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# The Implementation of Problem Based Learning Integrated with STEM-Based Worksheets to Improve Learning Motivation

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**ABSTRACT**

The teaching and learning process in the classroom has not been able to arouse students 'learning motivation so that the learning motivation of students is not maximal, students' learning motivation is not maximized, seen from the learning process there are still students who have not been able to focus their attention and concentration on learning, so that only a few participants students who are active in learning. In addition, there are still many students who are not confident, do not dare to ask questions and when doing group presentations not all students dare to speak, only rely on other friends. The research approach used is quantitative with the type of quasi-experimental research, the research design used is Pretest-Posttest Non-Equivalent Control Group Design. The study population was all students of class 10$^{th}$ Senior High School 1 Peusangan and Senior High School 2 Peusangan, amounting to 252 people. The sampling technique used was purposive sampling, the sample in this study consisted of 140 students. Instruments to measure motivation using a questionnaire in the form of pretest and posttest questions. Data analysis consisted of normality test, homogeneity test, N-gain test, paired sample t-test and independent sample t-test, at a significant level of 0.05. The results showed that there were differences in the learning motivation of students in the experimental class and the control class on environmental pollution material in class 10$^{th}$ Negeri Bireuen district.

**Keywords:** Problem Based Learning, STEM Based Worksheets, Motivation

## INTRODUCTION

This 21st century information can be accessed by everyone so quickly. Each individual must have qualified soft skills in order to enter the world of work and be ready to compete (Ritonga, et al., 2020). Schools provide valuable opportunities through the educational process to prepare students to enter the world of work.

STEM-based worksheets can effectively improve students' critical thinking skills. The indicator shows that the scientific phenomenon has the highest value and the conclusion-drawing indicator has the lowest value (Sulistiyowati, et al., 2018). The use of STEM-based worksheets has received good responses from students and can be used in the learning process (Aristo & Togi, 2019). The application of STEM can improve students' critical thinking skills (Ritonga & Zulkarnaini, 2021).

PBL learning model helps students to develop skills in identifying problems and students are required to work together in solving problems obtained from their real life. Learners realize that learning is needed to solve and understand very important problems (Barrows, 2002). In addition, PBL is combined with STEM education to produce meaningful learning through the systematic integration of knowledge, concepts and skills (Tseng, et al., 2013). The PBL model is active learning and is very effective in creating knowledge, and can improve analysis, evaluation and creation skills). The PBL model is more effective for teaching than traditional lecture discussions (Tarhan & Ayyildiz, 2015).

**Problem of Research**

The teaching and learning process in class 10th at Senior High School 1 Peusangan and Senior High School 2 Peusangan in the classroom has not been able to generate motivation to learn so that students 'learning motivation is not maximal, students' learning motivation is not maximized, seen from the learning process there are still students who are not able to focus their attention and the concentration on learning, so that only a few students are active in learning. In addition, there are still many students who are not confident, do not dare to ask questions and when doing group presentations not all students dare to speak, only rely on other friends.

Environmental pollution concept is one concept that is still considered difficult by most students. This is because the concept is still theoretical and so far the presentation has not maximized the critical thinking skills and learning motivation of students. Learning activities on environmental pollution concept show that students are not active in learning, students only listen to explanations and record the subject matter delivered by the teacher (Prihatini, 2017). Therefore, in the teaching and learning process, one of the solutions offered is implementing the PBL learning model combined with STEM-based worksheets.

The solution to be carried out is by applying the PBL model combined with STEM-based worksheets. Several previous studies related to research, namely the use of PBL have been conducted by Lapuz & Fulgencio (2020), the use of PBL can significantly improve critical thinking skills before and after learning activities. The PBL model has a higher influence on critical thinking skills and environmental attitudes than the conventional model. The use of the PBL model in solving environmental problems encourages students' critical thinking skills to foster environmental attitudes (Amin, et al., 2020). There is a significant difference in learning outcomes between students who have high and low critical thinking skills (Mulyanto, et al., 2018). The PBL model provides opportunities for learners to discover new knowledge to their prerequisite knowledge for solving problems. Therefore, they participate in an active process of creating innovative solutions to these problems through experience (Yazar, 2015). The PBL model can improve learning achievement (Sartika, 2018).

**Research Focus**

This study aims to determine the impact of implementing Problem-based Learning integrated with STEM-based worksheet on increasing Learning Motivation

## METHODOLOGY OF RESEARCH

### General Background of Research

This research was conducted at Senior High School 1 Peusangan and Senior High School 2 Peusangan. Sampling in the two schools was based on UN scores in biology subjects in 2019 which showed that both had the lowest average score. The approach used is quantitative. This type of research is quasi-experimental and uses applied methods to determine the differences that arise from a treatment on experimental variables. The treatment of both the experimental group and the control group was to test the consequences of the treatment used in learning.

### Subject of Research

The population in this study were all students of class 10th IPA at Senior High School 1 Peusangan and Senior High School 2 Peusangan, totaling 252 students. The sample in this study amounted to 140 students. The researcher determined the research sample class using purposive sampling. The taking of the experimental class and the control class was determined by looking at the standard deviation value of the homogeneous students 'pretest results (homogeneous students' abilities).

### Instrument and Procedures

The instrument used to measure learning motivation was a questionnaire accompanied by a rubric. The parameter in this study is to measure the learning motivation of students using four indicators, is attention, relevance, confidence, and satisfaction (Keller, 2010). The learning motivation questionnaire used in this study was in accordance with Keller's learning motivation indicators, then the questionnaire was developed by Huang and Foon (2016) and modified by researchers. Furthermore, the modified questionnaire was subjected to a validation test to expert lecturers.

### Data Analysis

The stages of data analysis were: 1) normality test, to test the normality of the data the Kolmogorov-Smirnov test was used. To perform this normality test using the SPSS program. Normality test criteria if the Sig. > 0.05 is declared normal, 2) homogeneity test, to test the homogeneity of the data can use the Levene test. To perform this homogeneity test using the SPSS program. Homogeneity test criteria if the Sig. > 0.05 is declared homogeneous, 3) independent sample t-test, namely the comparative test or different test to determine whether there is a significant difference in mean or mean between the 2 groups. To perform this test using the SPSS version 21 program. If the criteria ($p < 0.05$) then there are differences in the learning motivation of students.

## RESULTS AND DISCUSSION

The paired sample t-test was used to see differences in the learning motivation of students before and after learning by applying the PBL learning model combined with STEM-based worksheets in class 10<sup>th</sup> Senior High School Bireuen Regency on environmental pollution concept. The results of the paired sample t-test of the experimental class learning motivation are presented in Table 1.

**Table 1.** Paired Sample T-test Students' Learning Motivation in Experiment Class

| Score | Sample | Average | Std. Deviation | Paired Sample T-test |
|-------|--------|---------|----------------|----------------------|
| Pretest | 71 | 28,19 | 3,80 | $\rho < 0,05$ |
| Posttest | 71 | 73,60 | 8,36 | |

Table 1 shows that the results of the paired sample t-test in the experimental class were obtained ($\rho < .001$). So it was concluded that there were differences in the learning motivation of students before and after learning with the application of the PBL. combined with STEM-based worksheets in class 10<sup>th</sup> Senior High School Bireuen Regency on environmental pollution concept. The average increase in students' learning motivation indicators in the experimental class is presented in Figure 1.
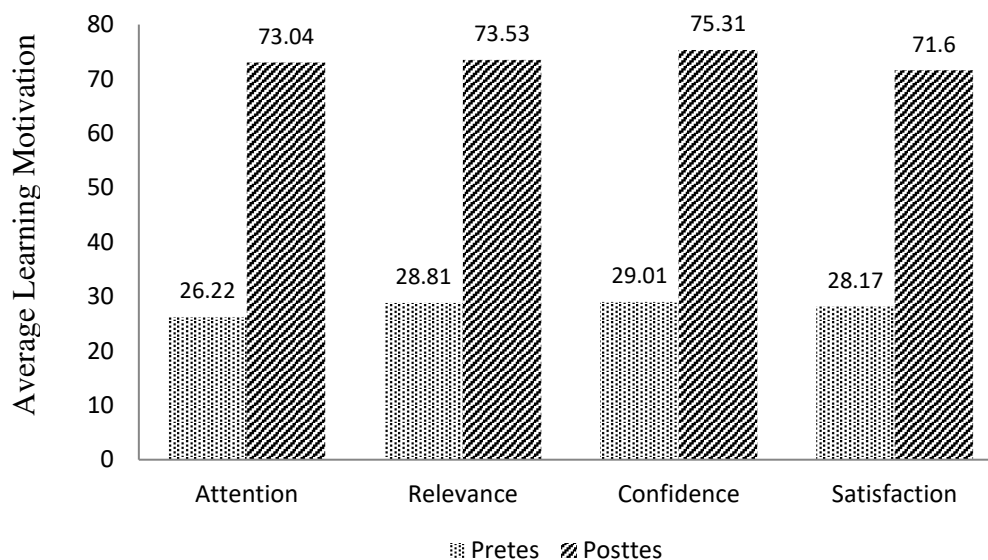


**Figure 1.** Average Indicators of Students' Motivation in Experiment Class

The results showed that the application of the PBL model combined with STEM-based worksheets could increase the learning motivation of class 10<sup>th</sup> students of Senior High School Bireuen Regency. The attention indicator shows a pretest score of 26.22 and a posttest of 73.04, this shows students feel that early learning on environmental pollution concept has something that catches their attention, so they are more interested in learning. The relevance indicator shows the pretest value of 28.81 and posttest 73.53, this shows that students feel the information obtained is in accordance with the students' learning interests, because in learning they are required to carry out experiments contained in STEM-based worksheets.

The confident indicator shows a pretest value of 29.01 and posttest 75.31, this shows that students are confident that they can find solutions to problems based on experiments carried out. The satisfaction indicator shows the pretest value of 28.17 and posttest 71.60, this shows that it has a very good impact in motivating students 'learning, stimulating students' curiosity so that when students are able to solve a problem, so that participants students feel more confident.

In line with the opinion of Husna et al., (2020) explaining that the implementation of STEM-based worksheets can significantly increase the learning motivation of students. The PBL model can also motivate students to achieve the desired learning outcomes. In PBL, students are trained to learn independently, independent learning is very important to promote student motivation (Harun et al., 2012).

Students can be motivated in a learning program after learning using STEM, where students discuss STEM concepts and activities, and can reveal certain program elements that motivate students (Chittum et al., 2017). Students' views about STEM education show that they consider STEM education to be instructive, entertaining, creative and motivating. Furthermore, students stated that STEM education increased their creativity and motivation towards the course and contributed to their career choices (Ugras, 2018).

The PBL model is used to motivate students to identify and research the concepts they need to know to work through these problems (Duch et al., 2001). The use of PBL can motivate students to high (Fukuzawa et al., 2017). The application of the PBL integrated with the mindmap can improve students' critical thinking skills (Ritonga et al., 2021).

The learning motivation of students in the control class taught using conventional methods in class X SMAN Bireuen Regency on environmental pollution concept was analyzed using the paired sample t-test. The results of the paired sample t-test learning motivation for the control class are presented in Table 2.

**Table 2.** Paired Sample T-test of Student Motivation of Control Class

| Score | Sample | Average | Std. Deviation | Paired Sample T-test |
|---|---|---|---|---|
| Pretest | 69 | 27,57 | 3,76 | $\rho < 0,05$ |
| Posttest | 69 | 66,97 | 7,04 | |

Table 2 shows that the results of the paired sample t-test for the control class were obtained ($\rho < .001$). So it is concluded that there are differences in the learning motivation of students before and after learning with the application of conventional methods in class X SMAN Bireuen Regency on environmental pollution concept. The average increase in students' learning motivation indicators in the control class is presented in Figure 2.
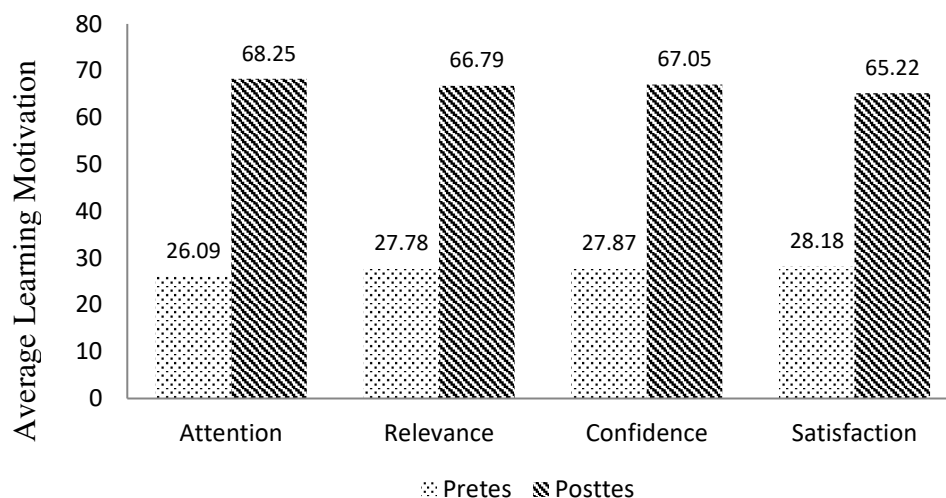
**Figure 2**. Average Indicators of Student Motivation in Control Class

The results showed that the application of conventional methods can increase the learning motivation of class X students of SMAN Bireuen Regency. The attention indicator shows a pretest score of 26.09 and 68.75 posttest, this shows that students feel that early learning on environmental pollution concept has something that attracts the attention of students, although there are still some students who are still not attractive to learn at the beginning of the lesson.

The relevance indicator shows the pretest value of 27.78 and posttest 66.79, this shows that some students feel the information obtained is in accordance with the learning interests of students, although there are still some students who feel that environmental pollution concept has not according to his interests. The confident indicator shows a pretest value of 27.87 and a posttest of 65.05, this shows that some students are confident in carrying out learning activities. On the indicator of satisfaction shows a pretest value of 28.18 and posttest 65.22, this shows that some students are more motivated to learn so that students feel more confident. In line with the opinion of Arief et al., (2016) explaining that there are differences in the initial and final motivation of students using conventional methods.

Before testing the hypothesis, the prerequisite test for the independent sample t-test was a test of normality and homogeneity, the data showed normal and homogeneous. The results of the independent sample t-test posttest of students' learning motivation at Senior High School Bireuen Regency, can be seen in Table 3.

**Table 3**. Results of Independent Sample T-test Posttest Students' Learning Motivation

| Group | Average Posttest | Independent Sample T-test |
|---|---|---|
| Experiment | 73,60 | $\rho < 0,05$ |
| Control | 66,97 | |

Based on Table 3. shows the results of the independent sample t-test obtained ($\rho < .001$). So it can be concluded that there are differences in the learning motivation of students between the experimental class and the control class on environmental pollution concept in class $10^{th}$ Senior High School Bireuen Regency. Learning PBL learning model combined with STEM-based worksheets shows that learning motivation is significantly better than students who take conventional learning on environmental pollution concept in class $10^{th}$ Senior High School Bireuen Regency.

The mean results of the pretest and posttest learning motivation for the experimental class and the control class to see the difference in the average learning motivation of students can be seen in Figure 3.



**Figure 3.** Mean Pretest and Posttest of Students' Motivation in Experiment Class and Control Class

Figure 3 shows that the difference in the mean learning motivation of students between the experimental class and the control class. The posttest mean of learning motivation for the experimental class was 73.60, and the control class was 66.97. Based on the average obtained in the experimental and control groups, it can be seen that the average learning motivation of students in the experimental group is greater than the control group. This means that students who take the PBL learning model combined with STEM-based worksheets show that students' motivation is better than students who take conventional learning.

The difference in students' learning motivation is caused by the use of PBL learning models combined with STEM-based worksheets, with the use of STEM-based worksheets students become more active in solving problems and students are more enthusiastic in conducting experiments because the STEM-based worksheets already exist. a guide for assembling the tools that have been provided by the teacher, the steps that students must follow when the experiment is more interesting because there are pictures of the steps that students must do so that the experiment can be carried out successfully.

The motivation of students is very influential on how to teach teachers. In accordance with the research results of Agustina et al., (2013) that experiments conducted by students lead to learning motivation by students because students want to get an award, besides that students will also try to do their best to get high scores. An interesting way of teaching can make students more enthusiastic about learning and will be more serious in learning the lessons that have been delivered by the teacher.

Previous research on the use of PBL learning models combined with STEM-based worksheets was conducted by Husna et al., (2020) explaining that the use of STEM-based worksheets can significantly increase learning motivation and creativity of students. The motivation to learn and the curiosity of students must be endeavored to increase learning involvement and creativity during class. Less varied learning models will make students quickly bored. Therefore, various learning approaches that are chosen properly can increase creativity and motivational learning of students (Hasan et al., 2019). The implementation of STEM-based learning strategies that have never been done before can increase the learning motivation of students (Rahmiza et al., 2015). The application of STEM can improve students' critical thinking skills (Ritonga & Zulkarnaini, 2021).

PBL learning can increase student motivation (Khusaini et al., 2018). This study is also similar to Azer (2009) concluded that the PBL method is important for creating good interactions between teachers and students and it will make the atmosphere of discussion in the learning system more effective. Similar results were expressed by Rerung et al., (2017) who concluded that the PBL method can significantly influence student learning. The PBL method can contribute to learning, students can develop and improve their learning and PBL abilities, the method can encourage students to learn actively, foster independent learning behavior, and students are given full responsibility for their own learning process (Mioduser and Betzer, 2007). The PBL model can significantly improve motivation and classroom atmosphere (Witte and Rogge, 2014).

While the learning motivation of students uses conventional learning, students feel bored with teacher-centered learning methods without any element of student activity in the process of teaching and learning activities in the control class. In addition, conventional learning does not provide opportunities for students to obtain their own knowledge about environmental pollution concept so that students are less motivated in learning. In line with the opinion of Arief et al., (2016) learning using a problem-based learning approach is significantly better than learning mathematics using a conventional approach in increasing student learning motivation.

## CONCLUSIONS

The implementation of the PBL learning model combined with STEM-based worksheets can increase students' learning motivation on environmental pollution concept in 10th Senior High School Bireuen Regency. In addition, there are differences in the learning motivation of students between the experimental class and the control class on environmental pollution concept in class 10th Senior High School Bireuen.

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