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The Relationship between Scientific Literacy Skills and Argumentation Skills Through Discussion of Socioscientific Issues on the Virus Concept

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A B S T R A C T

Scientific literacy skills are important in science learning, but the scientific literacy skills of students in Indonesia are still relatively low based on the results of PISA 2022. Scientific literacy skills can be improved through the integration of socio-scientific issues in learning and scientific literacy knowledge can be measured through student argumentation. Therefore, a study was conducted to determine the relationship between scientific literacy skills and students' argumentation through discussions of socio-scientific issues on the concept of viruses. The research method used was the pre-experimental designs method using one-shot case study and correlational techniques. The total sample used was 53 students with a purposive sampling technique. Data collection in this study used tests in the form of scientific literacy questions and argumentation skills questions. The results of the study showed a relationship between scientific literacy skills and argumentation through discussions of socio-scientific issues on the concept of viruses with a significance value of 0.017 which indicates a significant relationship and a correlation coefficient of 0.327 which means the strength of the correlation is in the sufficient category. The average scientific literacy ability of students is 66.65 which is included in the moderate category and argumentation skills are at level 3.

1. Introduction

The results of PISA 2022 indicate that the average scientific literacy skills of students around the world stand at 485, while Indonesian students score an average of 383, placing Indonesia in 67th position among 81 nations (OECD, 2023). These outcomes indicate that the scientific literacy skills of Indonesian students are classified as low (Tillah & Subekti, 2025). Therefore, it is necessary to integrate scientific literacy in science learning by providing scientific literacy questions that cover aspects of content, competence and context to students. Implementing scientific literacy makes science education more relevant and connects it to issues that pertain to students' everyday experiences (Situmorang, 2016). Understanding

scientific literacy is crucial for students to learn about various facets of life, particularly in the context of health (Barokah et al., 2024).

Socioscientific issues are issues that concern scientific issues or concepts, are controversial, can be discussed in the public domain and have political and social impacts (Tanfiziyah & Rochintaniawati, 2021). Socioscientific issues are very realistic and close to the daily lives of students (R. I. Putri et al., 2024). According to research conducted by Rahmayani (2019), implementing socio-scientific issue discussion methods in education can enhance students' scientific literacy skills more effectively than conventional discussion methods. The application of socioscientific issues in science learning has advantages, namely increasing scientific literacy skills so that students can implement science-based scientific knowledge in everyday life. However, in its application, socioscientific issues have disadvantages because the discussion process takes longer (M. R. Putri & Miterianifa, 2023).

The use of socio-scientific issues in science education aims to enhance students' active engagement in discussions or debates, enabling them to assess their understanding and strengthen their grasp of the concepts covered (Ramdani et al., 2020). This aligns with the findings of Budinarianti & Susiyawati (2024), which indicate that incorporating discussions on socio-scientific issues in science learning positively impacts students' argumentation skills. Argumentation skills are important for students because they are useful in making correct and logical decisions regarding controversial issues in everyday life (Istiana et al., 2019).

Argumentation is important to apply in science learning. This aligns with the view expressed by Fatmawati et al., (2018), which asserts that argumentation is intrinsically linked to science, serving as a fundamental component of scientific discourse used to address inquiries and resolve issues and disagreements through logical reasoning. Sudarmo et al., (2018) suggest that proficiency in argumentation, whether in writing or verbally, can serve as an indicator of students' grasp of concepts and reasoning abilities. Students who possess a solid understanding of the material and concepts are capable of crafting effective arguments (Wardani et al., 2018). This is supported by Anjani (2024), who states that scientific literacy skills have a significant impact on argumentation abilities, indicating that as students' scientific literacy improves, so too do their skills in argumentation, and the reverse is also true.

The material raised in socioscientific issue-based learning is material that can explore students' argumentation skills (Herlanti, 2014). Biology material at the high school level that can be studied as an interesting issue to discuss and includes socio-scientific issues is virus material. The selection of virus material is based on research by Saputri & Widyaningrum (2016) which states that viruses are one of the materials that are difficult for students to understand. The characteristics of virus particles that cannot be seen directly by the eye make learning difficult and require special understanding so that students understand better. Consequently, integrating socio-scientific issues is anticipated to enhance students' comprehension of viruses,

leading to an improvement in their argumentation skills as well (Wulandari et al., 2023).

Research conducted by Putriana (2021) reveals a positive correlation between scientific literacy skills and argumentation skills, with a correlation coefficient of 0.418, categorized as sufficient. This suggests that as scientific literacy skills increase, argumentation skills are also likely to improve. Researchers introduced innovations by implementing the socio-scientific issue discussion method to the concept of viruses. This aligns with previous studies indicating a connection between socio-scientific issue discussions and scientific literacy (Osborne, 2005; Dawson & Venville, 2009; Marreo & Mensah, 2010; Nuangchalernm 2010) and argumentation (Osborne, 2005; Chang & Chiu, 2008; Dawson & Venville, 2009). Therefore, research was conducted to determine the relationship between scientific literacy skills and students' argumentation skills through socio-scientific issue discussions on the concept of viruses.

2. Methodology

Research Design

This research employs a quantitative approach (Siroj et al., 2024) with correlational techniques (Selviana et al., 2024). The research method used is pre-experimental design. The design used in this study is a one-shot case study (Arib et al., 2024) with the pattern presented in Figure 1.

Figure 1. One-Shot Case Study Research Design (X = treatment with socio-scientific issue discussion method; O = post-test on the group given treatment) (Yessi, 2024)

This research will investigate the relationship between two variables, namely scientific literacy skills as variable X and argumentation skills as variable Y. The constellation of the relationship between the independent variable (X) and the dependent variable (Y) can be seen in Figure 2.

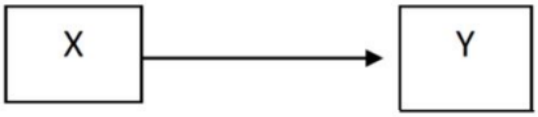

Figure 2. Constellation of the Relationship between Independent Variables (X) and Dependent Variables (Y) (Variable X = science literacy skills; variable Y = argumentation skills) (Hidayat et al., 2022)

Site and Participant

This research was conducted at Depok City State High School in the odd semester of the 2024/2025 academic year from September-December 2024. The sampling

technique used was purposive sampling (Subhaktiyasa, 2024). The sample used in this study amounted to 53 respondents consisting of 20 male respondents and 33 female respondents aged 15-16 years.

Data Collection

The data collection technique in this study was carried out using a written test. The written test on the science literacy ability instrument includes multiple-choice questions and essays, totaling 15 questions. The science literacy ability test questions were distributed to students via Google Forms. The argumentation skills test is in the form of a student worksheet consisting of four discourse questions.

Instruments

The instrument used in this study was a written test to measure scientific literacy skills. The test instrument was designed by applying the context, content, and knowledge aspects of PISA. This test was distributed to students via the Google form https://bit.ly/Post-testLiterasiSainsMateriVirus. This instrument consists of multiple-choice questions and essays totaling 15 items adopted from research conducted by (Rahmayani, 2019). The outline of the scientific literacy test questions can be seen in Table 1.

Table 1. Science Literacy Ability Test Question Grid

Learning Indicators	**PISA Competency Aspect Question Number**			**Number of Questions**
	Identifying Scientific Issues	**Explaining Phenomena Scientifically**	**Using Scientific Evidence**	
3.4.1 Identifying the characteristics and structure of viruses	-	**1 (K1,P2)**	-	**1**
3.4.2 Classifying types of viruses	-	-	**2 (K1,P2)** **3 (K1,P2)**	**2**
3.4.3 Explaining how viruses live and replicate	**4 (K1,P1)**	**5 (K1,P2)** **6 (K1,P2)**	-	**3**
3.4.4 Analyzing the role of viruses in everyday life	**7 (K1,P2)** **8 (K1,P2)** **9 (K1,P2)** **10 (K1,P2)** **11 (K1,P2)**	**12 (K1,P2)** **13 (K1,P2)** **14 (K1,P2)**	**15 (K1,P2)**	**9**
Number of Questions	**6**	**6**	**3**	**15**

Description:
PISA Context Aspect:
K1 = Health

PISA Knowledge (Content) Aspect:
P1 = Scientific inquiry
P2 = Scientific explanation

The instrument for measuring argumentation skills uses questions containing discourse. The questions consist of four questions related to virus material with different discourses or standpoints, where the questions are on the student's worksheet. The first discourse is about whether viruses are living things, the second discourse is about the Mpox virus which has the potential to spread like the Corona virus to cause a pandemic, the third discourse is about whether viruses are always detrimental, and the fourth discourse is about the government's efforts to quarantine foreign citizens before entering Indonesia with the presence of the SARS-CoV-2 virus. Students' arguments will be assessed using the Toulmin Argumentation Pattern (TAP) analysis framework to measure the level of argumentation (Herlanti, 2014) which is found in Table 2, then an assessment of the quality of the argumentation will be carried out to determine the category of argumentation content quality (Syafitri, 2023) which is found in Table 3.

Table 2. Framework for Analysis of Written Discourse Argumentation of the TAP Model

Level	Information
1	Discourse containing Claims (K)
2	Discourse containing Claims and Data (DK)
3	Discourse containing Claims, Data, Warrants without backing (DKW)
4	Discourse containing Claims, Data, Warrants with Backing, without qualifiers and/or rebuttals (DKWB)
5	Discourse containing Claims, Data, Warrants with Backing, and Qualifiers and/or Rebuttals (DKWBQR)

The following presents the assessment rubric for the argumentation content quality category in Table 3.

Table 3. Argumentation Content Quality Category Assessment

Evaluation	Category		
	1	2	3
Claim formation at level 1	Providing a statement of agreement or disagreement with the standpoint given, accompanied by a scientific explanation	Providing a statement of agreement or disagreement with the standpoint given, accompanied by a normative explanation	Providing a statement of agreement or disagreement with the standpoint given

Data usage at level 2	Mentioning data according to the standpoint provided along with information that enriches the data	Mentioning data according to the standpoint provided	Mentioning data according to the standpoint provided, but only partially
Providing Warrants at Level 3	Using reasons or reasoning that connects data and claims by showing expert views, written laws, and/or other reliable information (scientific) accompanied by an antithesis to the claim	Using reasons or reasoning that connects data and claims by showing expert views, written laws, and/or other reliable information (scientific)	Using reasons or reasoning that are normative in nature
Use of Backing at level 4	Providing legitimacy in the form of research data, figures, graphs, laws, and or other reliable information (scientific) by including reference sources from the references used	Providing legitimacy in the form of research data, figures, graphs, laws, and or other reliable information (scientific) without including reference sources from the references used	Providing legitimacy in the form of news or personal experiences that are normative in nature
Rebuttal usage at level 5	Explaining exception sentences that are based on research data, law, or expert (scientific) views so that they give rise to certain terms or conditions of the claim given	Explaining the exception sentence which is normative in nature so that it gives rise to certain terms or conditions of the claim given	Only stating that there is an exception, without providing an explanation

The validated instruments consisted of 15 items from a total of 15 questions. The results of the instrument test showed that all scientific literacy questions were valid and suitable for use as research instruments. The reliability value for multiple-choice questions was 0.78 and essay questions were 0.69, which were included in the high category (Arikunto, 2002). The level of difficulty of the questions showed that there was 1 question in the difficult criteria, 11 questions in the moderate criteria, and 3 questions in the easy criteria, then the test of the discriminatory power of the scientific literacy questions showed that there were 5 questions in the very good discriminatory power category, 8 questions in the good category, and 2 questions in the sufficient category.

Data Analysis

Data processing on the science literacy ability instrument is carried out by determining the value of the science literacy questions that have been tested on students. Furthermore, the categorization of student positions is carried out based on the PISA reference (OECD, 2023).

The analysis of argumentation skills was carried out using the Toulmin Argumentation Pattern (TAP) model analysis framework contained in Table 2, then an analysis was carried out on the quality of the argumentation content contained in Table 3. Scoring of argumentation skills was carried out based on the level and category of argumentation obtained by students. Guidelines for interpreting argumentation skills scores (Amalina et al., 2020) can be seen in Table 4.

Table 4. Argumentation Skills Score Interpretation Guidelines

Interpretation of Scores	Category
0 – 19.99	Very Weak
20 – 39.99	Weak
40 – 59.99	Fair
60 – 79.99	Strong
80 - 100	Very Strong

The investigation into the connection between scientific literacy skills and argumentation skills was conducted using the normality test and the Spearman correlation test. For this study, the normality test employed was the Kolmogorov-Smirnov test (Sintia et al., 2022). The results obtained showed that the scientific literacy ability variable was not normally distributed (Sig.) <0.05, namely 0.024 and the argumentation skills variable was also not normally distributed (Sig.) <0.05, namely 0.021. Data that are not normally distributed in both variables, then the Spearman correlation test is carried out (Nurhalijah et al., 2024). The criteria for the level of correlation strength (Anggun, 2022) are in Table 5.

Table 5. Correlation Strength Level Criteria

Significance Value	Correlation Strength Level
0.00 – 0.25	Very weak relationship
0.26 – 0.50	Relationship is sufficient
0.51 – 0.75	Strong relationship
0.76 – 0.99	Very strong relationship
1.00	Perfect relationship

3. Results and Discussion

The data in this study are data on scientific literacy skills and argumentation skills of class X students at Depok City State High School through discussions of socioscientific issues on the virus concept. According to Nadlir et al., (2024) the

learning process consists of three phases, namely planning, implementation, and evaluation. The planning stage in learning socio-scientific issue discussions on virus concept is carried out by compiling teaching modules, materials to be taught, and student worksheets based on socio-scientific issues, then the implementation stage is carried out by implementing learning according to the stages of socio-scientific issue discussions according to Herlanti (2014), namely polemics, exploration, action and conclusion. Furthermore, the evaluation stage is carried out using formative and summative tests. The following presents the stages of learning to discuss socio-scientific issues in Table 6.

Table 6. Stages of Learning Discussion of Socioscientific Issues

Meeting	Standpoint	Student Activities
1 (What is a virus?)	Do you agree that viruses are living things?	**Polemic:** students provide statements of agreement or disagreement with the standpoint given, then form groups into pro and con teams **Exploration:** students work on worksheets, find out scientific explanations related to the issues being discussed through references on the worksheets or other sources, and present their arguments according to the pro or con team, which will then be responded to or refuted by other teams **Conclusion:** students reaffirm their opinions on the issue being discussed
2 (Virus reproduction)	Do you agree that the Mpox virus has the potential to spread like the Corona virus and cause a pandemic?	**Polemic:** students provide statements of agreement or disagreement with the standpoint given, then form groups into pro and con teams **Exploration:** students work on worksheets, find out scientific explanations related to the issues being discussed through references on the worksheets or other sources, and present their arguments according to the pro or con team, which will then be responded to or refuted by other teams **Conclusion:** students reaffirm their opinions on the issue being discussed
3 (The role of viruses)	Do you agree that viruses are always harmful?	**Polemic:** students provide statements of agreement or disagreement with the standpoint given, then form groups into pro and con teams

		Exploration: students work on worksheets, find out scientific explanations related to the issues being discussed through references on the worksheets or other sources, and present their arguments according to the pro or con team, which will then be responded to or refuted by other teams **Conclusion:** students reaffirm their opinions on the issue being discussed
4 (Virus prevention)	Do you agree with the government's efforts to quarantine foreign nationals before entering Indonesia due to the presence of the SARS-CoV-2 virus?	**Polemic:** students provide statements of agreement or disagreement with the standpoint given, then form groups into pro and con teams **Exploration:** students work on worksheets, find out scientific explanations related to the issues being discussed through references on the worksheets or other sources, and present their arguments according to the pro or con team, which will then be responded to or refuted by other teams **Action:** students make posters and videos related to how to prevent viruses, then upload them to social media **Conclusion:** students reaffirm their opinions on the issue being discussed

The results of scientific literacy skills are obtained by calculating the value of students' answers, then categorizing students' scientific literacy skills based on the PISA reference. The following presents the results of the statistical analysis of students' scientific literacy abilities in Table 7.

Table 7. Statistics of Students' Science Literacy Skills

Descriptive Statistics	Science Literacy Skills
Number of Students (N)	53
Mean ($\bar{x}$)	66.65
Standard Deviation (SD)	15.40
Minimum Value (Min)	27.03
Maximum Value (Max)	89.19

The categorization of scientific literacy skills is divided into three, namely high, medium, and low. The determination of the score interval is based on the PISA score according to the OECD (2023). The following is a presentation of the categories of students' scientific literacy skills in Table 8.

Table 8. Categories of Students' Science Literacy Abilities

Number	Category	Score Interval	Frequency	Percentage (%)
1.	High	70 - 100	23	43.40
2.	Medium	40 - 69	28	52.83
3.	Low	0 - 39	2	3.77
	Amount		**53**	**100**
	Average		**66.65**	

Table 8 shows that the students' scientific literacy skills on the virus material are mostly in the moderate category, namely 28 (52.83%) students. These results show that most students already have sufficient scientific literacy skills, but still need to be improved, then students with low scientific literacy skills as many as 2 (3.77%) indicate that there are still students who cannot use data and scientific evidence to assess the quality of information and scientific arguments in the scientific literacy test given. Meanwhile, 23 (43.40%) students exhibit high scientific literacy skills, demonstrating that these students have a grasp of how to apply their knowledge effectively to address various issues, allowing them to make informed decisions based on scientific insights and reasoning.

The overall average of students' scientific literacy, as presented in Tables 8 and 9, falls within the moderate range, with a mean score of 66.65. These findings indicate that while students are capable of applying scientific thinking skills in their decision-making, some still lack a strong grasp of scientific concepts and processes. According to Fuadi et al., (2020), various factors impact scientific literacy skills, such as conventional science learning, neglect of scientific reading and writing skills as important competencies that must be possessed by students, students are accustomed to only completing tables provided by the teacher, which causes students' ability to interpret tables or graphs to be limited, and students are less accustomed to working on scientific literacy questions.

The indicators for assessing scientific literacy skills are divided into three aspects, namely competence, knowledge (content), and context (Rini et al., 2021). Table 9 indicates that the average level of scientific literacy among students in terms of competency is classified as moderate, recorded at an average of 66.25. These findings suggest that while students possess adequate skills in addressing queries or resolving scientific problems, there is still room for enhancement. Among the three indicators measuring scientific literacy ability, the indicator related to identifying scientific issues achieves a higher average than the others, at 68.80, which also falls within the moderate category. These results indicate that students

can already understand questions that are being studied scientifically, identify keywords from phenomena contained in scientific literacy questions, and know the basic patterns of scientific investigation, although they are not yet in the high category and still need to be improved.The following presents the average results of students' scientific literacy skills for each indicator in Table 9.

Table 9. Average Results of Students' Science Literacy Skills for Each Indicator

Number	Aspects of Scientific Literacy	Indicator	$\bar{x}$ ± SD Indicators	$\bar{x}$ ± SD Aspect
1	Competency Aspects	Identifying Scientific Issues	68.80 ± 17.43	66.25 ± 14.52
		Explaining Phenomena Scientifically	66.51 ± 19.73	
		Using Scientific Evidence	63.44 ± 12.94	
2	Knowledge Aspect (content)	Scientific Investigation	88.68 ± 31.99	77.04 ± 16.28
		Scientific Explanation	65.39 ± 16.59	
3	Context Aspect	Health	66.65 ± 15.40	66.65 ± 15.40

The capacity to recognize scientific issues related to the scientific understanding that students have about viruses demonstrates that students can identify problems within scientific literacy questions, indicating that the majority have grasped the material on viruses. Additionally, the average score for the indicator of explaining phenomena scientifically is 66.51, which falls into the moderate category, suggesting that students are able to apply their scientific knowledge to address scientific literacy questions concerning the concept of viruses. The lower average in comparison to the indicator for identifying scientific issues illustrates that students still struggle with analyzing discourse-based questions. This aligns with the perspective of Huryah et al., (2017), who stated that students' lack of familiarity with working on questions that require analytical skills can be one of the factors that influence scientific literacy skills.

The indicator based on scientific evidence has an average score of 63.44, which falls within the moderate range, suggesting that students are able to draw conclusions by interpreting data presented in tables or images related to scientific literacy questions on the concept of viruses. The average score for the indicator based on scientific evidence is lower than the other two indicators. This suggests that students are more competent in identifying issues and explaining observable phenomena than in interpreting data represented in tables or images. This aligns with the assertion by Yusmar & Fadilah (2023), which indicates that students' deficiencies in explaining tables or graphs may influence their scientific literacy skills.

The mean score for scientific literacy in the knowledge (content) aspect is 77.04, placing it in the high category. These findings suggest that students possess a solid comprehension of natural phenomena as they relate to human activities. This aligns with the viewpoint of Rini et al., (2021), who noted that the knowledge (content) aspect encompasses the fundamental scientific concepts necessary for understanding natural events and the alterations caused by human actions. The average score for the scientific investigation indicator surpasses that of scientific explanation, at 88.68, categorizing it as high. These results demonstrate that students have developed strong skills in gathering and interpreting data found in graphs and tables. Conversely, the average score for the scientific explanation indicator is 65.39, which falls into the moderate category, indicating that students possess an adequate ability to draw conclusions or explain information scientifically based on factual evidence.

The average ability in scientific literacy within the context aspect is 66.65, which falls into the moderate category. The context aspect evaluated in PISA includes four indicators, namely health, natural resources, environment, and the boundaries of science and technology. However, this study focused solely on the health indicator for the context aspect. These findings suggest that students are capable of applying their processes and understanding of science, particularly in the health field, though there is still room for improvement. This aligns with the viewpoint of Rini et al., (2021), which asserts that the context aspect pertains to applying scientific processes and concepts in everyday situations.

Another ability studied in this study is argumentation skills. This is because literacy skills affect argumentation skills. According to Wardani et al. (2018), the conceptual understanding possessed by students affects the arguments produced. Students who have sufficient conceptual knowledge can produce quality arguments. According to Sudarmo et al., (2018), the skills of oral and written argumentation can serve as a measure of students' conceptual knowledge and reasoning abilities. Argumentation skills in this study were measured using the Toulmin Argumentation Pattern (TAP) model argumentation assessment indicator to determine the level, then an assessment of the quality of the argumentation content was carried out. The analysis results regarding students' levels of argumentation are presented in Table 10.

Table 10. Results of Analysis of Students' Argumentation Levels

Level	Category	Amount (%)				
		Discourse 1	Discourse 2	Discourse 3	Discourse 4	Discourse 4 (After)
1	Discourse containing Claims (K)	26.42	21.57	26.42	12.24	11.32
2	Discourse containing Claims	-	-	-	-	-

	and Data (DK)					
3	Discourse containing Claims, Data, Warrants without backing (DKW)	67.92	49.02	39.62	59.18	67.92
4	Discourse containing Claims, Data, Warrants with Backing, without qualifiers and/or rebuttals (DKWB)	5.66	29.41	32.08	26.53	16.98
5	Discourse containing Claims, Data, Warrants with Backing, and Qualifiers and/or Rebuttals (DKWBQR)	-	-	1.89	2.04	3.77
	Total			**100**		

The results of the analysis of students' argumentation levels in Table 10 show that the argumentation skills of most students in discourses 1 to 4 are at level 3, where the results show that most students can present their arguments accompanied by reasons (warrants), but the reasons (warrants) are not supported by research data/expert opinions, figures, graphs or laws and are not accompanied by an antithesis to the claim. This is in accordance with the opinion of Erduran et al., (2004) who stated that arguments at level 3 contain weak claim, data and warrant components. Weak warrants are due to not being supported by evidence. According to Rahayu et al., (2020) level 3 shows that students have sufficient argumentation skills, but still need to be improved.

The standpoints in discourses 1 to 4 can be seen in Table 7. The argumentation results show that in discourse 3, there are students with argumentation level 5 of 1.89% and in discourse 4, there are 2.04%. These results show that students have been able to present their arguments accompanied by reasons (warrants), and the warrants are supported by expert opinions, and there is an antithesis to the claim, so that it is classified as a complete argument (holistic), namely an argument with strong reasons and not easily refuted. This is in accordance with the opinion of Erduran et al. (2004) at level 5, showing that the arguments presented by students are perfect.

According to Erduran et al., (2004) students who are at level 4 show that the arguments presented have clear rebuttals and there are several claims, then students who are at level 1 show that the arguments presented only contain claims and are weak arguments. Furthermore, in discourse 4 after learning the virus material there was an increase in the percentage of students who were at level 5, where initially in discourse 4 before learning it was 2.04% to 3.77%. This shows that the increasing

number of students who present perfect arguments, then an analysis was carried out on the quality of the content of the students' arguments as shown in Table 11.

Table 11. Results of Analysis of the Quality of Students' Argumentation Content

Argumentation Components	Category	Amount (%)				
		Discourse 1	Discourse 2	Discourse 3	Discourse 4	Discourse 4 (After)
Claim (K)	3	94.34	96.08	96.23	88.80	92.45
	2	5.66	3.92	3.77	10.20	3.77
	1	-	-	-	-	3.77
Data (D)	3	82.05	85	92.31	32.56	65.96
	2	-	-	2.56	-	-
	1	17.95	15	5.13	67.44	34.04
Warrant (W)	3	22.64	1.96	13.21	6.12	28.30
	2	71.70	94.12	83.02	83.67	67.92
	1	5.66	3.92	3.77	10.20	3.77
Backing (B)	3	100	75	94.44	100	66.67
	2	-	25	5.56	-	8.33
	1	-	-	-	-	25
Rebuttal (R)	3	93.33	100	100	100	57.14
	2	-	-	-	-	-
	1	6.67	-	-	-	42.86

The results of the analysis of the quality of the content of students' arguments in Table 11 show that the Claim component with the highest percentage in discourses 1 to 4 is in category 3, where the results show that most students agree/disagree with the standpoint given accompanied by scientific reasons. The data component with the highest percentage in discourses 1 to 3 is in category 3, while discourse 4 is in category 1, where category 3 data shows that most students can mention data according to the standpoint given, accompanied by reasons that strengthen the data. Meanwhile, category 1 data shows that there are students who mention data according to the standpoint, but only partially.

The warrant component with the highest percentage is in category 2, where the results show that most students can provide reasons for their arguments, accompanied by expert opinions or scientific explanations, but there is no antithesis

to the claim. Furthermore, the backing component with the highest percentage is in category 3 which shows that most students can provide support that strengthens their arguments in the form of research data or scientific explanations by including references from the references used, then the rebuttal component with the highest percentage is in category 3 which shows that most students can explain scientific antithesis sentences so that certain conditions or requirements arise for claims, then the students' argumentation skills were categorized in Table 12.

Table 12. Categories of Students' Argumentation Skills

Argumentative Discourse	Argumentation Score				Category
	Level	Content Quality	Total Score	Average	
Discourse 1	134	435	569	56.50	Enough
Discourse 2	146	408	554	55.01	Enough
Discourse 3	152	454	606	60.18	Strong
Discourse 4	150	366	516	51.24	Enough
Discourse 4 (After learning)	164	447	611	60.68	Strong

Table 12 indicates that the highest argumentation score of 60.18 is found in discourse 3 concerning the question of whether viruses are always harmful, which falls within the strong category. This outcome can be attributed to the fact that in the prior session, students learned about what viruses are and how they reproduce, thus equipping them with relevant knowledge about viruses. There was an increase in scores for discourses 1 to 3, whereas discourse 4 saw a decline in its score. This decrease might stem from students beginning to lose interest in the repetitive use of the socio-scientific issue discussion method. Meanwhile, in discourse 4, after learning, there was an increase of 60.68, which is included in the strong category, when compared to before learning, with an average of 51.24, which is included in the sufficient category. These findings suggest that students' argumentation abilities improved following the implementation of socio-scientific issue discussions concerning the concept of viruses.

The correlation test between scientific literacy skills and argumentation skills was carried out by first testing the normality, then the Spearman correlation test was carried out. The normality test in this study used Kolmogorov-Smirnov. According to Sintia et al., (2022) the normality test used Kolmogorov-Smirnov because the samples used were more than 50, namely 53 samples. The following are the results

of the normality test of scientific literacy skills and argumentation skills in Table 13.

Table 13. Normality Test Results

Aspect	Kolmogorov-Smirnov		Information
	Statistics	Sig.	
Science Literacy Skills	0.131	0.024	Not normally distributed
Argumentation Skills	0.133	0.021	Not normally distributed

The results of the normality test of the scientific literacy ability and argumentation skills test showed a probability value (Sig.) < (0.05). These results indicate that the data on scientific literacy ability and argumentation skills are not normally distributed. The results of the Spearman correlation test can be seen in Table 14.

Table 14. Spearman Correlation Test Results

Test Results	Score Acquisition	Conclusion
Sig (2-tailed)	0.017	There is a significant relationship
Spearman Correlation Coefficient	0.327	The direction of the correlation is positive, it has a fairly strong correlation relationship.

Table 14 presents the significance results of 0.017 < 0.05 indicating a significant relationship between scientific literacy skills and argumentation skills. The Spearman correlation test yielded a value of 0.327, demonstrating a positive correlation. Referring to Table 5, the strength of the correlation suggests a sufficient relationship between the two variables, implying that as scientific literacy skills improve, argumentation skills are also likely to enhance. This aligns with the findings of Fadlika et al., (2022), which indicate a correlation between scientific literacy and argumentation skills with a coefficient of 0.426, falling within the moderate category, these results indicate that the higher the students' argumentation skills, the higher the scientific literacy skills they have, and vice versa.

4. Conclusion

Based on the findings of the research and analysis presented earlier, it can be stated that there is a connection between students' scientific literacy abilities and their argumentation skills in discussions regarding socio-scientific issues related to viruses. This relationship shows a sufficient strength correlation, indicating that as scientific literacy skills increase, argumentation abilities also improve, and the reverse is true as well. Furthermore, the integration of socio-scientific issues has been demonstrated to enhance students' comprehension of virus concepts. The average scientific literacy skill level among students falls within the moderate range, and their arguments comprise components of claims, data, and warrant.

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