THE CORRELATION OF SCIENTIFIC ARGUMENTATION AND CRITICAL THINKING ON GLOBAL WARMING MATERIALS IN SMAN 19 SURABAYA

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Abstract

Argumentation is a the process of preparing for a formal statement that is accompanied by evidence and logical reasons. This study aims to analyze the effect of scientific argumentation skills on critical thinking skills. The research subjects used were 11th-grade students in 19 Senior High School, Surabaya. This study used an experimental design with quantitative descriptive 100 subjects of three classes. The question given is included in the topic of global warming. The research subjects were given ten questions related to scientific literacy and critical thinking questions. These ten questions must imply answered by giving logical reasons to support their answers. Each student's answers will be adjusted to the Toulmin's Argumentation Pattern assessment guidelines that have been adapted. The results of this study indicated that students 'scientific argumentation in level 2 and student's critical thinking in a moderate level. On average students provide good claims and evidence. In Pearson's correlation test, scientific argumentation skills on critical thinking skills have a great relationship. Knowing the level of student's intial ability in the arguments related to critical thinking, it can be prepared learning models that can provide to supporting influence in learning activities.

Keywords: Argumentation, critical thinking, and global warming

Abstrak

Argumentasi adalah proses penyusunan sebuah pernyataan yang disertai dengan bukti dan alasan yang logis. Penelitian ini bertujuan untuk menganalisis pengaruh keterampilan argumentasi ilmiah terhadap kemampuan berpikir kritis. Subjek yang digunakan dalam penelitian ini adalah peserta didik kelas 11 di SMA Negeri 19 Surabaya. Penelitian ini menggunakan deskriptif kuantitatif dengan 100 subjek atau 3 kelas. Pertanyaan yang diberikan masuk dalam materi pemanasan global. Subjek penelitian akan diberikan 10 pertanyaan yang terdiri dari pertanyaan yang bersifat literasi sains dan pertanyaan bersifat berpikir kritis. 10 pertanyaan tersebut harus dijawab dengan memberikan alasan yang logis untuk mendukung jawaban. Jawaban setiap peserta didik akan disesuaiakan dengan pedoman penilaian *Toulmin's Pattern Argumentation* yang telah diadaptasi. Hasil dari penelitian ini menunjukkan bahwa argumentasi ilmiah peserta didik berada pada tingkatan 2 dan berpikir kritis peserta didik berada pada level sedang. Rata - rata peserta didik memberikan *claim* dan bukti dengan baik. Pada uji korelasi pearson keterampilan argumentasi ilmiah terhadap kemampuan berpikir kritis memiliki hubungan yang sangat kuat. Mengetahui tingkatan kemampuan awal siswa dalam argumentasi yang terkait dengan berpikir kritis, maka dapat dipersiapkan model pembelajaran yang dapat memberikan pengaruh yang mendukung dalam kegiatan pembelajaran.

Kata Kunci: Argumentasi, berpikir kritis, dan pemanasan global

INTRODUCTION

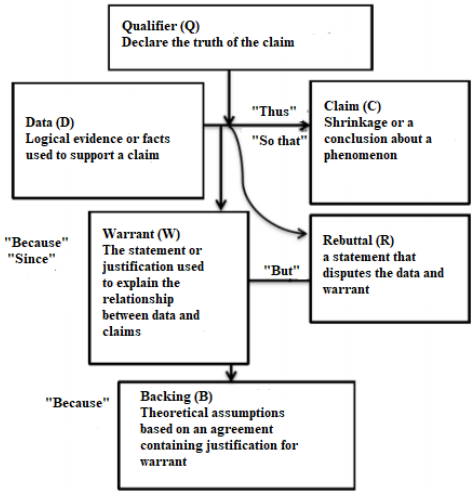
The curriculum currently being implemented in Indonesia is the 2013 curriculum where this learning will lead to students and can train students to think critically in solving a problem. This is consistent with the competencies needed in 21st-century learning (Kemendikbud, 2013). The 21st Century skills are synonymous with 4C: critical thinking, creative and innovative, communication, and collaboration (Doringin, 2017). The four aspects need to be combined in an education field, one of which is the field of science.

Facts of the results of the study Program for International Student Assessment (PISA) Carried out every three years to measure the learning competencies of students globally. The last three periods showed that the achievement of Indonesian children in science and literacy is still below the International average score. In 2012, Indonesia was ranked 64th out of 65 countries, ranked second lowest. The science field scored 382, and literacy scored 396 (OECD, 2012). In 2015 Indonesia was ranked 64th out of 72 countries, ranking 8th to the bottom. The science field scores 403 and literacy scores 397 (OECD, 2015). In 2018 Indonesia was ranked 74th out of 79 countries, ranked sixth lowest. The science field scored 396, and literacy scored 371 (OECD, 2018). Through the results of this PISA study, it can be concluded that Indonesia is often ranked last

The PISA framework emphasizes three scientific competencies: identify problems, explain or predict phenomena, and use scientific evidence to draw assumptions (OECD, 2006). Based on the PISA framework, it is clear that argumentation is a guideline for data collection. The results that have been presented show that students' argumentation skills in Indonesia are relatively low. Therefore the argument is something essential to do and learn.

The argument itself is a person's skill to carry out the process of compiling a statement that is accompanied by evidence and logical reasons to justify a belief, attitude or value, maintain it, and influence others (Inch & Warnick, 2006). According to Deane & Song (2014), argumentation skills have a role in developing critical thinking patterns and increasing understanding of ideas and ideas. Arguments in critical thinking refer to comparisons with supporting evidence and reasoning.

Toulmin's Argumentation Pattern (TAP) is a component of scientific argumentation consisting of data (data), claims (claims), justification (warrant), support (backing) and refutation (rebuttal) (Toulmin, 2003). Toulmin's argument is very useful in measuring someone's ability to argue. The results of Erduran, Simon, and Osborne's (2004) research showed that Toulmin's argumentation pattern is very suitable for identifying arguments and measuring the level of argumentation. The following illustration is an argument scheme based on the model proposed by Toulmin.



(Toulmin, 2003)

Figure 1. Scheme Toulmin Argumentation

Toulmin made a scheme regarding components in the argumentation process which was distributed into six components. 1] Qualifier (Q) is a statement stating the truth of a claim. 2] Data (D) is evidence or logical facts that are used to support a claim. 3] Claim (C) is a point of view or a conclusion regarding a phenomenon. 4] Warrant (W) is a statement or justification used to explain the relationship between data and claim. 5] Rebuttal (R) is a statement that denies a warrant. 6] Backing (B) is a theoretical assumption based on an agreement that justifies the warrant.

Assessment techniques are used to measure students' argumentation abilities based on written assessments. The assessment will be given a level for each argument that has been submitted by students.

Table 1. Matrix Toulmin's Argumentation Pattern

Level	Criteria
1	Arguments consist of straightforward claims against retaliation or claims against claims.
2	Arguments consist of claims with useful data, warrant or backing, but do not contain any rebuttal.
3	The argument consists of a series of claims with useful data, warrant or backing with feeble objections.
4	The argument shows a claim with an identified rebuttal. The argument might have multiple claims with feedback, but this is not necessary.
5	The argument shows a lengthy statement with more than one refutation.

(Toulmin, 2003)

Critical thinking is a supporting aspect of a person said to have a high level of thinking ability (Song & Deane,

2014). Critical thinking is closely related to problem-solving skills where the better the critical thinking skills, the better the ability to solve problems. Critical thinking is the ability to think higher than just knowing, understanding, applying, analyzing, and synthesizing Facione (2015). Critical thinking is an ability that can be trained and developed. Critical thinking skills have a relationship with argumentation skills. The indicator of analyzing arguments is to identify reasons (Duron & Waugh, 2006). Someone who is stated to have critical thinking skills then that person also has problem-solving skills. Therefore it can be said that someone also has excellent argumentation skills (Warnick, 2015).

The material on global warming is considered as the most suitable material to teach the argumentation process well. Because the material on global warming can be researched, scientifically proven, and discussed during learning. Also, the discussion on this material concerns life that can be seen and observed by students directly. So that students are considered able to provide arguments to interpret and evaluate human activities that have an impact on global warming (Manz, 2015)

Based on the results of preliminary research conducted at SMAN 19 Surabaya with a sample of 72-grade students, obtaining results on 82.4% of students do not know what is meant by scientific argumentation, and 85.3% of students never state scientific argumentation. Through interviews, many students who say that physics only races on the formula. Through the results of this PISA study, researchers chose material for global warming where this material is very close to daily life, and many benefits have been felt. So hopefully, students will more easily issue their arguments.

METHOD

This research uses an experimental design with the quantitative-descriptive method. This research will be carried out in 3 classes obtained through a purposive sampling method. Based on the policy to make class 11 maths and science specialization 1, 2, and 3 as a sample of this study. Total subjects will get 100 data, which means 100 students.

This data is taken after students get the material that has been explained by the physics teacher. A questionnaire obtained this data with ten questions that were validated by two validators. These ten questions contain questions that contain scientific literacy and critical thinking. The analysis technique is descriptive qualitative. The data that will be obtained related to scientific argumentation of students can use observer rubric, which was adapted by Toulmin. Data that has been analyzed will be categorized into the level of argumentation.

RESULTS AND DISCUSSION

Based on the results of a questionnaire conducted by 11th-grade students who deal with scientific arguments about global warming. Obtained the following results:

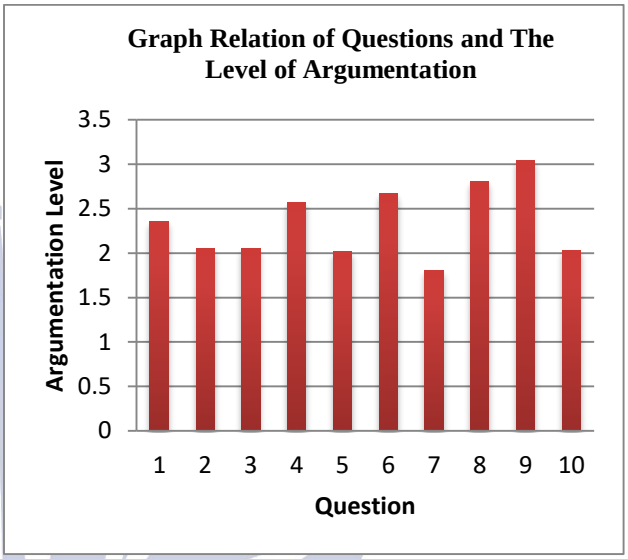


Figure 2. Graph of the Relation Between Questions and The Level of Argumentation

Based on the graph of the relationship between questions and the level of argumentation shows the level of student argumentation is in the range of level 2. The assessment used to assess the ability to argue written students is carried out by Toulmin's Pattern Argumentation that has been adapted by (Deta & Rizki, 2020).

Table 2. Scoring Criteria of Participants' Argument

Point	Criteria
1	a. The argument is fragile b. The claim is valid, and the data is not reliable c. The relationship between the claims, data, warrant fragile d. The relationship between the components no argument
2	a. The argument is quite good b. Claims inadequate and insufficient data good c. The relationship between claims and evidence good enough d. The relationship between the components is sufficient Argument
3	a. Strong argument

	b. The claim is valid; the data is strong and well warrant c. The relationship between claims and evidence d. Relationships between components are strong Argument
4	a. The argument is powerful b. Very valid claim, the data to clarify the claims, includes a strong evidence c. The relationship between the claim and the evidence is powerful d. Relationship between the components convincing argument

The pattern of scientific arguments presented by students can be made in the form of a framework (Sampson & Gleim, 2009) illustrated in Figure 2.

PROBLEM: Students are asked to discuss the impact of the greenhouse effect "One issue that is currently taking severe attention about global warming which has several impacts that are increasingly felt one of these impacts is sea level rise. Many say that the increase in sea level is caused by the melting of ice at the North Pole. Do you think the above statements are true? give your response to strengthen the answer! "

RESPONSE 1: One of the effects of global warming is the rise in temperature on the Earth's surface. The increase in the surface temperature of the Earth in the period 2015 - 2019 reached 1.1˚C. This was quoted by CNN Indonesia (Data). Rising sea levels characterize the increase in the surface temperature of the Earth. This is due to the melting of the north polar ice (Claim).

RESPONSE 2: Events that cause an increase in temperature on the surface of the Earth is the increasing amount of greenhouse gases in the Earth's atmosphere. Sunlight that hits the layers of the Earth's atmosphere is partly absorbed by gases in the atmosphere and partly destroyed to Earth. The light absorbed by gas causes the Earth to be confined. That also causes the temperature on the Earth to get hotter.

RESPONSE 3: Arctic ice caps which are north closed do not affect sea level rise at all. Because the ice at the North Pole floats like ice that does not change the volume, melting of the south pole which has the potential to increase sea level because of the average south polar region island covered with ice, existing ice can be colder than ice existing in the north. So what causes sea level to rise is the melting Of the ice at the south pole.

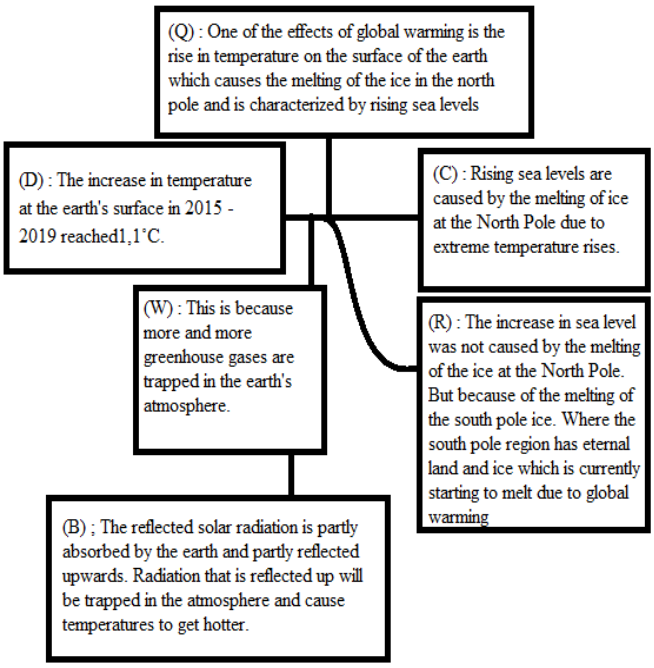


Figure 3. Toulmin's Argumentation Scheme In Global Warming

The ten questions used in this study are divided into literacy questions and critical thinking questions. Researchers have made five indicators of learning achievement. Each indicator two questions refer to science literacy questions and critical thinking questions. Questions on odd numbers refer to scientific literacy and questions on even numbers refer to critical thinking.

Where the odd number questions precisely on questions number 1 and 9 (scientific literacy questions) get a higher level of argumentation than questions number 2 and 10 (questions of critical thinking). In contrast, questions number 3,5 and 7 (scientific literacy questions) get lower levels of argumentation than questions numbers 4,6 and 8 (critical thinking questions).

Question number 3 and number 4 are questions that are in 1 indicator of the same learning. Question number 3 is scientific literacy, and question number 4 is critical thinking. In question number 3, ask about the sinking of the island of Sumatra. The average student answers the claims and evidence correctly for the inspection part of the relationship between claim and evidence. There were questions about the cause of the sinking of the island of Sumatra; students answered the sinking of the island of Sumatra due to over-exploitation from the mine. Actually, the incident happened because of rising sea levels. For questions that examine the justification for ideas clearly or qualifiers. Researchers ask whether the event is related to the melting of ice in the lid. Many students have doubts about answering these questions.

In question number 4, two images are provided. First is a graph of increasing sea surface temperature and the second picture is a map of the city of Jakarta with sea level and the addition of sea levels that have been drawn. In the mention of claims, many students answered correctly, but some of them misread the graph. Some students read that the graph is an increase in sea level, not an increase in seawater temperature.

In the context discussed for question number 3 and question number 4. Shows that the level of argumentation in science literacy questions is smaller rather than the level of argumentation on the question of critical thinking. This supports a survey conducted by the Program for international student assessment (PISA) that Indonesia, for four periods, consistently ranked 10th lowest in 3 categories, namely science, mathematics, and reading/literacy.

Question number 9 and number 10 are questions that are in 1 indicator of the same learning. Question number 9 is scientific literacy, and question number 10 is critical thinking.

Question number 9 about efforts to overcome the drought that will occur in an area. Some countries have a way to overcome the drought to put millions of millions of black balls into the reservoir. The black ball will float to cover these waters. It is a way to minimize the evaporation that occurs. Many students can state claims and evidence very correctly. The next question that asks whether this can prevent drought in the area. Some students have doubts about answering these questions. Some of them have become able, but without giving further explanation. Some of them answered that they could not do it because basically, this ball was just an ordinary black ball that could float in water.

In question number 10, 2 different images are given. Figure 8 is the bus with many passengers and cars with the same number of passengers. This difference in a picture should show that using public transportation will make the road condition drift / non-congested with air pollution caused by motorized vehicles reduced. Some students misinterpret this difference in pictures which results in incorrect answers of students.

The context discussed for question number 9 and question number 10 shows that the level of argumentation on the scientific literacy question is higher than the level of argumentation on the question of critical thinking. This shows that student's critical thinking skills are moderate. This is in line with the argumentation skills that have a level of argumentation at level 2.

Table 3. Pearson Correlation Test Argumentation with Critical Thinking

	Correlation Pearson		**Sig. (2Tailed)**	**N**
Argumentation	Argumentation	1		100
	Critical Thinking	0.902	0.000	100
Critical Thinking	Argumentation	0.902	0.000	100
	Critical Thinking	1		100

The table above is the calculation of Pearson correlation using SPSS (Yamin & Kurniawan, 2014). The correlation between the ability of argumentation with the ability to think critically based on the Pearson Correlation Value Interpretation Criteria. Through the above results obtained a relationship between the ability of argumentation and the ability to think critically shows a powerful and positive patterned relationship, meaning that the ability of argumentation will be in harmony with the ability to think critically.

The results of research conducted by (Bestiantono, 2020) show a significant relationship between the Argument-Driven Inquiry learning model and the scientific literacy ability of students. The use of the Argument-Driven Inquiry learning model can be applied to improve or train students to argue well. Research conducted by (Annisa, 2016) shows the application of Argument-Driven Inquiry learning models to improve the ability to argue and think critically among middle school students in the medium category. This can be tried for high school students by using the same learning model. Supported by Hanifah's research (2019), in his thesis, shows that there is an increase in the level of scientific argumentation that can be reached by students. (Dwiretno 2018) in his thesis obtained a conclusion through the one-way ANOVA test, the ADI model can practice the ability of scientific argumentation tests and student performance to reach level 3.

CONCLUSION

This study shows the results that scientific argumentation of students is at level 2 and critical thinking of students is at the level of being. On average students provide good claims and evidence. However, students are not correct in conveying their argumentation support to strengthen the claims and data that students have conveyed. In Pearson's correlation test, scientific argumentation skills on critical thinking skills have a great relationship. Therefore, it can be recommended that learning related to

argumentation can be applied so that students have excellent critical thinking skills.

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APPENDIX

3.12.2. Analyzing the Symptoms of Global Warming

3. The sinking of the island of Sumatra

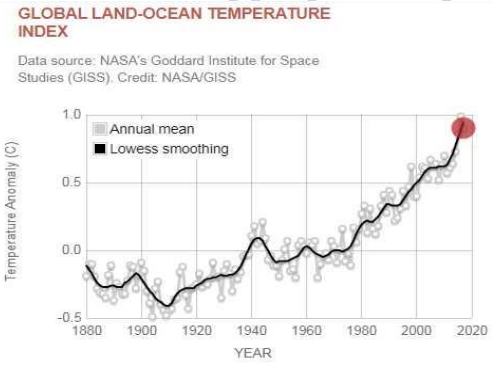
Picture 4. The sinking of the island of Sumatra

Palembang - The Forum for the Environment (Walhi) of South Sumatra, said four islands in the region are threatened with disappearing or sinking by 2020. According to him, four islands in South Sumateta are threatened with a disappearance that is because overall every year the water continues to soak the island during high tide. "Like Bird Island, Salah Island, Kalong Island, Keramat Island threatened to disappear this year (2020)," he said in Palembang, Tuesday (14/1).

He explained, in 2019, it was noted that two islands in his territory had been lost due to rising water levels. "Now, if last year (2019), there were two islands that were lost. The two islands are Betet Island which has a land elevation of -1 masl and Gundul Island -3 masl, "he added.

a. What can you conclude in the picture above?
b. Which evidence/data can you use to support the conclusions above?
c. What caused the event?
d. What will happen if this continues?
e. Is this related to the melting of the poles in the north?

4. Sea level rise



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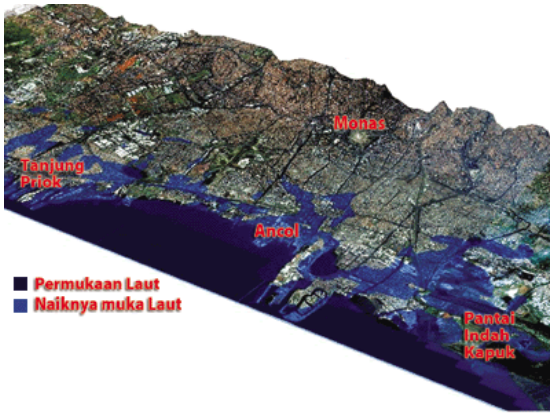
Picture 5. Temperature Land-Ocean



Picture 6. Jakarta Maps

"Global warming has resulted in rising seawater. In Jakarta, 5 to 8 millimetres a year. This is serious for the future. It is estimated that in the next few years the next 25 years, more than 2000 islands will sink.

a. What conclusions can you draw by looking at the first picture above?
b. Which data can support the conclusions you have made?
c. From the second picture, what did you get?
d. What assumptions can you use to emphasize point c?
e. What is the relationship between the rising Earth's surface and rising sea levels?

3.12.5. Explain Innovative Alternative Solutions to Solve Global Warming Problems

9. Efforts to Overcome the Drought Performed by various Worlds

Picture 7. Millions of Black Orbs in Reservoirs

Summer is sweeping and in some areas experiencing drought, including in other hemispheres in Los Angeles, America. To overcome this problem, the government released 96 million shade balls to be distributed to Los Angeles reservoirs, and these balls are just plain black balls that can float in water.

a. What conclusions can you get from the picture above?
b. Which evidence/data can support point a?
c. Do you think that can prevent the drought that is happening?
d. What is the process for this activity to reduce drought?
e. Explain the process of evaporation that makes it rain?

10.

Picture 8. Different Road Conditions

a. What can you conclude in the picture above?
b. Which evidence/data do you use to support the conclusions above?
c. Is this a solution to the traffic jam?
d. Does it have an impact on improving the temperature of the Earth?
e. How do you get people to do that?