



Influence of Problem Based Learning (PBL) in Calculating Time Duration on Students Learning Outcomes and Critical Thinking

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Abstract

The Problem Based Learning (PBL) model is a learning approach that places students in real-world situations or problems that require resolution. The purpose of this study was to determine the effect of PBL implementation in improving students' critical thinking in mathematics material, especially related to calculating time duration. Respondents in this study were students of SDN Kaling 01 and 02. The method used was a quasi-experimental design by comparing the impact of PBL on critical thinking skills in the control class (SDN Kaling 01) and the experimental class (SDN Kaling 02). The results of this study were obtained from a comparison of the average N-Gain in the control and experimental classes. The results in the control class, the average N-Gain was 0.42, which is in the moderate category, while in the experimental class the average N-Gain was 0.62, which is classified in the moderate category. This shows that the average N-Gain of students' learning outcomes in the experimental class is higher than in the control class, although both are in the moderate category.

Keyword: problem based learning, critical thinking, time duration, student learning outcome

1. INTRODUCTION

Mathematics is a fundamental scientific discipline in technological development and has great relevance in everyday life. Mathematics education not only teaches basic concepts, but also develops critical, scientific, independent and creative thinking skills in students. This is in accordance with the Minister of National Education Regulation no. 22 which emphasizes the importance of mathematics in responding to and appreciating science and technology. According to Government Regulation of 2013 No. 32 Article 19, the learning process in educational units must be carried out in an inspiring, interactive, challenging and fun manner. This approach aims to motivate students to actively participate in learning, as well as providing space to foster their creativity, initiative and independence in accordance with their

independence in accordance with their respective talents, interests and cognitive and psychological development. Thus, mathematics not only becomes an integral part of the educational curriculum, but also provides an important foundation for the development of thinking abilities and skills needed to face the challenges of the modern world. Good mathematics education can make a significant contribution in preparing young people to face the changes and complexities in today's global society. Understanding mathematics does require a high level of focus and concentration. Continuous practice in solving various types of questions is the key to mastering concepts well and achieving optimal mastery of the material [1]. For most students, mathematics is often considered a challenging subject and has a high level of difficulty. One of the materials in mathematics that often becomes an obstacle for students is calculating the duration of time. The most common problem experienced by students is a lack of self-confidence in solving mathematics problems, especially those involving the concept of time duration. Some students may not feel confident enough or feel that they do not have sufficient skills to cope with the material.

The general view that mathematics is a difficult subject often makes some students avoid or feel anxious when studying mathematics. This can hinder their learning process. Therefore, it is important to approach learning mathematics with a positive attitude, build self-confidence, and face challenges with the determination to continue learning and develop mathematics skills gradually. Low understanding of mathematics before trying to study it more deeply can have a negative impact on students. This is reflected in the low interest in reading among students in Indonesia, as stated by Zainal [2]. This low interest can affect their understanding of mathematical concepts that are important in everyday life and their academic abilities. The results of the 2018 Program for International Student Assessment (PISA) show that Indonesia is ranked 74th out of 79 countries in students' mathematical literacy abilities, with an average score of 379, far below the international average of 489 (OECD, 2019). As many as 76% of students in Indonesia did not reach level 2 in mathematics ability, while only 0.3% reached the highest level, namely level 5. This shows that there is a significant lag in understanding and ability in mathematics among Indonesian students compared to students from other countries. Low interest in reading and limited understanding of mathematics can contribute to gaps in thinking between students in Indonesia and in other countries. Therefore, greater efforts are needed to increase interest in reading and understanding of mathematics among Indonesian students, so that they can be better prepared to compete globally in terms of mathematical literacy and critical thinking skills [3].

Learning models have an important role in creating meaningful and effective learning experiences for students. Various types of learning models are used by teachers according to the material taught and existing class conditions. The aim of

implementing this learning model is to create quality, meaningful and effective learning [4]. By implementing appropriate learning models, teachers can increase students' interest and involvement in the learning process. Students tend to enjoy learning more because they are actively involved in more diverse and interactive learning activities. This also creates a more lively and dynamic classroom atmosphere, where students feel more involved and encouraged to learn better. In other words, implementing appropriate learning models can contribute significantly to achieving learning goals and improving the overall quality of education. These learning models not only create a better learning environment, but also help in developing students' abilities to understand and apply the subject matter better in their lives. The research entitled "The Effect of Applying the Problem Based Learning Model in Materials for Calculating Time Duration on Learning Outcomes and Critical Thinking in Class V Elementary School Students" was carried out to overcome obstacles that still exist in learning related to material calculating time duration. These obstacles include low critical thinking skills and suboptimal learning outcomes among students [5]. The Problem Based Learning (PBL) model was chosen as the approach in this research because it is considered to help students to be more actively involved in the learning process. PBL emphasizes real problem solving, where students are given challenges to solve problems that are relevant to everyday life. In this way, it is hoped that students can develop their critical thinking skills better, while increasing their understanding of the concept of calculating time duration. The aim of this research is to evaluate the effect of implementing PBL on student learning outcomes and also on the development of their critical thinking skills. Through this approach, it is hoped that students will be able to internalize concepts better and apply them in a wider context, as well as improve their ability to solve problems. Thus, this research not only aims to improve student learning outcomes in mathematics material, especially calculating time duration, but also to promote the use of innovative and effective learning models in the context of basic education. Identification of problems in SDN 1 Kaling, as follows, Lack of interest of students in mathematics and the assumption that mathematics is difficult, causes many students to avoid mathematics, As many as 76% of Indonesian students' mathematical literacy skills, Conventional learning models reduce students' interest and participation in mathematics, which looks passive, Students have difficulty in understanding the basic concepts of mathematics that are taught, are less skilled when solving problems with systematic steps, The level of critical thinking skills of students is still low, data shows that 15-30% of students do not complete mathematics learning.

2. METHOD

This research was observed to identify initial problems in the mathematics learning process in elementary schools. The problems was formulated and solutions are sought, so that they can influence students' learning outcomes and critical thinking abilities. The thinking framework in this research was used as a guide for understanding the influence before and after treatment, and functions as a procedural guideline in applying the Problem Based Learning Model to the material of calculating time duration on learning outcomes and critical thinking abilities of elementary school students. The research thinking framework can be seen in the illustration in Figure 1.

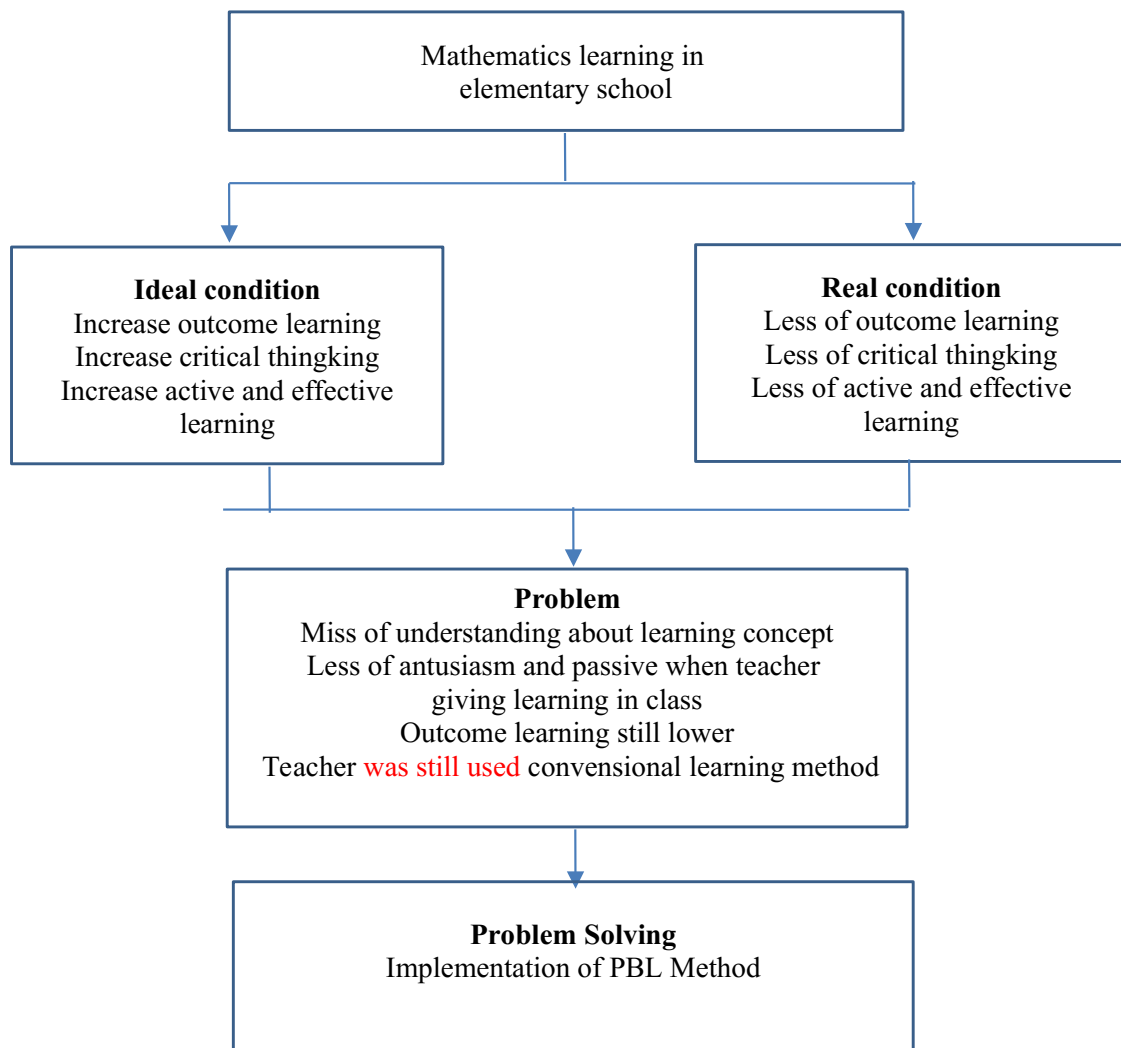


Figure 1. Research Framework

3. RESULT AND DISCUSSION

3.1 The Principal Mathematics Learning in Elementary Schools

Learning is an action or effort carried out to make students learn. In this process, teachers must optimize ideas and design interesting learning activities to create memorable learning experiences. Teachers are required to be creative and have high enthusiasm in organizing learning. This will spread to students' enthusiasm in receiving learning. According to Rusman [6], learning is a reciprocal process between teachers and students, both directly through face-to-face and indirectly through application media interactions. According to Siskayanti et al [7], learning is a serious and systematic effort that involves all physical and mental potential to acquire knowledge or expertise in a particular field. Learning is also a step of change, such as from a lazy character to being diligent and determined. It can be concluded that learning is an effort to understand or know something in order to achieve the ideals and goals of life. Factors that influence learning can come from within, such as feeling lazy (inside), or from outside, such as an uncomfortable environment or interference from other people (outside). Changes in character in learning can be measured, but do not occur in just one learning meeting, because good behavioral changes require consistent learning over time with the experience and learning practices gained. Learning activities can determine the success of learning objectives, so learning strategies are needed to plan, manage and evaluate the learning process. According to Muhammad et al [8], mathematics learning is an effort made by teachers to provide new insights to students in the hope of developing the ability to master mathematics as well as critical and creative thinking. Learning and teaching are closely related units, where these two activities collaborate to create a good relationship regarding the subject matter between teachers and students. Mathematics, as a mandatory science at all levels of education, aims to encourage students to have logical reasoning, critical, analytical, creative and cooperative thinking skills. Mathematics learning is a teaching and learning process carried out by teachers so that students can construct new knowledge, especially in improving their mastery of mathematics material. Mathematics learning is abstract, where things that are considered logical by teachers as educators may not necessarily be accepted without causing confusion among students. Many factors influence the low level of mathematical knowledge in Indonesia, including memory, critical thinking skills, and students' difficulties in solving mathematical problems [9].

3.2. Problems of Mathematics Learning in Elementary Schools

The quality of learning in schools is influenced by several factors, including teachers, facilities and the school environment [10]. Teachers, as one of the main components in learning, must have extensive knowledge according to their field of expertise and continue to develop creative ideas to create effective learning to achieve learning goals. Mathematics, as a compulsory subject, is often feared and has scary connotations among students from various levels of education. This creates additional challenges for teachers to plan mathematics learning that is fun and allows students to understand mathematical concepts thoroughly. Therefore, problem solving in mathematics learning can be done through the following stages: (1) understanding the problem, (2) preparing a plan, (3) implementing the plan, and (4) evaluating. Students learn mathematics as a result of problem solving. Regular practice in doing something is an effort to improve abilities in the desired field, the same as the goal of studying mathematics. Mathematical problem solving occurs when students encounter a situation that they understand but do not know how to find the solution to. They are interested in solving the problem and are asked to use mathematical concepts in solving it. Based on several cases that occur during mathematics learning, teachers can conclude and analyze class conditions to find the right solution. Teachers also need to understand the learning characteristics of elementary school students to implement appropriate learning, because each student has different characters, difficulties and understanding. This requires appropriate learning strategies, models and approaches [11].

3.3. Material for calculating time duration

Mathematics has a crucial role in improving thinking abilities. Even though it is often considered a scary subject for students, understanding mathematics is still important. The material in this subject functions as a conceptual tool that helps build and develop understanding and trains the necessary critical thinking skills [12]. This competency is very important so that students have the skills to obtain, manage and use information in facing a dynamic, uncertain and competitive life. The material for calculating time duration is an important basic skill to be learned by fifth grade elementary school students. According to Bahtiar [13], this material not only helps students understand the concept of time, but also trains their abilities in solving everyday problems that involve calculating time. Through this lesson, students will learn how to determine the difference between two given times, both in hours and minutes format and in more complex contexts. A good understanding of time duration will help students organize their schedules, understand the length of an activity, and improve their overall math skills. Following are the learning achievements to calculate the duration can be seen in table 1.

Table 1. Achievements Learning

Element of learning achievements	Learning achievements	Learning purpose
Measurement	Student can calculating the duration time	Student has competence to make time conversion
		Student can calculate the units of time operation
		Student can calculate duration time activities
		Student can calculate start and ending time activities
		Student can sort activities based on time

Understanding and learning more deeply about calculating time duration in various standard units such as seconds, minutes, hours, days, months and years is important for students. The following are some of the activities that will be studied in the material for calculating time duration: Conversion between time units: Students will learn to convert time from one time unit to another, for example from seconds to minutes, hours to days, months to years, and vice versa. Adding and subtracting time: Perform calculations to find the time difference between two given times, either in the same format (e.g. hours and minutes) or between different formats (e.g. days and hours). Application in real situations: Carrying out exercises to calculate the duration of time in the context of daily life, such as travel time, activity time, or the duration of certain activities. Understand different time notations: Understand how to write and read time in 12-hour (AM/PM) and 24-hour (military format). Problem solving: Students will be invited to solve problems that involve calculating the time duration to complete certain challenges or complex situations. These activities are designed to help students understand the concept of time duration comprehensively and can be applied in various contexts of daily life as well as improve their overall math skills.

Converting time units is an important basic skill students learn for everyday life. Standard units on Time measurements are seconds, minutes, hours, days, weeks, months and years. This is the relationship between units of time.

$$1 \text{ hour} = 60 \text{ minutes} = 3,600 \text{ seconds}$$

$$1 \text{ minute} = 60 \text{ seconds}$$

$$1 \text{ month} = 4 \text{ weeks} = 30 \text{ days}$$

$$1 \text{ week} = 7 \text{ days}$$

$$1 \text{ day} = 24 \text{ hours}$$

$$1 \text{ year} = 12 \text{ months} = 52 \text{ weeks} = 365 \text{ days}$$

In calculating time units using the 24 hour format, students will learn to determine the time signature correctly. Analog clocks are used as a tool to visualize time in this format. In an analog clock, there is a short hand that shows the hours and a long hand that shows the minutes. This process involves: Determining the hour with the short hand: Students can observe the position of the short hand on an analog clock to find out the number of hours displayed. Determining the minutes with the long hand: The long hand on an analog clock shows the position of the minutes, which is read by paying attention to the scale lines around the hour. The 24-hour format is used to indicate the time of day, where 00:00 is midnight and 24:00 is midnight the following night. Understanding and using this format helps students understand time more precisely, especially in the context of clocks used internationally and in situations that require precise timing.

To calculate the length of an activity or the duration of an activity, we can use the following simple formula:

$$\{\text{Activity duration}\} = \{\text{end time}\} - \{\text{start time}\}$$

For example, if we have a start time of 08:00 and an end time of 10:30, we can calculate the activity time as follows: Convert time into the same format, make sure the start time and end time are expressed in a consistent format, for example in hours and minutes. Calculate time difference, subtract the start time from the end time. For example, if the start time is 08:00 and the end time is 10:30, then:

$$\{\text{Time of activity}\} = 10:30 - 08:00$$

Add minutes if necessary, if the subtraction results in different hours and minutes, make sure to add minutes as needed. Application of this formula helps in measuring activity duration accurately, which is important in schedule planning and evaluating time efficiency.

To determine the start time and end time of an activity, there are two methods that can be used Determine the end time: If the start time and duration of the activity are known, then the finish time can be calculated using the following formula:

$$\{\text{End time}\} = \{\text{Start time}\} + \{\text{Activity duration}\}$$

Example:

If the activity start time is 08:00 and the activity duration is 2 hours 30 minutes, then:

$$\{\text{End time}\} = 08:00 + 2 \text{ hours } 30 \text{ minutes}$$

$$\{\text{End time}\} = 10:30$$

Determine the start time: If the completion time and duration of the activity are known, then the activity start time can be calculated using the following formula:

$$\{\text{Start time}\} = \{\text{End time}\} - \{\text{Activity duration}\}$$

Example:

If the activity end time is 12:00 and the activity duration is 3 hours, then:

$$\{\text{Start time}\} = 12:00 - 3 \text{ hours}$$

$$\{\text{Start time}\} = 09:00$$

Additional Explanation: Make sure to be consistent in the time format used (for example, using hours and minutes). If the activity duration is given in different units of time (for example, hours and minutes), be sure to convert it to the appropriate unit before performing calculations. The use of these formulas helps in determining the exact starting and ending points of activities, which is important in daily planning and time management.

3.4. Problem Based Learning Methods

A learning model is a method of delivering subject matter that greatly influences the learning process. This includes the formation of concepts and the way students receive material according to their thinking patterns. According to Amalia & Dewi [14], a learning model is a structured pattern that is used as a basis for designing learning activities, helping students obtain information, ideas, thoughts, and ways of expressing things. From this, it can be concluded that the learning model is the effort made by the teacher to achieve learning goals. The problem-based learning model is a model that focuses on problem solving, where students form their own knowledge and improve their thinking abilities through a series of learning activities. Learning that applies the problem based learning model will increase students' learning motivation when they solve a problem. This learning can be done individually or in groups. Each student has their own role in identifying problems and compiling their knowledge based on experience to find solutions. Thus, this model emphasizes the importance of communication, cooperation, and developing reasoning abilities [15]. The results in the control

class, the average N-Gain was 0.42, which is in the moderate category, while in the experimental class the average N-Gain was 0.62, which is classified in the moderate category. This shows that the average N-Gain of students' learning outcomes in the experimental class is higher than in the control class, although both are in the moderate category. Through the application of the problem based learning model, the goals that students wish to achieve include the ability to identify critical issues, become more independent, confident, able to integrate knowledge from various points of view, and evaluate ideas and research to increase knowledge [16]. This learning process is not systematically structured, so that at the problem identification stage, each student will play an active role and focus on acquiring new knowledge. Students are encouraged to think creatively, critically, and be confident in their mathematical abilities, so that they are able to understand mathematical concepts based on the problems studied during the process. In mathematics learning, the problem based learning model is very suitable to be applied to develop students' insight into mathematical concepts because it can improve their inquiry abilities contextually. The sense of self-confidence that emerges during the problem solving process will have a positive impact on superior learning outcomes and develop students' learning motivation in studying mathematics [17]. Based on the results of observations of learning implementation, the use of the problem based learning model with material for calculating time duration was implemented well. This learning model has a positive impact on improving learning outcomes and students' critical thinking abilities. This is known from the results of observations of the implementation of the problem based learning model. Observation activities are carried out in accordance with the observer's assessment using the learning process assessment sheet that has been prepared. Assessments are carried out by school principals and teachers to assess the extent to which the learning process is in accordance with the syntax of the problem based learning model.

4. CONCLUSION

The increase in student learning outcomes in calculating time duration cannot be separated from the application of the problem based learning model which encourages students to actively interact and express new opinions or solutions to mathematical problems. Students' activeness during the learning process has a positive impact on improving learning outcomes and making it easier for them to understand the material presented by the teacher. The increase in learning outcomes occurred as a result of implementing the problem based learning model which was implemented well by the teacher. The learning process which was initially teacher-centered changed to become student-centered. Implementing

student-centered learning requires innovative learning models, a fun learning atmosphere, and triggers critical thinking. Therefore, the application of the problem based learning model in this research is able to accommodate students' activeness in being student-centered, making the learning process more enjoyable because it is in accordance with the students' wishes. Suggestions for future research, from the results of the study of the application of the problem-based learning model to class V students of SSDN 01 Kaling, Karanganyar can be a learning innovation that is adjusted to the needs of students. The problem-based learning model can be implemented in other subjects as an alternative method that can improve learning outcomes and critical thinking of students.

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