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Scientific Argumentation Profile of Senior High School Students

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Abstract

This study aimed to describe students' scientific argumentation at the senior high school level. This study used a descriptive method and a test to assess the scientific argumentation of 49 students, consisting of eight questions from two themes. We used four components of scientific argumentation: students' ability to make claims and warrants, students' ability to construct counterarguments, students' ability to generate supportive arguments, and student's ability to generate evidence from Lin and Mintzes (2010). We quantified the qualitative data from students' answers and analyzed the data using descriptive statistics. The results showed that the scientific argumentation of senior high school students was 33% in the good category, 31% in the satisfactory category, 22% in the need improvement category, and 14% in the unsatisfactory category. For each component, 95% of students can make claims and warrants, 54% of students have the ability to construct counterarguments, 48% of students can generate supportive arguments, and 98% have the ability to generate evidence. So, the teacher needs to improve students' scientific literacy so students can give the argument with good references.

Keywords: Scientific argumentation, Profile, Senior high school students

INTRODUCTION

Scientific argumentation for understudies at the senior high school level is basic, and science education emphasizes what understudies know and how and why they know (Reiss et al., 1999). Scientific argumentation roles for expressing students' opinions, making decisions, and solving problems in daily life (Songsil et al., 2019). The scientific process skills that understudies create as a result of locks in in argumentation exercises can offer assistance understudies to create an understanding of the nature of science (Dawson & Venville, 2010). The National Research Council (NRC, 2012) recognized locks in in contention from prove as one of the eight basic logical hones understudies ought to involvement in K-12 science instruction. The European Union formally prescribed joining scientific argumentation as a critical competency for lifelong learning (European Union, 2006).We need more information on the students' scientific argumentation profile to determine the strategy to support the improvement of scientific argumentation.

In Indonesia, scientific argumentation is closely related to an imperative issue in later a long time, specifically 21st-century skills. Scientific argumentation fortifies the method of a claim by focusing on the ability to precise ideas and concepts around scientific phenomena in standard of living based on prove and their connection to existing hypotheses. 21st-century

skills are defined as competencies and skills that students should have to survive and have qualified skills and ethics for the world of work and citizenship in the 21st century, which emphasizes seven skills. The seven skills include; critical thinking skills and problem-solving skills, adaptability and agility, leadership, having initiative and entrepreneurial spirit, being able to communicate well orally and in writing, being able to access and analyze information appropriately and reasonably, and having curiosity and imagination skills (Wagner, 2010).

There are previous studies of scientific argumentation in Indonesia. Suraya et al. (2019) examined senior high school students' scientific argumentation and critical thinking skills through debate methods on biodiversity material. The result showed that students' scientific arguments and critical thinking are low at one of the schools in Kepulauan Riau. Rahmadhani et al (2020) also researched to determine the ability of scientific argumentation and to describe the profile of students' scientific argumentation ability based on indicators. The results showed that students' scientific argumentation abilities on additive and addictive substance material for junior high school at Salatiga were included in the very good (8%), good (49%), sufficient (35%), and not good (8%) categories. Profile of students' scientific argumentation abilities based on indicators sequentially from high to low are claims (average score: 2.68), rebuttal (average score 2.4), data (average score 2.24), and warrants (average score 1.33). Based on observation at one of the senior high schools in Banten, Indonesia, teachers focus on students' cognitive aspects, and students need more tests to explore their abilities. We need more information of the scientific argumentation profile of students to know the status of scientific argumentation in Indonesia. So, the teacher could determine a good strategy or approach to improve students' scientific argumentation related to 21st-century skills.

METHOD

This study uses a qualitative approach that is quantified, so the research method used is descriptive. The sample used was 49 high school students in a district high school in Banten, Indonesia. This study focuses on scientific arguments using issues related to the concept of biology subjects, namely the issue of the keto diet and warning graphic labels on cigarette packs. The scientific argumentation data is captured using tests with each issue consisting of four questions from four components from Lin and Mintzes (2010), such as students' ability to make claims and warrants, students' ability to construct counterarguments, students' ability to generate supportive arguments, and student's ability to generate evidence. The reference for using the score on a scale of four can be seen in Table 1, which was determined based on reference to Mardapi (2008), whose categories were adjusted to NCTE (2006), such as Good,

Satisfactory, Need improvement, and Unsatisfactory. Data were analyzed using descriptive statistics, which were then described by events in the field. In addition, each component of scientific argumentation is also analyzed.

Table 1. Conversion of scores into four scale

Formula	$X \geq \overline{X} + 1.Sbx$	$\overline{X} + 1.Sbx > X \geq \overline{X}$	$\overline{X} > X \geq X - 1.Sbx$	$\overline{X} \geq X - 1.Sbx$
Interval	X ≥ 2.67	2.67 > X > 2	2 > X > 1.33	X < 1.33
Category	Good	Satisfactory	Need improvement	Unsatisfactory

Information:

X = student score

X = average student overall score = 1/2 (ideal maximum score + ideal minimum score)

Sbx = standard deviation of the overall score = 1/6 (ideal maximum score – ideal minimum score)

RESULTS AND DISCUSSION

The results in Figure 1 showed that the scientific argumentation of senior high school students from 49 samples is 33% in the good category, 31% in the satisfactory category, 22% in the need improvement category, and 14% in the unsatisfactory category. It means that 64% of students have scientific argumentation skills, such as the ability to make claims and warrants, the ability to construct counterarguments, the ability to generate supportive arguments, and the ability to generate evidence. Based on the answers from students, there are for students easy to say agree or disagree but too hard to construct arguments or counterarguments. They are too difficult to give a scientific and systematic explanation. This is in line with Golanics & Nussbaum (2008) state that students were challenged to compile arguments or counterarguments due to low knowledge and social issues. Many students also avoid disagreements and exploration of counterarguments (Koschmann, 2003). This finding shows that science teachers need to use various learning, such as the socio-scientific approach. The socio-scientific approach could be a consider that contains social situations and talks about which rise in parallel with the headways in science and innovation and pass on moral and ethical implications at the center (Sadler & Zeidler, 2005). Socio-scientific issues moreover have a scientific base; delineating controversial issues and containing political and social measurements are considered a few of the characteristics of socio-scientific issues (Sadler & Dawson, 2012).

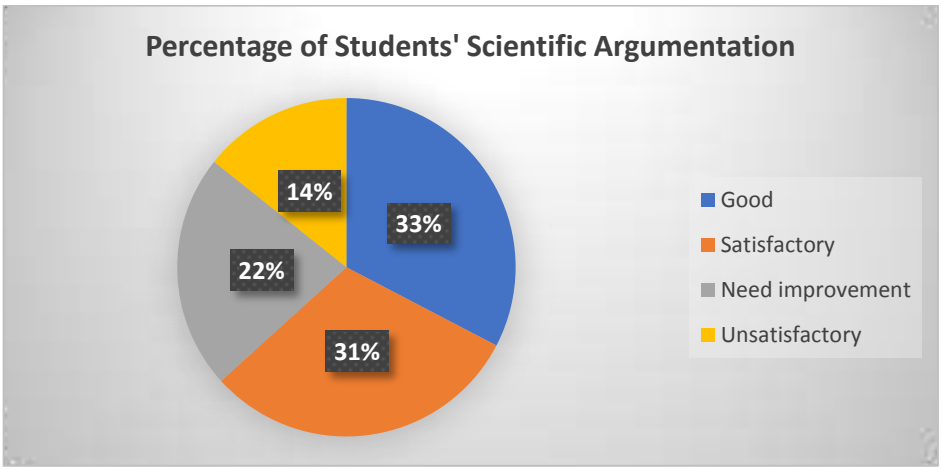

Figure 1. Percentage of students' scientific argumentation

We analyzed each component to make the scientific argumentation skills of students more straightforward, and it can be seen in Figure 2. 95% of students can make claims and warrants. They are so easy to make claims and warrants. 54% of students have the ability to construct counterarguments. From the answers, students construct counterarguments by themselves using their experiences. 48% of students have the ability to generate supportive arguments. In this component, the answers from students are very short and limited arguments. Only 45% of students have the ability to generate evidence. Students need help to give evidence from good references such as articles, books, or others. It also means scientific literacy of students is very low. Students in this area are especially limited in using scientific sentences derived from learning outcomes or the surrounding environment. This indicates that their knowledge still needs to improve, especially related to scientific concepts such as the dangers of smoking and diet patterns. Teachers have to stimulate students' scientific argumentation skills that focus on the ability to construct counterarguments, generate supportive arguments, and generate evidence. Several strategies to stimulate and improve scientific argumentation skills such as, Socio-scientific issues Online-Argumentation Pattern (SOAP) (Tsai, 2018) and Modified Argument-Driven Inquiry (MADI) Strategy (Ping et al, 2019) that implemented at senior high school level. Sari & El Islami (2020) found that SOAP and MADI contribute to enhancing scientific competencies, sustainability attitudes, science process skills, practical skills, and experimental planning. Engelmann et al. (2016) state that scientific reasoning and scientific argumentation use evidence and communicates and scrutinize the results of a scientific discovery process.

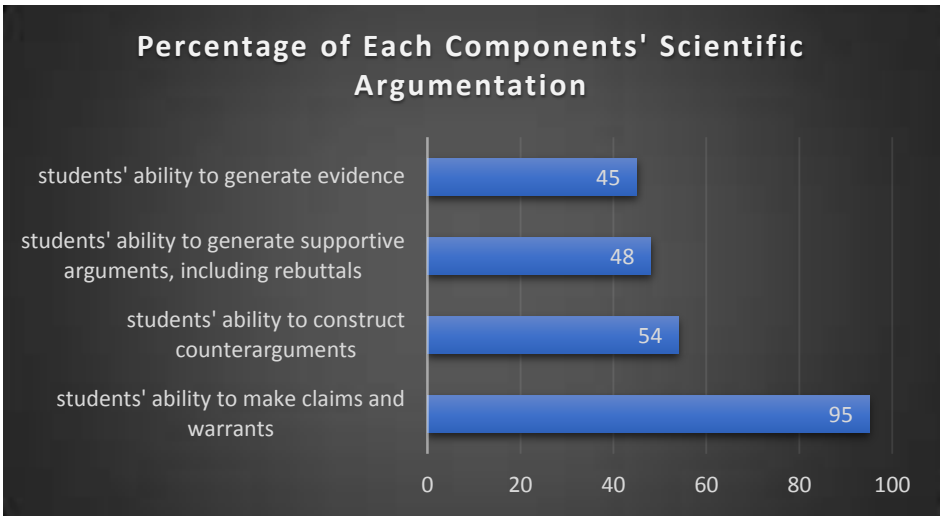

Figure 2. Percentage of each component's scientific argumentation

In addition to paying attention to approaches that can improve students' scientific argumentation skills, teachers need to touch on psychological aspects such as students' interest and motivation toward their desire to read and study science. According to Ryan and Deci (2020), basic psychology, such as intrinsic and extrinsic motivation, need satisfaction and support from teachers. Renatovna and Renatovna (2021) also state that students' interest is one of the psychological aspects essential to improve students' intellectual potential. On the other hand, students need to get directions that science is essential for daily life, with the facts and alternative solutions to solving problems in the surrounding environment. Several ways to give advice that science is necessary, such as implementing integrated science instructional material (Asrizal et al., 2018), giving worksheets based on scientific literacy (El Islami et al., 2019), and implementing model-based integrated inquiry in science, technology, engineering, and mathematics (MII-STEM) (El Islami et al., 2021).

CONCLUSION

Based on the results and discussion, the scientific argumentation of senior high school students is 33% in the good category, 31% in the satisfactory category, 22% in the need improvement category, and 14% in the unsatisfactory category. For each component, 95% of students can make claims and warrants, 54% of students can construct counterarguments, 48% have the ability to generate supportive arguments, and 98% of students have the ability to generate evidence. This study implies that science teachers have many challenges in improving students' scientific argumentation skills, starting from giving the motivation, and implementing a learning approach and worksheet or assessment to improve students' scientific literacy so that students can provide the argument with good references.

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