



The Implementation of Problem Based Instruction Model to Improve Problem Solving Ability on Mechanical Wave Material at SMA Negeri 3 Banda Aceh

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ABSTRACT

The research objectives were (1) to determine the increase in problem-solving abilities using the problem-based instruction model for class XI-MIPA-7 students on mechanical wave material at SMA Negeri 3 Banda Aceh, (2) to describe the activities of teachers and students in learning mechanical wave material using the problem-based instruction model for class XI-MIPA-7 SMA Negeri 3 Banda Aceh, and (3) to find out the response of XI-MIPA-7 students of SMA Negeri 3 Banda Aceh after using the problem-based instruction model. This study used a classroom action research method. The research subjects were 34 students of XI-MIPA-7 SMA Negeri 3 Banda Aceh. Data analysis using percentage techniques. Based on the results of data analysis, it can be concluded as follows: (a) there is an increase in student learning outcomes in solving problems by applying the problem-based instruction model. The class average score in cycle 1 meeting 1 was 71.47 with 58.2% completeness, while in cycle 1 meeting 2 increased to 82.5 with completeness 82.35%. And in cycle II the class average value is 85 with completeness of 94.11%; (b) teacher and student activities have increased in each cycle, an increase in the ability of teachers to manage to learn from moderate to very good categories, and (c) student responses tend to be positive. So, it can be said that the problem-based instruction model can be used to improve the ability to solve mechanical wave material problems in class XI-MIPA-7 at SMA Negeri 3 Banda Aceh.

Keywords: Problem solving ability, activities of teachers and students, students respond, and problem based instruction model

INTRODUCTION

The ability to solve problems is one of the thinking skills that can be developed and trained and is included in critical thinking skills. According to Dwyer (2014), critical thinking is reflective thinking, a complex metacognitive process that involves several skills such as analyzing, evaluating, and inferring which aims to make logical decisions about what to do in solving a problem. In fact, learning physics in schools does not involve scientific processes and attitudes so that students' thinking skills are less trained, especially in problem-solving skills. According to Sumarmo (Eka, 2015) the ability to solve problems includes the ability to analyze and evaluate arguments and evidence, make clarifications, make value judgments, compile clarity based on relevant and irrelevant data, identify and evaluate assumptions.

Based on the results of the Trends in Mathematics and Science Study (TIMSS) assessment and the Program For International Student Assessment (PISA), the results were

unsatisfactory. In 2016, Indonesia was ranked 36 out of 49 countries with an average science score of 397 for the TIMSS study results, while the PISA study results, Indonesia was ranked 69 out of 76 countries with an average science score of 403 (TIMSS, PRILSS & PISA, 2016). From the results of this assessment, it can be seen that the critical thinking skills of Indonesian students are still lacking.

This fact is supported by the results of the author's observations of the physics teacher at SMA Negeri 3 Banda Aceh, the learning model often used by teachers in physics lessons is a less innovative model. Usually, the teacher directly provides explanations without bringing students to problems related to everyday life. With such learning, students become less active in interacting and thinking so that the knowledge gained is not supported by an increase in students' problem-solving abilities. Based on the author's observations, it was also found that the students' physics problem-solving ability was low. For example, in solving questions, students have difficulty digesting questions, have not been able to derive formulas, and have not been systematic in solving questions. Physics problem-solving skills require higher-order thinking skills. If students' high-order thinking skills are low, then students will find it difficult to solve physics problems (Eka, P., Lestari, P., & Saputri, A.S., 2015). Efforts to make it easier for students to solve problems and effective learning application is needed. Effective learning is using the Problem Based Instruction model. According to Joyce (1992), "The learning model is a plan or pattern that is used as a guide in planning classroom learning or learning in tutorials and determining learning tools including books, films, computers, and others". Today, there are many learning models that are applied in the learning process, especially in physics learning. In its implementation in the class, learning models can be applied individually, and it can also be a combination of several of these models according to the nature and characteristics of the material to be taught by Joyce. One alternative learning model that is effective for training and developing students' thinking skills, especially the ability to solve problems on mechanical wave material, is to apply the problem-based instruction model (Arends, Richard I., 1997).

Research on improving problem-solving abilities in physics learning using the PBI model has been done before. The results of the study (Junaida et al., 2017) state that overall the PBI model has an effect on improving students' physics problem-solving abilities, but there are obstacles from this study, namely students find it difficult to dig back their initial knowledge to solve problems. In addition (Fitra et. Al., 2016) stated that learning using the PBI model was effective to improve students' problem-solving abilities. The results of research on improving the ability to solve physics problems using the PBI model have also not much research (Heller, P., 2001).

Based on the background description of the problem that has been described above, the problem arises whether the problem-based instruction learning model can improve the problem-solving ability of the mechanical wave material for class XI-MIPA-7 SMA Negeri 3 Banda Aceh?

Problem of Research

Based on the background of the problems raised above, the problems in learning Physics in class XI-MIPA-7 SMA Negeri 3 Banda Aceh during the learning process are the low ability of students to solve problems in learning, the used of learning methods that do not match basic competencies material, the implementation of learning that was not contextual, teacher-centered learning, the lack of students' ability to relate the ability to think physics material learned with problems of everyday life in their environment as a result of providing examples of lessons that focus on certain books, lack of student ability in scientific research, they are familiar with the material and solve only text-book problems.

Research Focus

Based on the above background, the increase in learning outcomes of class XI-MIPA-7 students after using a problem-based learning model on mechanical wave material at SMA Negeri 3 Banda Aceh needs to be known whether or not there is an increase in learning outcomes. In addition, the activities of teachers and students in solving problems after applying the problem-based learning model to mechanical wave material also need to be known to determine the impact of the application of this learning model.

METHODOLOGY OF RESEARCH

General Background of Research

This research was conducted at SMA Negeri 3 Banda Aceh which is located on Jalan Tgk. Daud Beureuh Number 454 Kecamatan Kota Alam Kota Banda Aceh, class XI-MIPA-7. This class has diversity in terms of student ability levels, meaning that this class is not a class that is only filled with high achieving students, but in this class, there are also students with moderate and low achievement. This research was conducted for 3 months, starting from January to March 2020. The timing of this research was based on the educational calendar and adjusted to the semester program that had been compiled. The research was carried out on effective school days and the physics lesson schedule in the author's class was assigned, namely XI-MIPA-7 even semester of the 2020/2021 school year.

Subject of Research

In this study, the research subjects were 34 students of class XI-MIPA-7 at SMA Negeri 3 Banda Aceh, and the object of research was solving problems abilities using the problem-based instruction model. Characteristics of students are that the ability of students to understand the concept is different (heterogeneous), some have high, medium, and low abilities. In addition, these students also have curiosity and motivation in learning physics.

Instrument and Procedures

The instruments used to collect data in this study were: teacher and student activity observation sheets, student response questionnaires, and learning outcomes test (Yusrizal,

2016). (1) The teacher and student activity observation sheet. Activities observed include teacher activities and student activities during the teaching and learning process using problem-based instructions on mechanical wave material. Data validation in this learning process is a triangulation between students, teachers who implement PBM, and collaborative teachers, namely other physics teachers as observers. (2) Questionnaire student responses to the learning process using problem-based instruction on mechanical wave material. The student response questionnaire is a triangulation between students, teachers who implement PBM, and collaborative teachers, namely other physics teachers as observers. (3) The test of student learning outcomes. Student learning outcomes tests are arranged according to the indicators contained in the lesson plan. The object material learning outcome tests are arranged based on the learning objectives to be achieved, used to measure student learning outcomes through the Problem-based Instruction (PBI) model for SMA Negeri 3 Banda Aceh students class XI-MIPA-7 even semester of the 2019/2020 school year, test form which is used is a multiple-choice test.

This research was conducted in 2 cycles and each cycle consisted of several stages, including: planning, implementation, observation, and reflection. The procedure for implementing this research can be seen in the image below (Arends, Richard I., 2007):

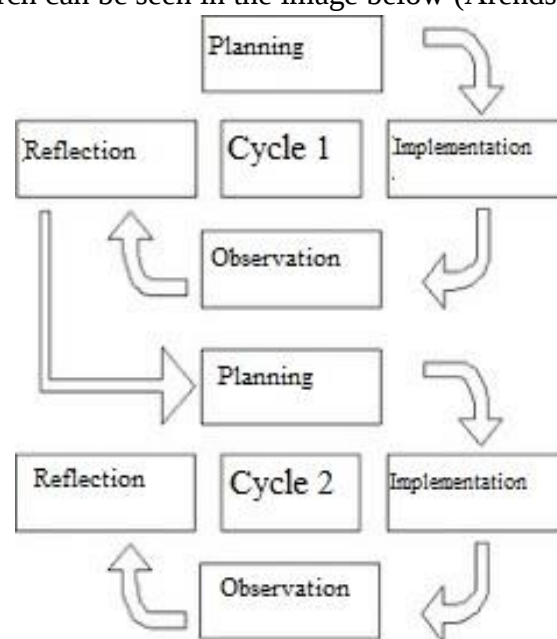


Figure 1. Research Procedure

Data Analysis

Data collection techniques in this study were divided into two, namely qualitative and quantitative data. Qualitative data is data taken from observation sheets, consisting of: (1) Data about student activity in learning is taken from observation sheets during the student learning process by observers, and (2) student response data is taken by questionnaire questions to students.

Quantitative data is data about student learning outcomes, which is obtained from the results of students' exams after completing learning from cycle 1 and cycle 2 of the study. Then the data is analyzed in the following way:

1) Learning Outcomes

Student learning outcomes are analyzed by counting the number of students who completed the Minimum Completion Criteria (KKM) of 34 students. Then the authors look for the highest score and the lowest value of student learning outcomes. The average score is calculated using the formula:

$$R = \frac{\text{Score Total}}{\text{The number of students}} \times 100\% = \frac{\sum x}{N} \times 100\%$$

The highest score, the lowest score, and the average score become the benchmarks for the level of understanding of students.

2) Observation Sheets of Teachers and Students Activities

The teacher and student activity observation sheets in learning are used to determining the activities carried out by teachers and students in teaching and learning activities. Teacher and student activity data in teaching and learning activities were analyzed using percentages:

$$P = \frac{F}{N} \times 100\% \quad (\text{Sudijono, 2005})$$

Note :

F = The frequency of teacher and student activities carried out

N = The number of teacher and student activities carried out

P = The percentage number of teacher and student activities

3) Student Response Questionnaire

The questionnaire is used to obtain information related to student opinions about the implementation of the problem-based instruction model. Student response data were analyzed using percentages:

$$P = \frac{F}{N} \times 100\% \quad (\text{Sudijono, 2005})$$

Note :

F = The frequency of students' response

N = The number of students

P = The percentage of response

RESULTS AND DISCUSSION

This research has 2 cycles in its implementation. Cycle 1 was held in two meetings with each meeting 2 x 45 minutes. The learning material in cycle 1 about the second wave of this meeting is taught by applying the problem-based instruction model. Each meeting consists of initial activities, core activities, and final activities. Initial activities begin with greetings, perceptions, motivation, and delivery of goals. Followed by core activities by applying the problem-based instruction learning model. The learning steps taken include (Abbas, 2007): (1) Student orientation to the problem with students watch a video about the material being studied;

(2) Organizing students to learn: dividing groups, each consisting of 5-6 people per group; (3) Guide students in individual or group investigations; (4) Propose allegations or possible answers/associate or reason; (5) Students provide various answers to the questions asked by one of the students; (6) Collecting data related to allegations or questions asked/predicting allegations; (7) Develop and present the work, the teacher directs and guides students to get answers to questions from the problems raised by one of the students by discussing and working on the questions in the worksheets; (8) Formulate conclusions based on data that has been processed or analyzed, present or present the results of the discussion; and (9) Analyze and evaluate the problem-solving process. The teacher provides feedback on the work done by each group.

The learning activity is closed by summarizing the learning results, reflection, and giving quizzes related to the material being studied. After the first cycle was carried out for 2 meetings, student learning outcomes in cycle 1 were measured by providing evaluation with a technique in the form of a written test and the instruments used were multiple-choice items and descriptions. The learning outcomes obtained can be seen in the following table:

Table 1. The Student learning outcomes in cycle 1 meeting 1

No	Test Result	Total	Percentage
1.	Students completed KKM	20	58,82 %
2.	Students uncompleted KKM	14	41.17 %

Table 2. The Student learning outcomes in cycle 1 meeting 2

No	Test Results	Total	Percentage
1.	Students completed KKM	28	82,35 %
2.	Students uncompleted KKM	6	17,65 %

Table 3. The Average student learning outcomes in cycle 1 meeting 1

No	Name	Score
1.	Highest Score	90
2.	Lower Score	40
3.	Total Score	2430
4.	Average Score	71,47

Table 4. The Average student learning outcomes in cycle 1 meeting 2

No	Name	Score
1.	Highest Score	100
2.	Lower Score	60
3.	Total Score	2810
4.	Average Score	82,5

Based on the observations obtained in cycle 1 meeting 1, the test results show that the average value of learning outcomes achieved by students is 71.47 with a percentage of 58.82% completeness, for the average value of learning outcomes achieved has reached the specified success indicators. However, the percentage is still below the determined success indicator. The average score of student activity in the first cycle of meeting 1 is 78.9 by 5% in the good category, while the teacher's performance in managing learning in the first cycle of meeting 1 is 79.48% with good criteria.

This happens because several factors include the following: (1) Students do not understand their roles and duties in group work because they are not familiar with the learning model applied, (2) Interaction between students has not gone well because students are not used to expressing their opinions to other friends in solving problems, (3) There are students who are passive and depend on the problems they face on their group, (4) In group discussions only dominated by clever students, (5) At the time of presenting group work results only a few groups are presenting the results of their group work because time is not possible, (6) The teacher in providing guidance is not evenly distributed, only provides guidance to groups who actively ask questions (Abdurrahman, M., 2003). The description above states that in cycle I the success indicator has not been achieved. Therefore it is necessary to have an action in cycle 2 so that student learning outcomes can be improved and achieve the specified success indicators. The comparison of learning outcomes between cycles 1 and 2 can be seen in the graph below:

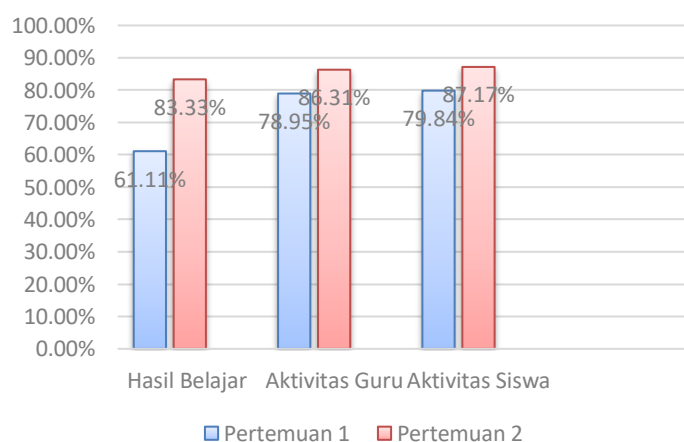


Figure 2. Graph of Student Learning Outcomes in Cycle 1

After doing cycle 2 for 1 meeting on material about the nature of waves, student learning outcomes in cycle 2 were measured by providing an evaluation in the form of a written test with an instrument in the form of multiple-choice questions. The understanding obtained can be seen in the following table:

Table 5. The Student learning outcomes in cycle 2

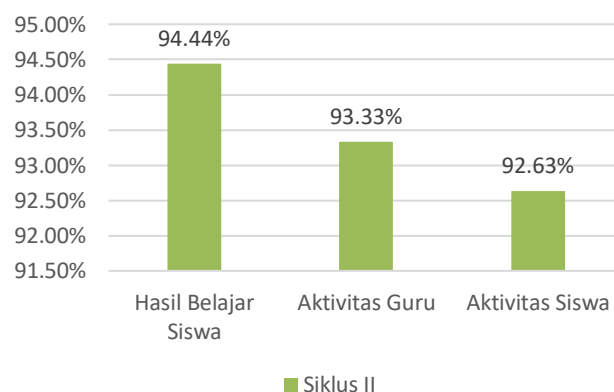
No	Test Result	Total	Percentage
1.	Students completed KKM	32	94,11 %
2.	Students uncompleted KKM	2	5,56 %

Table 6. The Average student learning outcomes in cycle 2

No	Name	Score
1.	Highest Score	100
2.	Lower Score	60
3.	Total Score	2890
4.	Average Score	85

During the second cycle, observations are made of the process of the action taken. Observations were made on student activities and teacher activities. In this case the observation uses the observation sheet that has been prepared. In this cycle, there are several changes in student behavior. The change in question is generally a change for the better. These changes include the test results in cycle 2, the average value of learning outcomes achieved by students is 82.35 with a percentage of 94.11.% Completeness. The learning outcomes have reached the specified indicators, namely a class can be said to be complete learning if the class is at least 85% of students have achieved class learning completeness.

The success of learning activities in cycle 2 is influenced by several factors (Nur, M., 2011) including the following: (1) Students are getting used to working in groups, (2) The courage of students to interact is going well because students are getting used to asking questions and expressing their opinions to fellow friends In solving problems, (3) Students begin to be active and know their assignments so that they do not depend on the problems faced by their friends in the group, (4) Because students are active in group discussions, the teacher can guide students during the discussion evenly so that the discussion can run effectively (Ibrahim, M., & Nur, M., 2000).

**Figure 3.** Graph of Student Learning Outcomes in Cycle 1

Based on the results of teacher and student observations, the test results in cycle 2 can be evaluated that the steps that have been programmed and implemented are able to achieve the expected goals in the study (Nurhadi, B. Y., & Senduk, A. G., 2004). In the end, changes in teacher teaching behavior and changes in student behavior facilitated through this action research have an impact on improving student learning outcomes, where the results of this study indicate that students achieved learning completeness, a situation that was difficult to achieve previously.

Based on the data obtained above, the researcher concluded that the learning carried out in cycle 2 had obtained maximum results in studying the properties of waves. Higher-order thinking is a factor that can improve problem-solving skills (Soewarno, S., et al., 2020). This shows that with maximum learning outcomes, students have an increase in thinking skills which have an impact on increasing problem-solving abilities (Merisa, N. S., et al., 2020). For this reason, the researcher does not need to proceed to the next cycle, because the learning outcomes obtained have reached the performance indicators, namely using the threshold requirements for students' cognitive scores, namely reaching 75% individually and 85% classically (a class can be said to be complete learning if the class is at least 85 % of students have achieved completeness in-class learning).

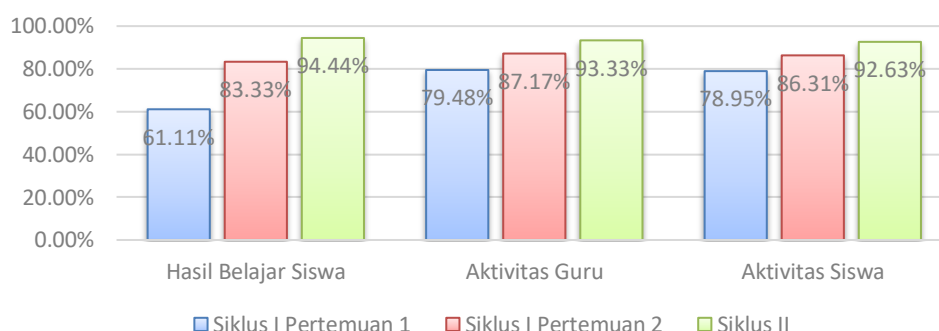


Figure 4. Graph of classroom action research cycles 1 and 2 results

Based on the results graph in cycle I and cycle II, the use of problem-based instruction models to solve problems can improve student learning outcomes in class XI MIPA 7 at SMA Negeri 3 Banda Aceh in the academic year 2019/2020 on mechanical wave material.

After the learning activity ends, students are given a questionnaire containing 20 statements regarding the use of the problem-based instruction model to all students consisting of 34 students. The response questionnaire is used to determine students' interests and opinions on the use of problem-based instruction learning models on mechanical wave material. Student responses can be seen in table 7 as follows:

Table 7. Student Responses to Problem-based Instruction Model

Aspect	Statements Number		Percentage (%)	Note
Fun	Positive	1	81,25	Strongly Agree
	Negative	7,12	31,94	Disagree
Motivation	Positive	2,11	88,19	Strongly Agree
Activeness	Positive	3,10,9,17	88,69	Strongly Agree
Confidence	Positive	4,8,14,15,19	81,50	Strongly Agree
	Negative	13,20	47,90	Disagree
Interest	Positive	5,16,18	87,03	Strongly Agree

Table 7 shows the students' responses to the use of the problem-based instruction model which includes 5 aspects with 20 statements. In the fun aspect, the percentage obtained is 81.25% with the strongly agree category which shows that students enjoy learning with the problem-based instruction learning model and students respond 31.94% with the category of disagree with statements number 7 and 12 which contain "I don't like with the appearance in the worksheet used in the problem based instruction learning model, and "I am not happy when studying using the problem based instruction learning model", this shows that students like the look of the worksheet used and students enjoy learning with the problem based instruction learning model.

In the aspect of motivation, the percentage obtained is 88.19% with the category of strongly agree which shows that students are motivated to be more active in participating in learning with the problem based instruction model. In the activeness aspect, the percentage was 88.69% with the strongly agree category, which indicates that students are becoming more active in asking questions and expressing opinions and activities in the group. In the aspect of belief, the percentage obtained is 81.50% with the category strongly agree, which indicates that students believe they get good grades and can work on the questions given without being influenced by friends' answers. Students also responded with a percentage of 47.90% with the category of disagreeing with statements number 13 and 20 which contained "I can only work on the questions given in the problem based instruction learning model if assisted by friends" and "I'm not sure I can do it. the questions given by the teacher using the problem based instruction learning model, this shows that students are sure they can work on the questions given by the teacher. In the aspect of interest, the percentage was 87.03% with the category strongly agree which shows that students are interested in learning by using the problem based instruction model and are interested in the appearance of the worksheet used. The details are depicted in the chart below:

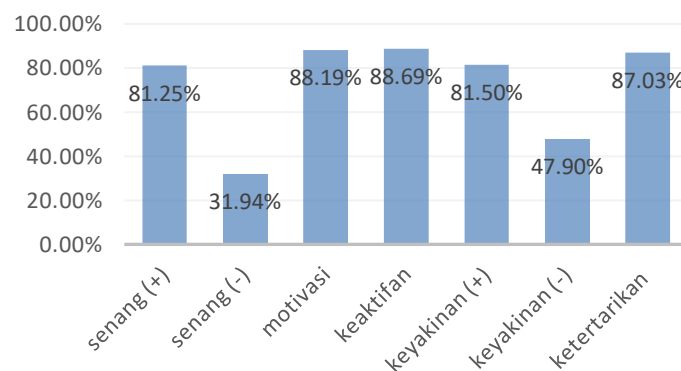


Figure 5. Percentages of Students Response Questionnaire

This proves that most students are fun with the learning process by applying the problem-based instruction model. In addition, student responses to the problem-based instruction learning model are also very positive. This positive response shows that students are very enthusiastic about the learning presented (Susanto, A., 2013). This can motivate

students to increase attention and make students engage in enjoyable learning experiences (Trianto, 2009).

Based on student responses from the 20 statements given, it can be said that the problem-based instruction model can be used to improve students' problem-solving abilities at SMA Negeri 3 Banda Aceh.

CONCLUSIONS

Based on the results of the action research that has been carried out, it can be concluded that the application of the problem-based instruction model as a learning model in physics learning, especially on wave material can improve the problem-solving skills of class XI MIPA 7 students at SMA Negeri 3 Banda Aceh. Teacher activity is categorized as very good in the mechanical wave learning process using this learning model, and student activity has also increased after the application of the problem-based instruction model with a very good category. The problem-based instruction model is proven to be able to improve students' problem-solving skills, teacher and student activities in learning, especially wave material. With this research, it is hoped that students will no longer experience difficulties in solving problems in mechanical wave material and learning in the classroom is more enjoyable.

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