Application of problem based learning (PBL) to increasing student activity in the subject matter of temperature and heat

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Abstract. The study of Problem Based Learning (PBL) application on the subject matter of temperature and heat aims to see: (1) an increase in the activity of students taught by applying PBL learning models. (2) increased student learning performance by using student worksheets. (3) Researcher's achievement when applying PBL in learning. This type of research is quasi experiment with a population of all students of class X MIA MAN Binjai as many as six classes. The research sample was determined by simple random sampling technique. The instrument used to collect data consisted of 3 student worksheets based on 3 sub-materials in the subject matter of temperature and heat and student activity observation sheets for each sample. Descriptive data analysis results, obtained research findings are: (1) the activity of students taught by applying PBL learning models increases with the active category. (2) the learning performance of students who learn to use student worksheets increases in each learning. (3) Researchers were able to apply learning with PBL models with good categories.

1. Introduction

Physics is the science that discusses natural phenomena and behaviors that can be observed and applied by humans in life. Physics is one of the fields that promotes the development of a nation, because it plays an important role in technological innovation [1]. Physics invites students to be able to understand, think, and analyze various symptoms and problems in everyday life [2]. The ability of students to understand, think, and analyze various symptoms and problems of life is part of students' activities when learning physics, but based on observations at MAN Binjai, student activities during learning are still in the less active category which results in less maximum learning outcomes. Mundilarto and Ismoyo's research said that student activity is a reflection of students' value in learning [3]. Mundilarto and Ismoyo provide an assessment of problem-based learning with the results of the scale reflecting that students' positive beliefs increase after each learning activity. The use of PBL models using experimental methods and demonstration methods make students demonstrate scientific behavior and develop experience in using scientific methods and develop reasoning ability in thinking because PBL emphasizes the problem as the basis of learning, so learning with PBL activities brings results that are in accordance with the objectives of physics learning. The use of PBL to study science creates opportunities for students to identify the strengths and weaknesses they have during the learning process, PBL as a student-centered learning model so as to prepare students to connect scientific concepts with real life situations so that students are able to deal with real life problems using scientific thinking [4].
PBL activities according to Tasoglu and Bakac involve problem scenarios developed through steps namely; (1) Students are introduced to a problem situation; (2) Each group member presents their ideas about the problem and expresses their opinions through discussion; (3) Group members share their prior knowledge about the problems presented; (4) Group members define and discuss information needed to solve problems; (5) If all members of the group do not have information about problems, group members will conduct research; (6) discuss with group members and tutors. One group member presents a solution to the problem at the same session; (7) Application [5]. Step-by-step PBL activity scenarios depicted in Figure 1.

![Figure 1. PBL Activity Scenarios](image)

Increasing learning activities of students in problem-based learning have affected students' physical problem-solving abilities, learning activities of students in problem-based learning makes students enthusiastic in learning because students have an active role and enthusiasm in learning so that they have more independent learning abilities [6]. Based on previous observations and research it is important to do research on the application of problem based learning to increase student activity in the subject matter of temperature and heat.

2. Research Method

2.1. Research Design
The Research carried out for 3 months in the even semester of 2017/2018 school year in MAN Binjai. This type of research is a quasi-experimental, presented with the design of a single-form case study (One-Shot Case Study) which is an experiment carried out in the absence of a comparison group and also without an initial test. The purpose of the study with a simple single-form case study is to determine the effect of the treatment given regardless of the influence of other factors.

2.2. Research Subject
Research Subjects in the form of population in the study were all students of class X semester II MAN Binjai. The research sample is part of the number and characteristics possessed by the population consisting of one class randomly selected by simple random sampling technique, ie each class within the population has the right to have the opportunity to become a research sample. Class X MIA 3 is a research class that is taught the subject matter of temperature and heat by applying the model problem based learning.
2.3 Research Procedures

Study begins with initial observations to school, namely interviews with physics teachers and giving questionnaires to students of class X MAN Binjai. Then determine the sample consisting of one class randomly selected by simple random sampling technique. The sample class is given learning using the PBL model. The research procedure can be seen in Figure 2.

![Figure 2. Research Procedures](image)

2.4 Data Collection Techniques

Research uses two methods of data collection, namely tests and observations. The test instrument is in the form of student worksheets given in each learning, and observation instruments in the form of student activity observation sheets and conformity observation sheets in class lesson plans with implementation. The collection of research data can be seen in Table 1.

| Data         | Types Data                              | collection techniques | instruments                                      |
|--------------|-----------------------------------------|-----------------------|--------------------------------------------------|
| Student      | Learning Process                        | Test                  | Student worksheets in                             |
|              | Achievement                             |                       | the form of essays                                |
| Student      | Students Activity                       | Observation           | sheets activity problem                           |
| Researcher   | Achievement of the Application of       | Observation           | based learning                                    |
|              | Problem Based Learning Model             |                       | guide sheets Teacher activities during             |
|              |                                         |                       | learning with learning plans                      |

2.5. Data Analysis Techniques

Obtained in the study in the form of student activity data and the achievement of the application of problem based learning by researchers were analyzed through descriptive analysis and the ability of the learning process through student worksheets analyzed by looking for average values achieved by students in each learning.

3. Result

3.1. Student Achievement in the Learning Process
Achievement of the student learning process is measured through student worksheets compiled by researchers according to students' understanding needs according to the syllabus regarding temperature and heat material. Student worksheets lead students to find knowledge in groups. Students are encouraged to work together to do the practicum according to the work steps on the LKS. LKS requires students to analyze the problem, write down the facts found during the practicum, connect the practicum done with the problem discourse and read the references so that the problem can be solved properly [2]. The results of the assessment of student worksheets can be seen in Table 2.

| Group | Worksheet 1 | Worksheet 2 | Worksheet 3 | Average |
|-------|-------------|-------------|-------------|---------|
| I     | 87          | 87          | 82          | 85.3    |
| II    | 90          | 85          | 80          | 85      |
| III   | 87          | 85          | 85          | 85.6    |
| IV    | 80          | 87          | 85          | 84      |
| V     | 85          | 85          | 87          | 85.6    |
| VI    | 80          | 89          | 80          | 83      |
| VII   | 85          | 89          | 82          | 85.3    |
| VIII  | 87          | 90          | 83          | 86.6    |
| Average | 85          | 87          | 83          | 85      |

The average value of worksheets I on temperature and expansion of submersion by 85 then increased by 2.3% in student worksheets II with heat submersion and change form of objects, and decreased by 4.5% on student worksheets III by submitting heat transfer. Average value of student activity sheets (LKS) by applying the model problem based learning related to temperature and heat material has a good category because the PBL model LKS presents problems of daily life so students understand more about the problem, able to make hypotheses (temporary answers) with initial abilities owned, and able to prove the hypothesis through experimental activities [7].

3.2. Student Activity in Application of Problem Based Learning Learning

Observation of student learning activities is carried out during learning activities which consist of three meetings, aiming to observe students' learning activities during the implementation of learning with problem based learning models and find out whether PBL models lead to the emergence of various other activities that support students for learning [8]. Assessment indicators used in the assessment of student activities in problem-based learning are the ability of students oriented to the problem, student organization in learning, the ability of students to investigate problems in groups and personally, develop and present work and analyze and evaluate the problem solving process. Through observation of student activities, it can be known the activeness and enthusiasm of students in learning because students who play an active and enthusiastic role in learning will have more independent learning abilities and better learning outcomes [6]. Student activity in applying problem based learning is visualized in Figure 3.
Student activities have increased in each phase of learning from the first meeting to the third meeting. The increase in student activity on the indicators of presenting the work is the most significant activity indicator of 16.37%. Significant increase is caused by the model problem based learning that makes students enthusiastic to exchange information between groups so that the shortcomings of each group related to temperature and heat can be known and the teacher can provide the right final conclusions for each group [7]. The average student activity during the learning process always increases. During learning activities take place learning by applying problem based learning encourages students to help each other, share knowledge, and appreciate between the different learning abilities possessed by each student [9].

3.3. Achievement of the Application of Problem Based Learning Model in Learning
Applying the PBL model in learning is able to invite students to learn more actively, PBL helps students develop problem solving skills in discussions, idea ideas, and social interaction with other friends that spur the formation of new ideas and enrich intellectual growth students [10]. The percentage of achievement of researchers in applying the model problem based learning on learning temperature and heat is shown in Table 3.

| Table 3. Percentage of Achievement in the Application of Problem Based Learning Model |
|----------------|----------------|----------------|----------------|
| Phase I        | Indicator                  | Achievement/  |
|                |                            | Meeting (%)   |
| Provide        | Researchers have delivered learning objectives.  | 1  | 2  | 3  |
| orientation    | Describe various logistical needs.                   | 75 | 100| 100|
| about problems | Designing the right and authentic problems.          | 100| 100| 100|
| to students    | Motivate students.                                       |    |    |    |
| Phase II       | Researchers help students define learning material.   |    |    |    |
| Organizing     | Researchers help students organize learning tasks    |    |    |    |
| students       | related to learning problems.                         |    |    |    |
| to research    | researchencouraging students to get the right        |    |    |    |
| Phase III      | information.                                            |    |    |    |
| Assisting      | Helping students carry out experiments.               |    |    |    |
| independent    | Help find material explanations related to           | 75 | 75 | 100|
| investigations | investigations                                        |    |    |    |
| groups         | Help find solutions to problems                       |    |    |    |

Figure 3. Student Activity in Learning Problem Based Learning
Phase IV
Develop and present artifacts and exhibits
- Researchers help students in planning and preparing appropriate artifacts, such as reports, video recordings, and models.
- Researchers help students to convey the results of the investigation to their friends.

Phase V
Analyze and evaluate the problem-solving process
- Researchers help students reflect on the investigations that have been conducted.
- Researchers evaluate the process and results of problem solving that students use.

Researchers have applied the problem based learning model when learning material temperature and heat in three meetings. The observer was judged to get a perfect score in phase II and IV, namely the phase of organizing students to learn and the phase of helping develop and present the results of the study, while the less perfect phase according to observers was in phase V, which was to help analyze and evaluate the process in solving problems.

The application of PBL as a learning model when teaching can improve student performance in physical sciences if relevant factors such as teaching aids, class size, teaching subject qualifications, and teaching experience have been conditioned and will have an impact on student achievement [4]. Applying the PBL Model improves student skills identifying the relationship between cause and effect of a problem, generalizing to understanding new information more efficiently, improving critical thinking skills, understanding key information ideas, identifying knowledge structures and understanding the contents of the lesson [11].

4. Conclusion
Descriptive data analysis results, obtained research findings are: (1) the activity of students taught by applying PBL learning models increases with the active category. (2) the learning performance of students who learn to use student worksheets increases in each learning. (3) Researchers were able to apply learning with PBL models with good categories.

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