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Enhancing Students' Scientific Argumentation Skills through STEM-Based Problem Based Learning

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Abstract

This study examines the efficacy of STEM-based Problem Based Learning (PBL) in enhancing scientific argumentation skills among students, focusing on respiratory system material. Employing a Quasi-Experimental Design, this research involved tests, observations, and questionnaires to assess the changes in students' scientific argumentation abilities. The study enrolled students from two classes, utilizing a purposive sampling technique to ensure comparability. Results indicated a significant improvement in students' scientific argumentation skills, with average scores increasing from 81.57% in the first meeting to 86.14% in the second meeting, categorized as very good. Additionally, statistical analysis revealed a notable difference between the experimental and control groups, with a p-value less than 0.05, confirming the effectiveness of the STEM-based PBL approach. The study suggests that integrating STEM into PBL can significantly enhance students' critical thinking and problem-solving skills, recommending wider application in educational settings to better prepare students for complex scientific challenges.

Keywords: *Problem Based Learning ; STEM ; Scientific Argumentation Ability*

INTRODUCTION

Learning through problems such as Problem Based Learning according to Giena (2017) has been shown to stimulate students' argumentation skills. Teachers can guide and direct discussions primarily directed to improve reasoning collaboratively. Through the teaching of problems, students are encouraged to provide a solution in solving problems, so that in the process of solving such problems students should discuss and communicate with their group to exchange opinions (argumentation) on issues presented related to everyday life.

The ability to think at a high level, especially the ability to argue, is one of the skills that must be enhanced in the development of science and technology in the 21st century. (Imaniar & Astutik, 2019). Argumentation skills are one of the things that can encourage students to participate in presenting facts, data, and theory to support claims about a problem (Rahayu et al., 2020). Learning argumentation in the classroom not only emphasizes that students put forward an opinion or idea, but also provides a strong reason for a given problem, as well as demands students to think critically, communicate, collaborate, and be creative. In order to be able to create arguments that can prove their truth and strive to improve their self-quality in the face of the era of the 4.0 industrial revolution. (Anita et al., 2019).

The National Education Association (NED) has defined 21st Century Skills as "The 4Cs." The "4Cs" include critical thinking, creativity, communication and collaboration. Sugyarti (2018) stated that in formal schools, learning has been demanded to apply 4C skills (Critical Thinking, Communication,

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Collaboration, Creativity). According to Husamah (2018) stated that as progress increases in the 21st century, the role of education is to prepare generations in mastering the skills they need to face the challenges of the time. Thought of topics, content and problems is done through analysis, evaluation and reconstruction (Papp et al., 2014). Based on various research results, the students' 4C (Critical Thinking, Communication, Collaboration, Creativity) competence is still low. According to the results of the Trends in International Mathematics and Science Study (TIMSS), critical thinking skills of Indonesian students are still at the bottom of the countries surveyed. (Purwati, 2016). Furthermore, based on the study conducted by Atminingsih (2016) students in learning Biology is still low that the average score of creative thinking ability is 25.5%. Based on the data, it is also seen that the students are still low ability to investigate, giving reason in various problems related to life situations.

So the improvement of high-level thinking skills especially the ability to argue on the competence of 4C (Critical Thinking, Communication, Collaboration, Creativity) in science is in fact also very necessary in the learning process. Based on the results of an interview with one of the biology teachers at SMAN 5 Cirebon on January 23, 2023, stated that students still have difficulty working on topical topics. Students have difficulty arguing and are unable to express their opinions to argue on a problem. Because this is what causes the student's biology learning process to be less active or passive. Then the teacher of biology at SMAN 5 Cirebon also stated that in the process of learning biology has also applied the learning model problem based learning to the material of the respiratory system but has not been integrated with other disciplines such as combined with science, technology, engineering and mathematics.

Based on this, one of the learning innovations that can be applied to improve the ability of scientific argumentation is STEM (Science, Technology, Engineering, and Mathematics) based Problem based learning. (Arends, 2007). STEM (Science, Technology, Engineering, and Mathematics) is learning based on the combination of many disciplines of science, technology, engineering/design, and mathematics. (Afriana et al., 2016). Argumentation plays an important role in developing critical thinking patterns and adding insights to a deep understanding of one or more ideas (Song and Deane, 2014). Argumentation is important to be developed in biology learning, it's because it can enhance thinking to test students' understanding. There are three reasons why argumentation is important in learning: (1) scientists use argumentation to develop and enhance their scientific knowledge, (2) society uses argumentation in scientific debate, and (3) students need to formulate arguments to strengthen their understanding. (Erduran, 2005).

The fact is that there are still many students who have difficulty in this, so learning should start to be directed to involve students in scientific argumentation as part of science (Erduran, 2006). One attempt to enhance students' argumentation skills is by applying a STEM-based PBL learning approach. The integration of STEM in PBL learning can direct students to solve a given problem in a group, so they can encourage students to collaborate and be responsible for their own work, as well as to master the management of discussions according to the situation of the respective groups. (Farwati et al., 2017).

Based on this, the STEM-based PBL implementation is learning that integrates science, technology, engineering and mathematics to solve the problems discussed in learning. Therefore, in this STEM based PBL students practice to see and analyze a problem from various fields.

Research Objectives:

Based on this, the STEM-based PBL implementation is learning that integrates science, technology, engineering and mathematics to solve the problems discussed in learning. Therefore, in this STEM based PBL students practice to see and analyze a problem from various fields.

1. analyze student activity in STEM-based PBL learning
2. analyze differences in improved argumentation ability of students in experimental and control classes
3. analyze students' responses in PBL-based STEM learning.

RESEARCH METHOD

The research method used is Quasi Experimental design where this method is a comparative research. Testing hypotheses means testing population parameters in the form of comparisons. This method was chosen because it was in line with the research objective to be achieved, namely to know the differences between a variable, i.e. the cognitive abilities and creativity of biological students with different treatment. (Sugiyono, 2016). The research design used was a pretest posttest control group design.

The population in this study is the entire students of XI grade IPA in State High School 5 Cirebon of 210 students. While the samples used in this research are students of Class XI IPA-5 and XI IPA-6. According to Sugiyono (2016) Purposive Sampling is a technique for determining samples based on certain considerations. As for the provision in sampling on this study is to choose classes with the same number of students.

The data collection technique in this study uses observation methods, question tests, and elevate student responses. The instrument used the STEM-based PBL activity observation sheet, the subject instrument to see differences in students' increased scientific argumentation capabilities, on the respiratory system material and the student's statement-shaped response lift to see students' responses related to the implementation of STEM based PBL models.

Data analysis techniques use judgment validator tests, elementary test tests including validity tests, reliability tests, difficulty levels and question differentiation. Then on statistical tests using SPSS 25.0 software that is using the N-gain test, the prerequisite test is the normality and homogenity test. Then the hypothesis was tested using independent T-Test samples and Mann-Withney U tests.

LITERATURE REVIEW

Problem Based Learning Model

Problem based learning, its use within higher levels of thinking, in problem-oriented situations, including how to learn problem-based learning, among other things, aims to help students develop thinking skills and problem-solving skills. Besides, problem-based research is also a learning that the recipient does by presenting a problem, submitting claims, facilitating research and opening dialogue. The problems studied should be consistent problems found by the students in everyday life. Problem-based learning allows to train students in integrating knowledge and skills simultaneously as well as applying them in relevant contexts (Wood, 2003). In brief, PBL is a pedagogical approach that enables students to learn while engaging actively with meaningful problems. Students are given the opportunities to problem-solve in a collaborative setting, create mental models for learning, and form self-directed learning habits through practice and reflection (Schmidt, etc, 2000 ; Norman, etc, 1992; Hmelo , Silver, 2004).

PBL as a pedagogical strategy appeals to many educators because it offers an instructional framework that supports active and group learning—premised on the belief that effective learning takes place when students both construct and co-construct ideas through social interactions and self-directed learning (Glasser, 1989; Pallinscar, 1998). Another study focusing on the self-study phase found that students who studied beyond the learning issues generated by the tutorial group during the initial problem analysis phase achieved better test results.

STEM

The STEM concept is a cross-disciplinary education approach that emphasizes integration between the four disciplines, Science, Technology, Engineering and Mathematic. The main objective is to improve students' understanding of scientific and mathematical concepts, as well as developing critical thinking, problem-solving, and collaborative skills. (Forawi, 2018; Widya et al., 2019). The STEM approach emphasizes the interaction between these four fields, enabling students to link concepts between different disciplines and apply their knowledge to real-world situations. It helps prepare them for the complex and rapidly growing challenges of the modern world, as well as opening up career opportunities in a range of industries that rely on science, technology, engineering, and mathematics. (Soomro 2019; Khadri 2022).

As a trend that is being widely implemented in the world of education, STEM is a solving approach to real-life issues by directing the student's mindset as either a thinking scientist or engineer. The purpose of thinking as a scientist or engineer is not just to prepare students to become scientists or engineers, but in the real world can be problem solvers, innovators, inventors, logical thinkers, and build independence. (Narendranath & Allen 2023). There are many ways to integrate STEAM, including implementing a problem base learning model. STEM PBL facilitates the integration of content from many naturally different subjects in line with the focus of science, technology, engineering, and mathematics (STEM)(Perry, & Hong 2023). The integration of STEM in PBL learning can direct students to solve a given problem in a group, so they can encourage students to collaborate and be responsible for their own work, as well as to master the management of discussions that are appropriate to the situation of each group. (Farwati et al., 2017).

Scientific Argumentation

Scientific argumentation is the process used by scientists to build, defend, and compile arguments based on evidence and logical reasoning. (Apriyanti & Sumira 2020; Hoti & Muka 2017). It is one of the key aspects of scientific practice and forms the basis of systematic scientific research. In the field of scientific research, argumentation plays an important role in building, defending, and regulating ideas based on evidence and logical reasoning. It allows scientists to present their findings, analyze data, and draw conclusions systematically and persuasively. (Huang & Archer 2017). This process ensures that scientific knowledge is based on strong evidence and can survive the supervision of the scientific community. In addition, scientific argument cultivates critical thinking skills and encourages open dialogue and collaboration among scientists. By engaging in scientific argumentation, researchers can challenge existing theories, propose alternative explanations, and contribute to the advancement of scientific knowledge. (Siswanto et al., 2017).

This study uses the argumentation component according to McNeill & Krajcik (2011) which has four components of argumentation, namely: Claim, Evidence, Reasoning, and Rebuttal. Claims can also be interpreted as statements of what has been understood or as conclusions that have been reached from investigations or read texts. Evidence is an information-supporting data to support a claim that comes from a source that can be observed in the same way by anyone and features can be constantly observed. Reasoning is an explanation of how evidence supports a claim and invites or convinces others that the evidence used can support the claim. Rebuttal can also be interpreted as evidence that denies or contradicts the claim.

RESEARCH METHOD

The methodology adopted for this research is a Quasi-Experimental Design, chosen to facilitate a comparative study between two groups—experimental and control—to evaluate the effectiveness of STEM-based Problem Based Learning (PBL) in enhancing students' scientific argumentation skills. The Quasi-Experimental Design allows for pre- and post-intervention comparisons to determine the efficacy of the educational interventions without random assignment to groups. This design is particularly suitable for educational settings where random assignment may be impractical or unethical.

The subjects of this study were selected from State High School 5 Cirebon, focusing on two classes of eleventh-grade science stream students (Class XI IPA-5 and XI IPA-6), involving a total of 210 students. A purposive sampling technique was utilized to choose these specific classes due to their comparable characteristics in terms of student numbers and baseline academic performance. This method ensures that the samples represent a population that shares similar attributes relevant to the study, thus controlling for potential confounding variables.

Data collection was carried out using multiple techniques to obtain a comprehensive understanding of the impacts of the intervention. These included standardized tests to measure changes in scientific argumentation skills, observations to gauge student engagement and interaction during lessons, and questionnaires to assess students' perceptions and responses to the STEM-based PBL approach. The observation instruments were specifically designed to track active participation and problem-solving approaches during the sessions.

Analysis of the collected data was performed using various statistical tools provided by SPSS software, version 25.0. The analysis included validity tests, reliability assessments, and the calculation of difficulty levels and differentiation among test items. The hypothesis testing involved comparing pretest and posttest scores using Independent T-tests and Mann-Whitney U tests to ascertain statistically significant differences between the control and experimental groups. Furthermore, the N-gain score calculations were used to quantify the magnitude of improvement in students' argumentation skills, offering insights into the educational impact of the STEM-based PBL model.

This methodological framework aims to robustly test the research hypothesis that STEM-based PBL enhances scientific argumentation skills, providing a structured approach to examine the educational benefits of this interdisciplinary learning model in a real-world classroom setting.

FINDING AND DISCUSSION

Student learning activities with STEM-based PBL implementation on respiratory material

Student learning activity is observed using observation sheets at the time of teaching learning activities. This observation activity aims to measure student activity during learning performance. The following is a graph of student learning activity by applying a Problem Based Learning model based on Science, Technology, Engineering and Mathematics (STEM) to each aspect or evaluation indicator at each meeting**.**

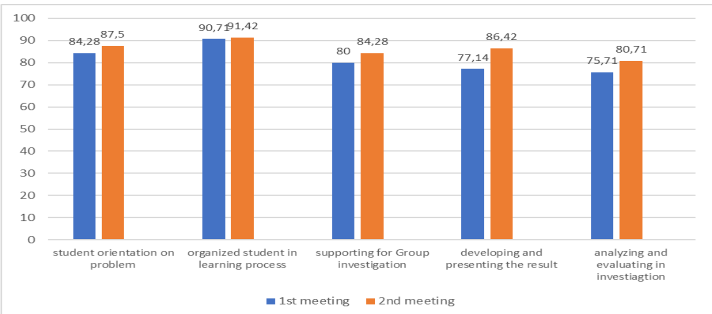

Figure 1: Student Activity

Figur 1 shows student learning activity at the first meeting and second meeting by applying a Problem Based Learning model based on Science, Technology, Engineering and Mathematic (STEM). Based on the results of the observation sheet at first meeting there are indicators that have achieved the highest presentation score of 90,71% on indicator 2, with very good criteria. Then the second highest score is on indicator 1 (orienting students to problems) with a presentation of 84.28% with a very good category. Then the student's learning activity on indicator 3 (supporting the investigative group) has a presentation of 80%, on this indicator the student performs a survey of the tasks given by the teacher. Then the result of indicator 3, is continued on the indicator 4 (developing and presenting the results of the discussion), where it obtains the presentation of 77.14% and indicator 5 (analysing and evaluating the research process) the indicators obtain the lowest presentation score compared to other indicators is 75.71%. It can be concluded that in indicators 3, indicators 4 and indicators 5 have good categories.

Students' learning activity at the meeting of the second meeting was the indicator that obtained the highest presentation score of 91.42% on indicator 2 (organizing students in learning) with excellent criteria. This indicator 2 determines the attitude of students in classroom learning, where students are required to be more active when Learning is ongoing. Then the second highest score obtained is on indicator 1 (orienting students to problems) with a presentation of 87.85% with a very good category. Then the student's learning activity in indicator 3 (supporting the investigation group) has a presentation of 84.28%, on this indicator students conduct a survey of the task given by the teacher. Then results of indicators 3 are continued on the indicator 4 (developing and presenting the results of the discussion), where they obtain presentations of 86.42%. and indicator 5 (analysing and evaluating the research process) such indicators obtain the lowest presentation score compared to other indicators of 80.71%. It can be concluded that in indicators 3, indicators 4 and indicators 5 have good categories.

Based on the results of the remaining learning activity overall it can be concluded that the student activity in the learning activity with the Problem Based Learning model based on Science, Technology, Engineering and Mathematic (STEM) on the material of the respiratory system in each indicator has a very good category because it achieves an average presentation of 81.57%.

The following is a graph of student activity in general at the time of implementation or application of the Problem Based Learning model based on Science, Technology, Engineering and Mathematics (STEM):

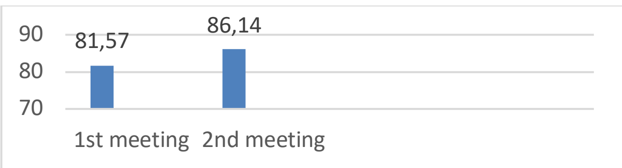

Figure 2: The average of student activity

Figure 2 shows the student's learning activity in general in the experimental class, the observations that have been made on the learning process by applying the Problem Based Learning model based on Science, Technology, Engineering and Mathematic (STEM) obtained variable results. However, the learning activity of students in the first and second meetings is in the very good category, where the presentation of student activity at the first meeting was 81,57% while at the second meeting was 86,14%. Based on the above data, it can be concluded that the application of the learning model done to the learning process by applying the Problem Based Learning model based on Science, Technology, Engineering and Mathematic (STEM) can improve student learning activity in particular in the activity of orienting students to problems, organizing in learning, supporting research groups, developing and presenting the results of discussions and rationalizing and evaluating the research process.

Students' differences in scientific argumentation ability between experimental and control classes

The differences in increased scientific argumentation of the students studied have a reference on the aspects of scientific arguments. In this study there are four indicators of scientific argumentation used: claim, evidence, reasoning and rebuttal. Below is a graph of the pre-test average value of each indicator of scientific argumentation :

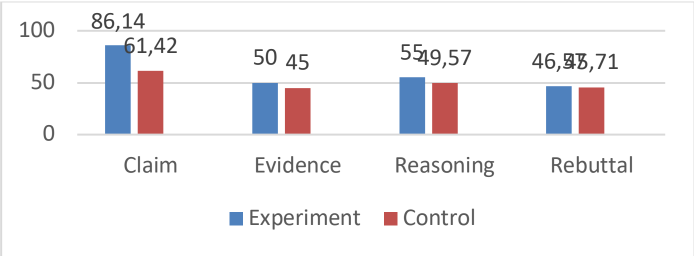

Figure 3: Average value of the pre-test indicator of scientific argumentation ability of the experimental class and the control class

Description :
Claim : First statement answering a problem
Evidence : Scientific data supporting a statement
Reasoning : Consideration explaining a problem
Rebuttal : Disagreement is an argument against the statement

Figure 3 shows the result of the pretest of the experiment class is that the highest average pretest value lies in the Claim aspect whereas the lowest pretest average value is in the Rebuttal aspect. Then the average pre-test of the controlling class, in the aspect of the claim also achieves the higher average value and the aspect of the rebuttal obtains the lower average value. Below is a graph of the average value of each posttest indicator of scientific argumentation:

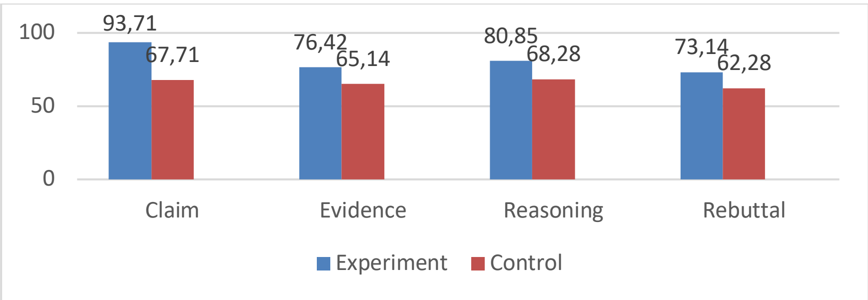

Figure 4: Average posttest values per scientific argumentation ability indicator of experimental class and control class

Based on Figure 4, the highest posttest average for experiment class and control class is in the Claim aspect, whereas the lowest average posttest value is in rebuttal aspect. Thus, it can be concluded that the mean posttest class and the counter class for each aspect of scientific argument is Claim > Evidence > Reasoning > Rebutal. Based upon these data, it may be inferred that the average post test value for experimental and control classes has increased from the average pre-test value.

Based on the figure 4.7, the students of the experimental and control classes obtained an average of 59.39 for the middle class, whereas the control class received an average score of 50.6 for the medium class. As for the average of the posttest students' scientific argumentation skills in the experiment and control class, there was an improvement. The improvement achieved by the experiment class was higher compared to the control Class, where the experiment classes received the average rating of 81.1 for the high category, while the control classes experienced an increase of an average value of 65.82 for the moderate category.

Below is a graph of N-gain scientific argumentation capabilities of experimental classes and control classes in general:

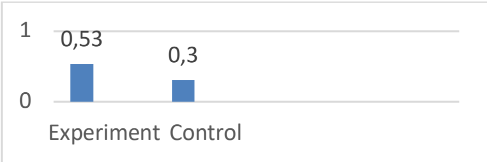

Figure 5: N-Gain values of scientific argumentation ability of experimental classes and control classes in general

Based on Figure 5, it is known that experimental class has experienced a higher improvement in scientific arguments than the control class. The experimental class obtained a N-gain score of 0.53 which means that it belonged to the medium category. The comparison of the two N-gains is the average N-gain of each class.

In the experiment class, the highest N-gain score is the first indicator and the lowest is the fourth indicator, whereas in the control class the higher N-gain value is the third and lowest the third indicator. Based on the achievement of the N- gain value, it can be concluded that N-gain in the experimental class can be written with the average Claim > Reasoning > Evidence > Rebuttal, and in the controlled class has the average Reasoning > Evidency > Rebuttal > Claim. The data used in the statistical test is N-gain data to determine the improvement of the student's argumentation skills between the experimental class and the control class.

The results of the hypothesis test differences in the scientific argumentation ability of students in the experimental class and the control class are presented in the following table:

Table 1: Results of the N-Gain Hypothesis Test

		Levene's Test for Equality of Variance		t-test for Equality of Mens		
		F	Sig.	t	df	Sig. (2-tailed)
n_Gain	Experiment	6,009	,017	7,818	67	.000
	Control			7,869	57,184	.000

Table 1 shows the results of the hypothesis test from N-Gain data in general. The significance value of N-Gain based on the T-Test result is 0,000 which means that Ho is rejected and Ha is accepted.

Student Response to STEM-based Learning Model Implementation

Students' response to learning implementation using a Science, Technology, Engineering and Mathematic (STEM) based Problem Based Learning model can be measured using quosioner. The average presentation of the highest positive statements against learning using the STEM-based Problem Based Learning model was 82.9% and the lowest was 77.1%. Then the average presentation of the greatest negative statements towards learning using STEM - based Problem Baseed Learning learning model was 69.3% and lowest 62.1%.

Based on the data, it can be concluded that biology learning by applying the Science, Technology, Engineering and Mathematic (STEM) based Problem Basing Learning model to the respiratory system language received a good response from students on the positive statement by obtaining very good criteria and negative statement obtained well criteria.

DISCUSSION

Students' learning activities with the application of Problem Based Learning based on Science, Technology, Engineering and Mathematics (STEM) require students to be more active in learning. Arends (2008) in his research stated that the learning model Problem Based Learning is learning that has the essence of providing a variety of authentic and meaningful problem situations to students. The role of teachers is to provide various authoritative laxities to demand the student's activity in solving such problems. As for the application of Problem Based Learning (PBL), learning will be done individually through the process of solving problems of everyday life that is integrated with the aspects of science, technology, engineering, and mathematics in each syntax or indicator of learning problem-based learning. Based on this discussion, it shows that the implementation of Problem-based Learning (PBL) based on Science, Technology, Engineering and Mathematics (STEM) has a positive influence on learning success.

The results show that Problem-Based Learning (PBL) based in Science, Engineering, Mathematic (STEM) in the learning process is interesting and enjoyable for students so that students feel motivated to play an active role in following learning activities using the model of Problem based learning based on science, Technology and Engineering. (STEM). According Susanto (2013) in his book stating that "students' success in learning also depends on the model of presentation of material. Models of presentation that are pleasant, interesting, easy to understand and not boring influence learning success."

Based on the data, it can be concluded that there is a difference in the improvement of the students' ability to scientific argumentation significantly. The difference between the average value of the student's scientific argumentation ability between the experimental class and the control class on each indicator of the scientific argumenting ability in Figure 4.4 shows that the average posttest value of experimental and control class has increased from the pretest average. The results of this study are reinforced by the previous research carried out by Rahmad (2018) on the “Application of Problem Based Learning to Environmental Pollution Materials to Improve the Ability of Scientific Argumentation of MIPA Class X Students”. The results show that the application of Problems Based learning can improve the ability of written scientific argumentation of students as seen from the results of the Percentage of access to the component of the written scientific argumentation ability of students namely claims belong to the very high category of 97.37%; evidence of 85.97% belongs to the category of very high; and reasoning belonging to the higher category of 76.31%. According to Mc.Neill and Krajick (2006) aspects of scientific arguments capability include Claims, Evidence, Reasoning and

Rebut. Based on the research results, the aspect of claims obtained the highest percentage average value compared to other aspects. It is not difficult for a student to make a statement about a problem in learning, because it can be logically based on the knowledge of the student himself. In addition, the claim to be given by the student is a statement or a short Claim. But the student is not advised to originate in giving his statement, because the claims underlying Evidence and Reasoning. According to Fisher (2009), the ability to argue scientifically in particular claims is the foundation of logical and critical thinking that involves the capacity to make an opinion in the argument that is a reason supported by Keraf (2007) a scientific argument is a statement supported by some evidence or fact.

The next aspect of scientific argumentation is that the Evidence aspect is the third aspect that achieves the highest percentage after the Reasoning aspect, according to the researchers this happens because the Evidences aspect is providing scientific data to support a Claim. Where students are required to present scientific data both of the theories that they have learned in learning as well as scientific data derived from the student's own knowledge that comes from various media. A little statement or insight will make it difficult for students to provide scientific data, even a minimal understanding of biological concepts in learning can make it hard for students in providing scientific data to support a claim. Khun (2010) states that one's argument is not only theoretical but must be proven true either by providing examples of real facts or the results of research from experts.

The next aspect of scientific argumentation is the aspect of reasoning which obtains the second highest percentage of average value after the claim. This is because, according to the researchers, students are able to give their argument in writing by giving consideration and explanation of a problem and accompanied by examples of their facts that support their argument. The findings of this research are reinforced by Sandoval's study (2005) that students use sufficient evidence or attempt to justify their statement or use of evidence in the arguing produced. A reasoning aspect is a reasoning or justification as evidence that can be examples of facts or scientific examples that have occurred or are still in theoretical form. Where students are required to present reasons, examples as evidence to justify Claim and Evidence initiated. Reasoning is an important aspect because neither claims nor evidence can be proven if evidence cannot be presented. It would be difficult for students to do if the student's curriculum is not well mastered in biological concepts and theories so that students cannot provide supporting evidence according to Khun (2010) arguments are not only limited by theory but students must be able to prove their truth.

The next aspect of scientific argumentation ability is the Rebuttal aspect that obtains the lowest percentage of average values. This is because, according to the researchers, the student is still unable to provide an alternative explanatory illustration or counter-evidence, why the alternative reasoning is not appropriate, so Rebuttal can also be interpreted as evidence that denies or contradicts the Claim. The results of this study are reinforced by Maya's (2016) study which showed that the argument component was eventually obtained from a statement that describes a phenomenon accompanied by relevant evidence and based on the concept or assumption underlying it.

The student's response in the learning process is an important thing, because through this response, the researcher can know how much positive or negative response the student gives to the learning applied in the classroom. This means that when a student gives a positive response, it indicates that the student receives a treatment of the application of a Problem Based Learning model based on Science, Technology, Engineering and Mathematics (STEM) so that he has a positive attitude towards the learning process. (STEM).

Teaching teachers that attract the attention of students because the learning activities carried out have a difference from previous learning. Teachers challenge students to solve a real problem in their environment. So that the difficult concepts in the matter of the human respiratory system can be easily understood. Learning like this is felt so real, so that students are easier to understand the concepts taught and encourage students to make between the knowledge they have and its application in their lives as members of the family and society. (Trianto, 2007).

Application of the learning model makes students more active in learning, more exploring and completing all their learning tasks, so will have a good impact on increased learning outcomes, as well as on students' ability to scientific argumentation. This is in line with Nasution's opinion in Djaali (2013) that the student's learning attitude will be manifested in feelings of pleasure or dissatisfaction, agree or disagree, like or dislike these things, such attitudes will influence the learning process and the results they.

If the student is unhappy with the learning, then the student responds negatively with a negative response so that the student will not follow or ignore the learning activity. The positive response given by the student to learning with the Problem Based Learning (PBL) based on Science, Technology, Engineering and Mathematic (STEM) learning model because the student feels interested in the learning environment applied so there is a good response from the student.

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