Individual LKS (1 a), pro and con group LKS, 2b (positive and negative impacts), pro and con group LKS, 2c on recommended steps/efforts/solutions

These functions can be classified into six categories: claim (claim/C), data/reason/evidence (ground/G), justification/guarantee (warrant/W), support (backing/B), modal qualifier (modal qualifier/MQ), and possible rebuttal/PR (Table 3). With these six elements, argument writing can be patterned into 5 structures (patterns). The five patterns include pattern I (C-G), pattern II (C-G-W), pattern III (C-G-W-B), pattern IV (C-G-W-B-MQ), and pattern V (C-G-W-B-MQ-PR). The C-G pattern is the simplest pattern. That is, an argument consists of a statement and at least a reason or several reasons or evidence (Syaifudin & Utami, 2011).

The level of students' oral arguments is analyzed using an argument analysis framework according to Erduran which classifies arguments into five levels, namely: level 1, level 2, level 3, level 4, and level 5. Meanwhile, students' written arguments can be analyzed. by using an assessment rubric according to Dawson and Venville which consists of four levels, namely level 1, level 2, level 3 and level 4 (Herlanti, 2014).

The results of the data that have been collected from the learning process were analyzed descriptively using discourse analysis, namely by analyzing oral argumentation discourse on discussions of socioscientific issues and also analyzing the results of written discourse on student worksheets or LKS (Subiantoro et al., 2013). The rubric for assessing student worksheets can be seen in Table 4.

Audio-visual recordings are used as learning tools to find out the oral argumentation discourse of each student. Oral arguments will be transcribed and analyzed. Meanwhile, the Student Worksheet (LKS) is for written argumentative discourse. Written arguments will be analyzed and assessed using the argumentation scoring rubric. Questionnaires were also used as additional data and field notes. The questionnaires were tabulated and analyzed at each stage.

Toulmin's argument based on Erduran's analytical framework can be seen in Table 2. Toulmin's argument based on Dawson & Venville's analytical framework can be seen in Table 5.

Table 2. Level or quality of argument according Erduran et al.

Level	Quality of Argument
Level 1	Arguments consist of arguments in the form of simple claims versus counter claims or claims versus claims.
Level 2	Arguments consist of arguments in the form of claims with counter claims accompanied by data, warrants or backings but not rebuttals.
Level 3	Arguments consist of arguments with a series of claims or counter claims accompanied by data, guarantees or support with occasional weak rebuttals.
Level 4	Arguments consist of arguments with claims with one rebuttal that can be identified clearly and precisely, one argument can contain several claims or counter claims.
Level 5	Arguments consist of broad arguments (extended, but still related to the topic presented) with more than one clear and precise rebuttal.

Table 3. Rubric for determining argument components

Argument Component	Description	Linguistic Features
Claim	If the student develops his claim based on the cartoon concepts presented or based on other students' statements. Claim in the form of a statement of agreement.	I agree with… I support…. I think …..is correct……
Counter Claim	When students develop The claim is based on the concept cartoon presented or based on the statements of other students. Counter claim in the form of a statement of disagreement.	I do not agree…. I don't agree with…. I don't think it's appropriate...
Warrant	If the student makes a guarantee as a justification for the claim he made.	I agree with …because……. Why do I support….. because.. The thing that makes me not agree is….
Backing	When students present data or facts to support his warrant.	Based on what I've experience… According to what's in book…. When we look at the facts about…. From the theory I read… I've heard of… The following phenomena/data/facts prove…….
Rebuttal	If students make a rebuttal, especially against other students' statements or rebuttal to all statements on the concept cartoon.	I don't agree with your opinion because… I don't agree with the whole statement because… I don't agree with you because based on what I've experienced...
Qualifier	If students assign the strength of the data to warrants and can limit universal claims	If students assign the strength of the data to warrants and can limit universal claims

Table 4. Student worksheet assessment rubric.

Argument Component	Description	Linguistic Features
Claim	If the student develops his claim based on the cartoon concepts presented or based on other students' statements. Claim in the form of a statement of agreement.	I agree with… I support…. I think …..is correct……

Counter Claim	When students develop The claim is based on the concept cartoon presented or based on the statements of other students. Counter claim in the form of a statement of disagreement.	I do not agree…. I don't agree with…. I don't think it's appropriate…
Warrant	If the student makes a guarantee as a justification for the claim he made.	I agree with …because……. Why do I support….. because.. The thing that makes me not agree is….
Backing	When students present data or facts to support his warrant.	Based on what I've experience… According to what's in book…. When we look at the facts about…. From the theory I read… I've heard of… The following phenomena/data/facts prove…….
Rebuttal	If students make a rebuttal, especially against other students' statements or rebuttal to all statements on the concept cartoon.	I don't agree with your opinion because… I don't agree with t0he whole statement because… I don't agree with you because based on what I've experienced…
Qualifier	If students assign the strength of the data to warrants and can limit universal claims	If students assign the strength of the data to warrants and can limit universal claims

Table 5. Analysis of the levels of written arguments according to the dawson & venville analysis framework

Level	Description
Level 1	Describing the argument is just a claim
Level 2	Describe the claim and data (information supporting the statement) and/or guarantor/warrant (relationship between statement and data).
Level 3	Describe the claim, data, guarantor, backing (assumptions to support the guarantor) or convincing statement/qualifier (under circumstances where the statement is true).
Level 4	Describing claims, data, guarantors, supporters and convincing information

Table 6. Levels of students' oral arguments in the first meeting

Level	Category	Quantity
1	Claim (c)	1
2	Claim+data (cd), Claim + warrant (cw)	10
3	Claim+warrant+data (cwd) accompanied by a weak rebuttal	1
4	Claim+warrant+data (cwd) accompanied by a good/clear rebuttal	1
5	Claim+warrant+data (cwd) accompanied by more than one good/clear rebuttal	2

RESULTS AND DISCUSSION

Visualization of the students' verbal argumentation patterns at the first meeting showed that there were components of argumentation in the form of claims, warrants/supporting claims (warrants) and rebuttals, but there was no evidence (data) supporting students' arguments (Figure 1). The total claims formed in the discussion above are five claims, the guarantees or supporters for claims are twelve and the disclaimers are three, with one of them being weak. The category of argumentation that only contains claims (c)

there is only one claim, marked by a dotted line connecting "students" to "contra-1 group (Raul)". This claim is weak because it is only delivered randomly and briefly by several students from the pro group in the form of a "agree" statement. There are ten categories of arguments containing claims and evidence (cd) and/or claims and guarantees (cw), one of which was put forward by the contra-1 group (Raul) when answering questions from the teacher.

"I went because I've been practicing for months and I'm tired, it's impossible not to go, it's a waste of time, there's no result.."

There are three categories of arguments containing claims, evidence, guarantees or warrant, rebuttals (cwr), with one of them being weak. One example of an argument that falls into this category is the one put forward by the pro-1 group (Elan) to the contra-1 group (Raul).

"I don't agree with Raul because we are preparing for worse. As if we go there and practice, but then we are infected, when we come home we cannot practice."
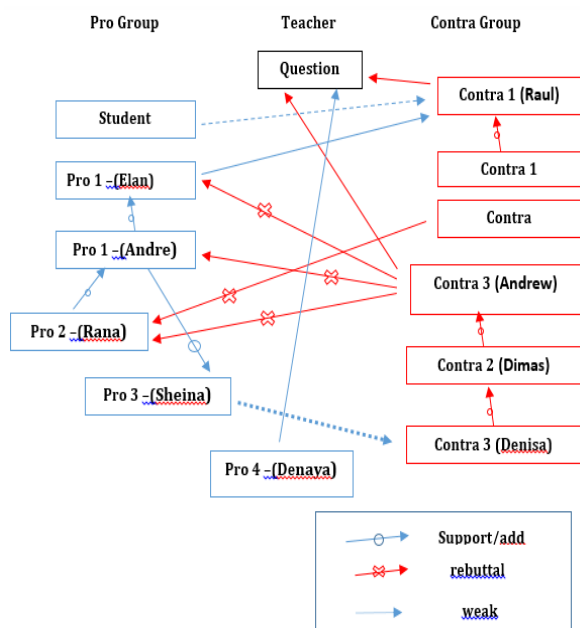

Figure 1. Visualization of the First Meeting Oral Argument Pattern.

Arguments included in the category (cwr) can also be seen from the contra-3 (Andrew) group which was addressed to the pro-1 (Elan), pro-1 (Andre) and pro-2 (Rana) groups.

"I don't agree with all of your opinions because we shouldn't think negatively first. Your chance to become an athlete is only once in a lifetime. It's impossible to come again. While the Olympics only once a year, not necessarily in the next four years, maybe we'll get that opportunity again. Then about the Zika virus, the country where Andre says that mosquitoes can live anywhere is wrong. Actually, imagine. you are an athlete. It shouldn't be possible for you to be placed in a public place, you must

be placed in some kind of athlete's guesthouse, the stadium must be a luxury stadium, it's impossible for you to be placed on the streets. Is it?"

The analysis of the patterns and categories of oral arguments above shows that the level of students' verbal arguments at the first meeting was at level 5, with more than three claims components, more than three guarantees and more than one refutation (Table 6). This indicates that the discussion went quite well, although only a few students dared to express their opinion. Of the 34 total students in one class, only ten of them dared to put forward an argument. The ability of students to express this opinion can be influenced by several factors (Bahri et al., 2021). Visualization of oral argumentation patterns at the first meeting can be seen in Figure 1. While at the second meeting it can be seen in Figure 2.
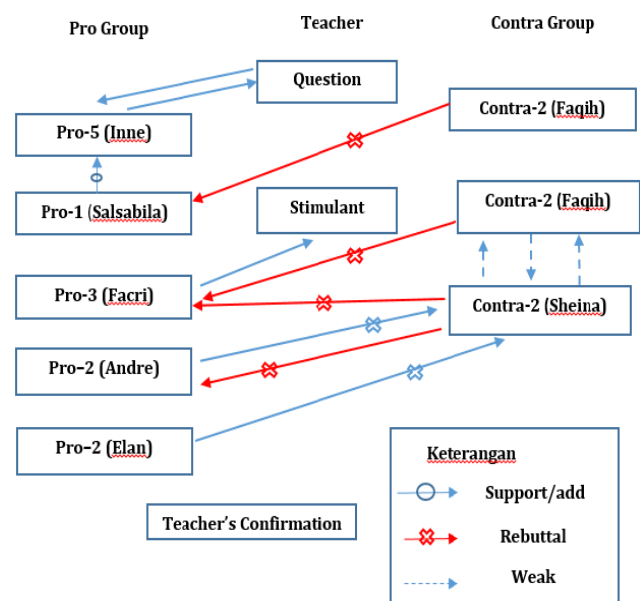

Figure 2. Visualization of the Second Meeting Oral Argument Pattern.

The discussion went quite well at the meeting, a fairly high level of oral argumentation was achieved, the pattern of argumentation varied (there were claims, guarantees/warrant, rebuttals), many students expressed their opinions. It can be said that the discussion of

socio-scientific issues can make students trained to think more critically. If the learning is repeated, it is not impossible that critical thinking skills will increase. Teaching about issues that develop in society and science will help improve students' skills and critical thinking.

The first meeting with the second has a different pattern of argumentation. This pattern can be seen from level 2 (cd+cw code) totaling 10 and level 5 (cwd code with more than 1 good disclaimers) totaling 2 in the first meeting. The number of categories of argumentation patterns that exist reached a total of 15. Meanwhile, the second meeting of argumentation patterns showed that level 2 numbered 5 and level 5 numbered 3. The number of categories of argumentation patterns that existed reached a total of 9. Thus, overall it can be seen that there is a decrease in the number of argumentation patterns discussion between the first meeting and the second. The number of discussion argumentation patterns decreased but the quality of skills or the level of argumentation increased (increased level 5 from 2 to 3). Although, research notes that the distribution or dominance of discussion levels is still centered or mostly at level 2.

Another difference between the two discussions on socioscientific issues is the number of participants involved in the discussion. The first meeting noted that there were around 10 participants. Meanwhile, in the second meeting there were around 7 participants. Thus, in this study there was a decrease in the level of participation of students involved in the discussion. This situation is very likely due to several things, including: Passive contributions in the form of invitations to other discussion partners to discuss matters outside the topic of discussion, conversations that deviate from the discussion material, student arguments are not as expected, the teacher does not stimulate the discussion process , and discussion argumentation patterns are still

dominant at level 2 (cd+cw). The pattern of argumentation at level 2 means that the discussion is still in the form of statements accompanied by certain data or guarantees in the form of references but it is still not systematic.

Analyzing from the two discussion meetings on socioscientific issues that there are a number of things that might influence the differences in argumentation patterns from one meeting to the next (plus the argumentation pattern still dominates at level 2). Researchers noted several things that could be the cause, including: 1. The ability of students to explore the depth of biological concepts is still lacking. 2. The data provided is still invalid and not systematic. This condition is strengthened by the lack of ability to connect or look for relationships between knowledge of the application of biology in the field with the theory received in class. What should be, students can scientifically evaluate (connect) information found in the real world or outside the classroom (Espeja & Lagarón, 2015; Khishfe, 2017). 3. The lack of integration of each biology concept, such as when the teacher teaches there is no apperception (which connects the previous subject to the next subject) and the initial knowledge possessed by students. These things are very likely to be the cause of the lack of systematic arguments given by students in discussions (Anisa et al., 2017; Devi et al., 2018; Herawati et al., 2019).

Previous research (related to the analysis of argumentation skills) has differences from this research. Previous research related to argumentation skills by raising environmental issues (pollution/pollution). Meanwhile, this research is related to viral biology concepts (Zika Virus, vaccines, and HIV/AIDS). This study also focuses on analyzing patterns of oral and written argumentation skills with argumentation levels. Previous research showed that students' argumentation abilities between the experimental and control classes

experienced differences after seeing the increase/change in the results of the pre-test and post-test. The argumentation ability of the experimental class students was high as seen from the high syntax scores (above 80% and in the very good category) such as scientific background, evaluation of information, Local, global and national dimensions, and Decision Making. Overall, the discussion of socioscientific issues gave a positive response to the application of learning (Siska et al., 2019).

This research has differences with previous studies. The difference lies in the themes and concepts of biology (environmental change). Meanwhile, this research deals with viral biology concepts (Zika Virus, vaccines, and HIV/AIDS). Discussion of other socioscientific issues is associated with students' creative thinking. The profile of students' creative thinking skills has increased which can be seen from the results of the pre-test and post-test in the experimental and control classes, especially in aspects of original thinking (Indriani & Jayanti, 2022). Meanwhile, the research carried out focused on analyzing patterns of oral and written argumentation skills with levels of argumentation.

This research has differences with previous studies. The difference lies in the themes and concepts of biology (biotechnology). This research deals with viral biology concepts (Zika Virus, vaccines, and HIV/AIDS). Meanwhile, themes in other studies revolve around issues such as fruit and vegetable controversies resulting from genetic engineering improvements, the application of biotechnology in the food sector, baby genes, etc. The number of responses/responses to the biotechnology module reached 87.50% and there was an increase in students' creative thinking in the medium category. This difference can also be seen in the data analysis. The research carried out focuses on patterns of oral and written argumentation skills with levels of argumentation. Meanwhile,

biotechnology research analyzes an increase in creative thinking on socioscientific issues before and after the discussion takes place, with an increase in the N-Gain value (Pursitasari et al., 2022).

Written argumentation skills have not been able to reach the highest level, this is in accordance with previous research (Herlanti, 2014) which examined students' writing skills on transgenic issues. Most of the argumentations were in level II; participants gave a claim within a warrant. Only a few arguments were in level IV, it's a holistic argument that contained a claim, a warrant, a backing, and a rebuttal. Most of the arguments had simple type or chain type.

CONCLUSION

The conclusion of the study showed that the quality of the students' oral arguments reached level 5 at the first meeting. That is, students have been able to express claims (claims) accompanied by guarantors of claims (warrants) and rebuttals (rebuttal) quite well. The discussions that took place in the class were quite attractive and interesting. The quality of the students' written arguments reached levels 2 and 3 at the first meeting. That is, able to present a claim (claim) accompanied by a guarantor of claims (warrants) and evidence (data) that is still simple. This means that students' arguments consist of arguments in the form of claims (claims) accompanied by guarantors of claims (warrants) and evidence (data) and rebuttals that are still weak. Oral argumentation skills in groups have reached the highest level, but individual written argumentation skills must be improved.

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