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Analysis of The Students' Argumentative Skills of Senior High School in Covid-19 Pandemic using Problem Based Learning in Static Fluid

Wahdania Eka Putri[1*], Widha Sunarno[1], Ahmad Marzuki[1]

[1] Physics Education of Post Graduate Program, Universitas Sebelas Maret, Surakarta, Indonesia

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Abstract: This study aims to describe and analyze the students' argumentative skills in the subject of static fluid using the PBL model with the experimental method, after the lesson is given to students. This type of research is descriptive research.The subjects of this study are 34 students of XI MIPA 2 class of SMAN 1 Tanggul. The sampling technique used in this study was simple random sampling. The data was collected by using an essay question consisting of 8 questions which have been adjusted to the indicators of argumentation ability which include; argument evidence, counter argument evidence, refutation evidence, argument justification, counter argument justification, and rebuttal justification. The data analysis of this research used a descriptive approach by calculating the score. The results showed that the average argument evidence indicator is 1.5 with the high category, the counter argument evidence is 1.5 with the high category, the refutable evidence is 1,4 with the high category, the argument justification is 2.1 with the high category, the justification the counter argument is 2.1 with the high category, and the rebuttal justification is 2.1 with the high category. Based on the research that has been done, it can be concluded that the students' argumentative skills on each measured indicator are high.

Keywords: Argumentative Skills; Problem Based Learning; Static Fluid

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Introduction

The development of science and technology has a very broad impact on human life, one of them are education's field. Education is required to be able to produce human resources who have complete competence known as 21st century competence. The 21st century is a century that prioritizes human quality in all efforts and work results. The demands of the 21st century cause schools around the world to come closer to learning designs that can support student success in the 21st century. The 21st century skills are placed into three categories, they are, *Learning and innovation skills*, which consist of communications and collaboration, creativity and innovation, critical thinking and problem solving (Trilling & Fadel, 2009). The characteristics of humans who have successfully faced 21st century abilities are people who have problem-solving abilities, critical thinking skills, argumentation skills, cooperation skills, contextual learning abilities, media literacy skills, and information technology literacy. This ability can be achieved through well-prepared and appropriate learning, where students are involved in learning activities to understand the material being studied, not just memorizing. The success of a lesson is influenced by the learning process that implemented. The main part of the learning process includes formulating questions, describing mechanisms, and building arguments. In solving problem, it must provide an argument and concrete evidence, besides that argumentation is also very important for scientific practice (Osborne et al., 2004).

Email: wahdaniaputri28@student.uns.ac.id

The demands of the 21st century require students to improve and develop 21st century skills and abilities, one of them is argumentation skills. Argumentation is important for developing skills to analyze and engage in arguments that can construct scientific explanations, and develop critical skills and evaluate various alternatives (Osborne, 2005). The process of associating an idea with the right reasons and according to the available data is called argumentation (Toulmin, 2003). Individual justification of their ideas by using persuasive evidence that is used to convince others about the truth of the ideas they propose is described an argumentation. Argumentation refers to a person's ability to think about scientific topics like they are a scientist by expressing thoughts in written or oral form (Saracaloglu et al., 2011).

The argumentation process as "predictive construction". According to this definition, producing structure by connecting terms and concepts from simple thought to certain conclusions is considered a creative process (Driver et al., 2000). Meanwhile statement accompanied by reasons whose components include Claims (conclusion, proposition, or statement); Data (evidence supporting claims); Evidence (explanation of the link between claim and data); Support (basic assumptions that support the evidence); Qualification (condition that the claim is true); Last, Disclaimer (conditions that invalidate the claim) is called argument (Toulmin, 2003).

In accordance with the demands contained in the 2013 curriculum, that be able to produce creative, innovative, affective, and productive human resources in Indonesia through strengthening integrated knowledge, attitudes and skills, therefore students are required to be able to increase their level of knowledge and abilities in every subject in the school. One of the efforts to develop high-level abilities is to develop problem-solving and critical thinking skills. The activity of putting forward an argument, where a person must collect facts to show an opinion or something is said to be true or not through argumentation, so that the argument must have a basis, namely thinking and being logical (Marhamah *et al*., 2007).

Argumentation is very important in the world of education. The argument includes four aspects, namely claims, evidence, reasoning (reason), and rebuttal (rebuttal) (McNeill et al., 2006). Although scientific argumentation is very important for students, it is still rarely included in learning physics in class (Nur & Susantini, 2015). Students have a lot to learn about the types of *claims* that must be made, how to develop these claims, what evidence is needed, and how to put these components together and how to interpret them (Sandoval & Reiser, 2004). Students are often asked to collect data and then understand a phenomenon based on that data when they are involved in scientific argumentation in class, research shows that this aspect of scientific argumentation is often difficult for students (Sampson et al., 2011). The ability of scientific argumentation has been applied to several physics lessons such as thermodynamics (Sudarmo et al., 2018), measurement (Mubarok et al., 2016), heat (Putri, 2018), and Newton's law (Muliardi et al., 2018). But from several findings, the results showed that the argumentation ability was in the low category. Penelitian yang dilakukan dilakukan di salah satu SMA Kabupaten Pemalang berjumlah 33 orang. It was found that only 25.19% and 26.31% of the samples had the ability to argue scientifically on the aspects of backing and warrant (Mubarok et al., 2016). The low skills of students' scientific argumentation caused by lacking of excercising to argue scientifically (Mahardika, 2015). The weakness of students' argumentation skills can be due to supporting evidence that may not have been sufficiently developed and students may not recognize or respond to alternative points of view (Ferretti *et al*., 2000).

Students need to develop several important things related to understanding and the ability to be able to participate in scientific argumentation. First, an individual must be able to use important conceptual structures (eg scientific theories, models, laws or concepts) and cognitive processes when reasoning about a topic or problem. Second, an individual must know and use the epistemic framework that characterizes science to develop and evaluate claims. Third, the most importantly, individuals who engage in scientific argumentation must understand and be able to participate in the social processes that shape how knowledge is communicated, represented, argued, and debated in science (Duschl, 2008).

Argumentation is one way that can be used to strengthen students' scientific concepts. Argumentation has a dual function, which is to help students discover unthinkable aspects of interactions and to support increased student thinking. Students can be said to be successful in learning the students understand and understand the concepts that are concepts by the teacher. According to Pratiwi et al., (2019) Good understanding of concepts can improve student skills such as remembering, finding facts, applying, analyzing, and expressing new concepts in other ways. However, most teachers only focus on mathematical solving rather than understanding concepts. One of the learning models that can improve students' conceptual understanding is the learning-based learning model (PBL). The PBL model encourages students to do scientific filling in order to acquire scientific knowledge. One way to improve students'

understanding of concepts is by applying the experimental PBL learning model.

The ability to argue using the Problem Based Learning (PBL) model obtained data, namely the students' argumentation skills had increased in every aspect (Pritasari, 2016). Mubarok et al., (2016) also stated in their research that the ability of argumentation was a significant effect on student learning outcomes.

Teachers must develop and improve their abilities in teaching argumentation so that teachers and schools must carry out appropriate learning activities, design positive learning environments, and provide argumentation models that can foster their students' argumentative skills (Maloney & Simon, 2006).

The problem-based learning model (PBL) is learning that involves problems whose solutions require students to practice analytical, application, and integration skills (Kendler and Grove, 2015). Wulansari *et al*, (2018) suggest that PBL is a learning model in which students are required to learn by solving problems that are given as a stimulus to encourage student curiosity to study subjects and as a trigger in increasing knowledge and understanding of teaching materials. PBL aims to provide opportunities for students to argue through learning and interaction between students (De Simone, 2008). PBL encourages students to engage in information seeking activities, specific objectives that enable the integration of new knowledge with a broader understanding and experience.

Physics studies are focused on understanding rather than remembering because physics material is not only about concepts but experiments, calculations, and graphical representations (Mustofa, 2016).

Problem Based Learning (PBL) has characteristics where students are faced with problems as the basis of learning. Arends (2012) argues that a good problem for PBL must contain 5 important things, namely: 1) authentic, 2) broad enough so that learning objectives can be achieved, 3) the problems discussed are deliberately made incomplete, thus triggering student confusion, 4) in accordance with the development of student knowledge, and 5) motivating students to try to find solutions to problems. Dewi (2016) revealed that PBL can provide flexibility for students to build their knowledge and find or apply their own creative ideas, so that they are more actively and creatively involved in the learning process.

Selection of the right learning model and method is very important to support the success of a learning process. Each method and learning model has its own strengths and weaknesses. Physics material taught in the classroom would be better if it is related to everyday life. Students will be better to understand a concept from the material being taught because students have or often encounter them in real life. A concept that raises problems in real life can be solved with a problem-based learning model, namely the PBL (Problem Based Learning) model. Static fluid teaching material discussed the concept of pressure, hydrostatic pressure, Pascal's law, and Archimedes law. Not a few student have their own opinion about the concept, about how things are in the water. The sate of the object in water will be in accordance with the archimedes law: An object that is completely or partially immersed in a fluid is lifted upward by a force equal to the weight of the displaced fluid (Tipler, 1998). Bouyancy occurs because the pressure in the fluid increases with the increase in the fluid. Thus, the upward pressure exerted on the bottom plane of the object entering the water will be greater than the pressure acting on the plane above the object.

This research is different from research in general, where researchers usually test directly or face to face with respondents. Due to pandemic conditions that made it impossible for face-to-face meetings, learning in this study was carried out online using several digital applications such as WhatsApp and Google classroom. This article will discuss students' argumentative abilities in static fluid subjects after being taught using the PBL model with the experimental method.

Method

This research is a descriptive study. This research conducted in October 2020 at SMAN 1 Tanggul Jember, East Java through online learning using Google Classroom and Whatsapp application. The population in this study are all students of class XI MIPA and the sample in this study is class XI MIPA 2 as many as 34 students. The sample selection technique used was simple random sampling. The method used in this study can be seen in figure 1.

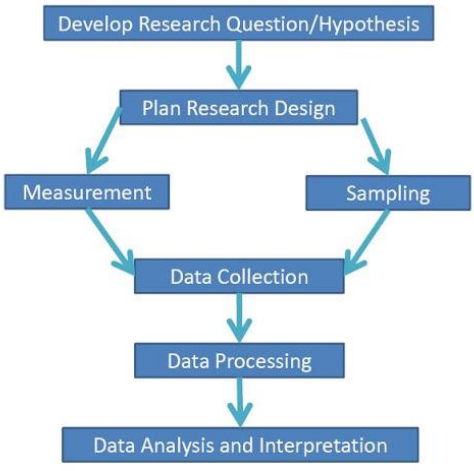


Figure 1. Research scheme

The data collection technique uses a test instrument for essay questions totaling 8 items with static fluid material that have been adjusted to the indicators of argumentation ability which include *argument evidence, counter argument evidence, rebuttal evidence, argument justification, counter argument justification,* and *rebuttal justification*. The research data which obtained will be categorized based on the argumentation ability criteria according to Supeno (2015). The argumentation ability criteria can be seen in the following table 1 and table 2. How to calculate the score on the ability of argumentation in the following way.

$$y = \frac{the\ number\ of\ scores\ obtained}{maximum\ score} \quad (1)$$

The data analysis technique for the argumentation ability uses the calculation of the scores obtained from the results of the students' work which are then categorized according to the argumentation ability criteria table.

Table 1. Achievement criteria a score of evidence of argument, counter argument, and rebuttal

No	Score Range	Criteria
1	0 ≤ x ≤ 0,4	Very low
2	0,4 < x ≤ 0,8	Low
3	0,8 < x ≤ 01,2	Medium
4	1,2 < x ≤1,6	High
5	1,6 < x ≤ 2	Very high

(Supeno, 2015)

Table 2. Achievement criteria score of argument justification, counter-argument, and rebuttal

No	Score Range	Criteria
1	0,5 ≤ x ≤ 1,0	Very low
2	1,0 < x ≤ 1,5	Low
3	1,5 < x ≤ 2,0	Medium
4	2,0 < x ≤ 2,5	High
5	2,5 < x ≤ 3,0	Very high

(Supeno, 2015)

Result and Discussion

The following are the result of students' answer to the question of argumentation skill.

Problem

Two students are discussing the sinking and floating behavior of an object. Below is their statement.

Student 1: The shape of an object affects the sinking and floating behavior of an object. Bowl-shaped objects will float while non-bowl-shaped objects will sink in a certain liquid.

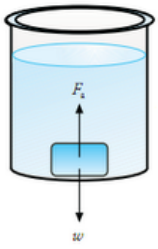
Student 2: The type of material affects the sinking and floating behavior of an object. Objects that have a lot of room in the inner structure will float. Meanwhile, objects that have less space in the inner structure will sink in a certain liquid.

To provide reinforcement of the opinions of the two students, there are several possible pictures to support their statements.

Observation

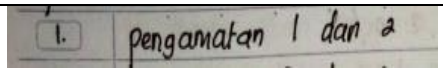
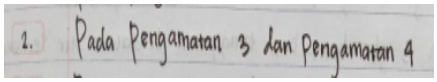
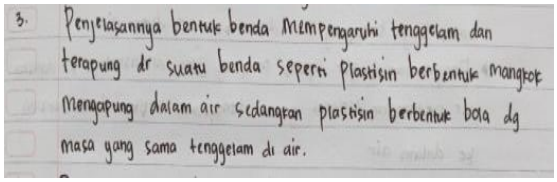
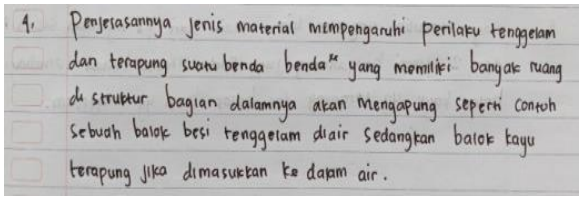
1. The bowl-shaped plasticine floats on the water while the spherical plasticine with the same mass sinks in the water

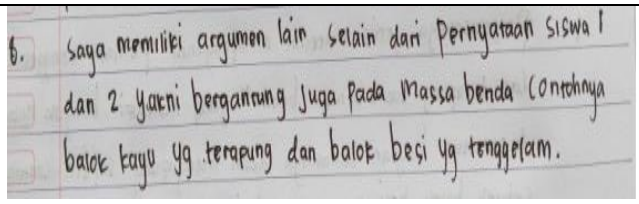
2. Ships made of iron float on the water. Meanwhile, the iron block sank in the water



3. An iron block sinks in the water. Meanwhile, wooden blocks float when put into the water

4. A sponge floats when put in water. Meanwhile, salt crystals sink when put into water.

Question	Answer
1. Which observations could student 1 use to support his statement?	 Observation 1 and 2
2. Which observations could student 2 use to support his statement?	 Observation 3 and 4
3. What explanation could student 1 use to strengthen his statement? (Based on the observations you have chosen to support student 1's statement)	 the shape of an object affects the sinking and floating of an object, such as plasticine in the form of a bowl floating in water while plasticine in the form of a ball with the same mass sinks in water.
4. What explanation could student 2 use to corroborate his statement? (Based on the observations you have chosen to support student 2's statement)	 the type of material affects the sinking and floating behavior of an object. objects that have a lot of space in the inner structure will float, for example, an iron block sinks in water while a wooden block floats when put into the water.
5. Which student statements do you agree with? (student statement 1 or student 2 statement), or do you have other arguments (opinions) ?, Explain your reasons based on the observations provided!	
6. Which student statements do you agree with? (student statement 1 or student 2 statement), or do you have other arguments (opinions)?, Explain your reasons based on the observations provided!	
7. If you agree with student 2's statement, provide a reason why you do not agree with student 1! 'S statement. Which pictures and observations do not specifically match student 1's statement?	

Question	Answer
8. If you have other arguments (you agree with both statements i.e. student 1 and student 2 or you disagree with both), explain your reasons! Which pictures and observations do not match your argument in student 1 and student 2's statements?	 I have another argument apart from the statements of students 1 and 2 which is also dependent on the mass of the object. for example, floating logs and sinking iron blocks.

Based on the results of the analysis, if students have other arguments then questions number 5, 6, and 7 do not need to be answered. The ability of argumentation consists of several indicators, namely argument evidence, counter argument evidence, rebuttal evidence, argument justification, counter argument justification, and refutation justification. Each indicator of the ability of the argument has its respective criteria for achieving a score as shown in Table 1 and Table 2.

The average score of the argumentation ability indicator can also be seen in Figure 2 below.

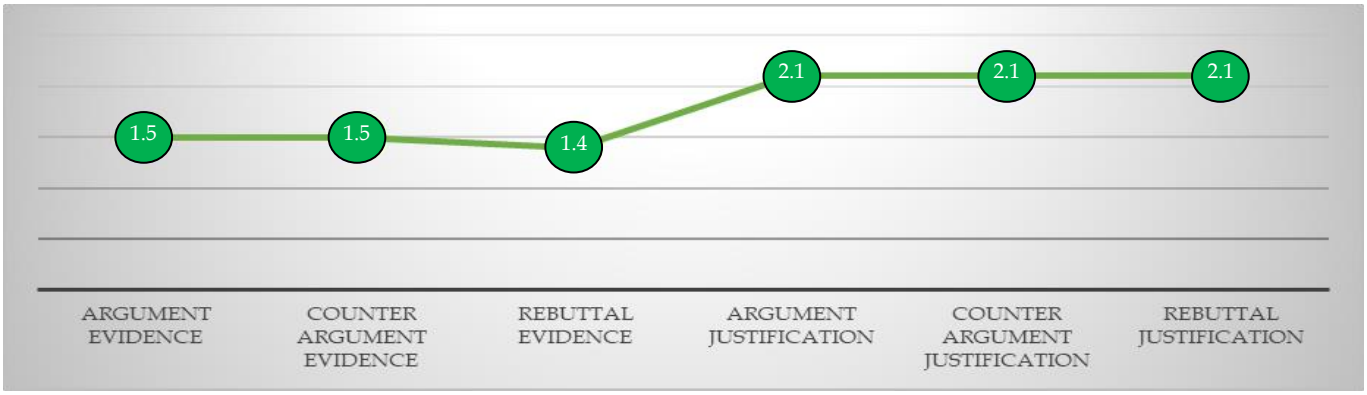


Figure 2. Graph of the average score of the argumentation ability indicator

Figure 2 Shows the results of research where the average argument evidence indicator is 1,5 with the high category, the counter argument evidence is 1.5 with the high category, the refutable evidence is 1.4 with the high category, the argument justification is 2.1 with the high category, the justification for the counter argument is 2.1 with the high category, and the rebuttal justification is 2.1 with the high category. These results indicate that the students' argumentative skills are good for each indicator. This success is achieved well because of the selection of the right model and method. Researchers used the PBL model combined with the experimental method, where students participated directly in proving a problem. The achievement of this success is inseparable from several obstacles, namely learning that is carried out online, unstable signals and practicum do virtually which makes students difficult which makes teachers need to provide more guidance to students. Sarira et al., (2019) in their research stated that the aspects of argumentation ability from high to low are rebuttal, claim, data, and warrant, respectively. In line with this study, Afisha et al. (2015) revealed that the PBL learning model can improve students' scientific argumentation skills. The grouping of the student's score achievement criteria can be seen in table 3 below.

Table 3. Argument score achievement criteria data

Indicator	Criteria				
	VH (%)	H (%)	M (%)	L (%)	VL (%)
Argument evidence	50	0	50	0	0
Counter argument evidence	56	0	44	0	0
Rebuttal evidence	47	0	53	0	0
Argument justification	0	26	74	0	0
Counter argument justification	0	20	80	0	0
Rebuttal justification	0	20	80	0	0

It can be seen from Table 3 that, the average *argument evidence* indicator achieved by students in Very High (VH) criteria is 50% and in the Medium (M) criteria is 50%; then indicators of the average *counter*

argument evidence achieved by students in Very High (VH) criteria is 56% and in the Medium (M) criteria, is 44%; then indicators of the average *rebuttal evidence* that achieved by students in the Very High (VH) criteria is 47% and in the Medium (M) criteria is 53%; the indicator of the average *argument justification* achieved by students in the High (H) criteria is 26% and in the Medium (M) criteria is 74%; the indicators of the average *counter argument justification* achieved by students in the High (H) criteria is 20% and in Medium. This research was conducted by applying the PBL learning model along with the experimental method. The PBL model has 5 stages according to Arends (2012), namely 1) orient student to the problem, 2) organize students for study, 3) assist independent and group investigation, 4) develop and present artifacts and exhibits, and 5) analyze and evaluate the problem-solving process. In stage 1 the teacher introduces the problem topic to students by reviewing the learning objectives, explaining the material needed, and motivating students to be actively involved in problem solving activities, then in stage 2 the teacher helps students organize in determining student learning tasks related to the problem, at this stage 3 teachers encourage students to collect relevant information to solve problems both individually and in groups, then in stage 4 the teacher helps students plan, report, and present solutions through various works to share information, and finally at stage 5 the teacher helps students reflect on the process of investigating and solving problems that students have done. When students are faced with problems, students are asked to solve these problems by collecting information through investigative activities or conducting experiments to prove and solve existing problems. The experimental method is used in this study to support students in carrying out investigative activities, besides that students who carry out direct practicum activities will make students' memory stronger and have a better understanding of the problems being solved. This is able to make students active in arguing activities because students experience and do practical work directly.

Conclusion

Based on the results of data analysis and discussion, it can be concluded that the average argument evidence indicator is 1.5 with the high category, the counter argument evidence is 1.5 with the high category, the rebuttal evidence is 1.4 with the high category, the argument justification is 2.1. with the high category, the counter argument justification was 2.1 with the high category, and the rebuttal justification was 2.1 with the high category. The application of the PBL model must be carried out with careful preparation, starting from learning instruments to data collection instruments. Due to the Covid-19 pandemic, So this learning is carried out online which requires teachers to be able to streamline the time when learning takes place. In applying the PBL model using the experimental method, the researcher should make the maximum preparation so that the results obtained are optimal.

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