IMPROVING MATHEMATICS LEARNING OUTCOMES WITH PROBLEM-BASED LEARNING AND LIVEWORKSHEETS AT BUDI MULIA DUA VOCATIONAL HIGH SCHOOL

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Abstract: This research aims to progress students' mathematics learning achievement through the application of a problem-based learning model demonstrate helped by live worksheets in class XII of Budi Mulia Dua Vocational High School for the 2024/2025. This research is classroom action research carried out in 2 cycles. Each cycle consists of planning, action, observation, and reflection. The research subjects were 20 students in class XII of Budi Mulia Dua Vocational High School for the 2024/2025. Research data was obtained through tests, observation and documentation. Data analysis uses qualitative descriptive analysis techniques. Data validation uses triangulation method. The results of the research show that there is an increase in the learning outcomes of students at XII Budi Mulia Vocational High School for the 2024/2025 academic year through the application of the problem learning model assisted by live worksheets. The increase in learning outcomes is shown by an increase in the average percentage of achievement of mathematics learning outcomes from 44.5 in pre-cycle to 70.83 in cycle 1, then increasing to 76.9 in cycle 2. Based on these results it can be concluded that there is an increase in student learning achievement in mathematics lessons, especially statistics material with the problem-based learning model demonstrate helped by live worksheets. The integration of liveworksheets in syntax PB, can increase student enthusiasm and interests. The limitation of this study is the small sample size, which means there is potential for bias in data collection. In addition, this study is also limited to statistical material.

Keywords: problem-based learning, learning outcomes, mathematics, liveworksheets, vocational education

Introduction

Mathematics could be a science or knowledge almost learning or logical thinking that's required by people to live, which forms the basis for the development of modern technology. Mathematics plays an important role in various disciplines and encourages the development of human thinking. Mathematics is considered a subject that must be understood and a conceptual tool for constructing and reconstructing material, honing, and training the thinking skills needed to solve problems in life. (BSKAP, 2022). The important role of mathematics in the current technological era is not in line with the facts that occur in the field. In fact, mathematics is still a subject that is not in demand and is considered difficult for some students, this causes students' disengagement in learning and low math learning result. (Meliana, 2023; Ardila, 2017; Hidayati, 2023).

The characteristics of students at the vocational level are different from high school students, especially in their orientation and learning style. In general, high school students focus more on academic achievement in subjects such as math, science and social studies, while vocational students focus more

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on mastering vocational skills in the majors taken. This also causes the student's interest and learning results of vocational students in mathematics to be usually lower than high school students. This is a challenge for math teachers to continue to improve students' math learning outcomes through various innovative models, methods and supporting learning media.

Budi Mulia Dua Vocational High School is an inclusive school in Yogyakarta. Based on observations at Budi Mulia Dua Vocational High School, it is known that the characteristics of students there are very diverse, ranging from students with above-average cognitive abilities to students with border line abilities. The results of the midterm assessment of class XII mathematics showed that only 30% of students reached the KKM (passing grade) score of 73, while 70% of other students scored below the KKM (passing grade). The observations and interviews results explain that there are several things may affect the low learning outcomes of students in mathematics. Among them is the use of learning models and media that are less than optimal and varied.

Innovative and fun learning models greatly affect the quality of the learning process, so that it can improve students' math learning outcomes. One of the recommended learning models is the problem-based learning (PBL) model. Problem-based learning is defined as a learning model that involves students in solving authentic and complex problems. PBL aims to improve students' critical thinking skills and analytical abilities, as well as encourage them to take responsibility in the learning process (Schwartz, 2001: 2). The syntax of Problem-Based Learning (PBL) according to Arends (2012), includes: (1) Orient students to the problem, (2) Organize students to learn, (3) Guide independent and group investigations, (4) Develop and present results and (5) analyze and evaluate solutions. Several studies have shown that the problem-based learning model can increase students' interest and math learning outcomes (Mertayasmini, 2023; Mashuri, 2019; Fatkhurrohman, 2023; Sholikhakh, 2019).

Learning media is also one of the variables that is often used to improve mathematical literacy skills. Learning media is increasingly developing in line with the times and technology. The emergence of computers and digital transformation in all aspects of people's activity allows for a representative environment for interactive mathematics learning. This environment can be present in different modes of representation through several applications/platforms (Sümmermann et al., 2021). One of the learning media that can improve math literacy is liveworksheet. Liveworksheets is one of the digital platforms based on e-worksheets. On its website, liveworksheets writes that liveworksheets allows users to turn traditional printed worksheets and class assignments (doc, pdf, jpg) into interactive online exercises with automatic grading, making them real. An amazing tool for students, teachers and schools.

Based on the results of Faridi's research (2023) the use of liveworksheets can enhance students' learning outcomes in mathematics.

Various studies on the use of PBL models to enhance student math learning performance have been conducted, as well as research on the use of liveworksheets to improve student math learning outcomes. Research related to the use of problem-based learning models assisted by liveworksheets on several variables has been studied, such as: to improve students' mathematical communication skills (Nurjiah, 2024), to improve students' mathematical creative thinking skills (Sari, 2023) and to improve students' mathematical problem solving (Haqiqi, 2021). Meanwhile, the purpose of this study is to enhanced students' mathematics learning outcomes using the PBL model assisted by liveworksheets on statistics material at Budi Mulia Dua Vocational High School which is a novelty in itself from previous studies.

Materials and Methods

This research method is Classroom Action Research (CAR), which in general is a type of research that aims to improve and improve the quality of the learning process in schools in general and in the classroom in particular (Sugiyono, 2013). This research was carried out in 2 cycles, using the Kurt Lewin CAR model in which there are four stages of implementation including planning, action implementation, observation, and reflection. This research was conducted at SMK Budi Mulia Dua in October - November 2024. The subjects of this study were class XII students totaling 20 people consisting of 12 female students and 8 male students.

Data collection techniques used in this study were tests and observations. The research instruments used were a mathematics test and an observation sheet on the implementation of learning. The research instruments were validated using expert judgment by two validators who were experts in the field of mathematics education. Meanwhile, the reliability of the mathematics test was measured using Cronbach's alpha. Data analysis using qualitative descriptive analysis techniques. Data analysis carried out is by the average percentage of students' mathematics learning outcomes to determine the improvement of student learning outcomes and analysis of the percentage of learning implementation to determine the description and increase in the percentage of successful implementation of learning according to the predetermined syntax.

The syntax that will be used in developing research instruments in the form of teaching modules and observation sheets for learning implementation is the syntax of problem-based learning combined with the help of liveworksheets in several syntaxes, namely:

1. Orient students to the problem,

2. Organize students to learn using liveworksheets,

3. Guide independent and group investigations with the help of liveworksheets,

4. Develop and present results using liveworksheets

5. Analyze and evaluate solutions.

Meanwhile, the development of question instruments to measure students' mathematics learning outcomes was prepared based on the Dirjendikdasmen Decree (2017) on basic competencies 3.2.7. Evaluate statistical studies in contextual problems and 3.2.8. Solve contextual problems related to the study of statistics.

The indicators of success in this study are defined as follows:

1. The students' mathematics post-test results reached 73 (in accordance with the predetermined minimum passing grade).

2. More than 60% of students achieved a passing grade

3. The percentage of the learning implementation were at least in the good category, based on table 1 below.

Table 1: Criteria for Learning Implementation

Percentage Interval	Criteria
$90\% \leq x \leq 100\%$	Excellent
$80\% \leq x < 90\%$	Good
$70\% \leq x < 80\%$	Fair
$60\% \leq x < 70\%$	Poor
$0\% \leq x < 60\%$	Very Poor

Results and Discussion

This research was conducted in two cycles, each cycle consisted of two meetings, with the time allocation of each meeting 2 x 45 minutes. The percentage of learning implementation of problem-based learning assisted by liveworksheets in cycle 1 amounted to 85.7% in cycle 2 increased to 92.9%
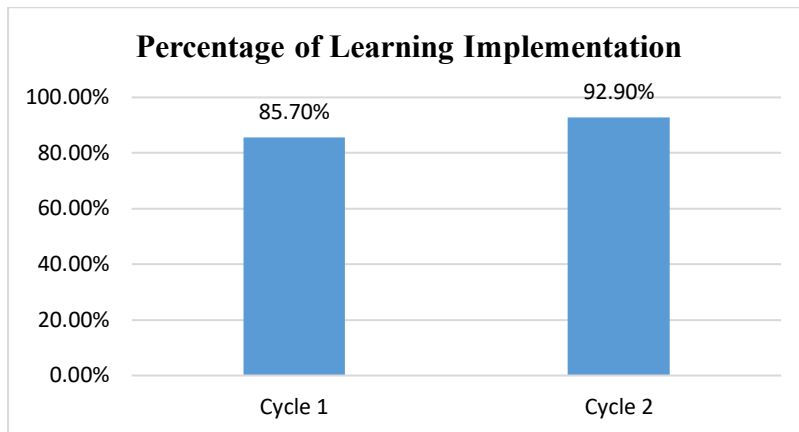
Percentage of Learning Implementation

Figure 1: Graph of the percentage of learning implementation of problem-based learning assisted by liveworksheets.

From the data above, it can be seen that there is an improvement and increase in the implementation of learning from cycle 1 to cycle 2. Notes and reflections on cycle 1 include: (1) During learning, the teacher had checked and provided information about using the liveworksheet platform, but at the end of the session there was one group that did not submit to email so that the answers were not recorded. (2) Not all students are actively involved in the discussion, there are some students who are still passive during group discussions. (3) Learning time management is not maximized, so there are two groups that have not presented the results of their group discussions. (4) The teacher did not conduct feedback and immediately concluded together with the students because the time had ended. The reflection carried out at the end of cycle 1 was used as the basis for planning improvements in the implementation of learning in cycle 2. After making improvements in cycle 2, the percentage of learning implementation in cycle 2 increased to 92.9%. Some evaluations on the implementation of cycle 2 learning include: (1) The number of students who have not been active in the discussion has decreased. (2) Learning time management has been better, according to the plan in the teaching module. (3) All groups can present the results of their group discussions. (4) The teacher has given feedback but not maximally exploring feedback from students because the time has ended. Based on the observation results and the percentage of learning implementation, it can be said that the implementation of learning has been in the very good category and has improved from the previous cycle.

The implementation of the problem-based learning model assisted by liveworksheets is different from the usual problem-based learning model, namely the integration of liveworksheets in syntax 2 to 4, namely (2) organizing students to learn using liveworksheets, (3) guiding independent and group

investigations with the help of liveworksheets, (4) developing and presenting results using liveworksheets. Based on the observation results, students look more enthusiastic and interested.

Student math learning outcomes tests were conducted 3 times, namely during the pre-test, post-test cycle 1 and post-test cycle 2. The average pre-test achievement of students' math learning outcomes was 44.52, then in the post-test cycle 1 it became 70.83 or increased by 59.10% from before. In the post-test cycle 2, the average math learning outcomes increased to 76.92 or increased by 8.59% compared to cycle 1. The data on the average score of students' math learning outcomes are presented in the following diagram:

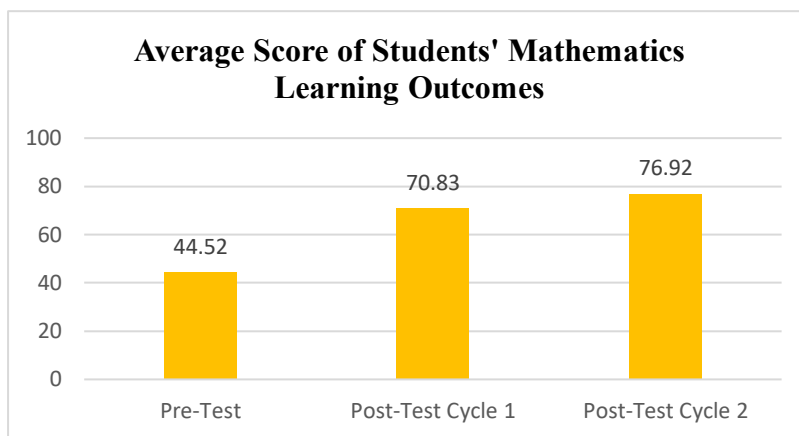**Average Score of Students' Mathematics Learning Outcomes**

Figure 2: Graph of the average score of students' math learning outcomes

The KKM (passing grade) value that has been determined in this study is 73. Students are said to be complete if they get a minimum score of 73 and are said to be incomplete if they score less than 73. Based on the data on students' mathematics learning outcomes, the number of students who achieved scores above the KKM (passing grade) increased from the pre-test, post-test cycle 1 and post-test cycle 2. Based on the pre-test results, there were only 3 students who were complete, or only 15% of students who achieved a minimum score of 73. In the results of post-test 1 there were 10 students who got a minimum score of 73 or 50% of students who were complete. While the results of post-test 2 students who scored above the KKM (passing grade) increased to 14 students or 70% of students were complete. From the graph below, it can be seen that the number of students who are complete is increasing from 15%, 50% and 70%, while the number of students who are not complete is decreasing from 85%, 50% and to 30%.
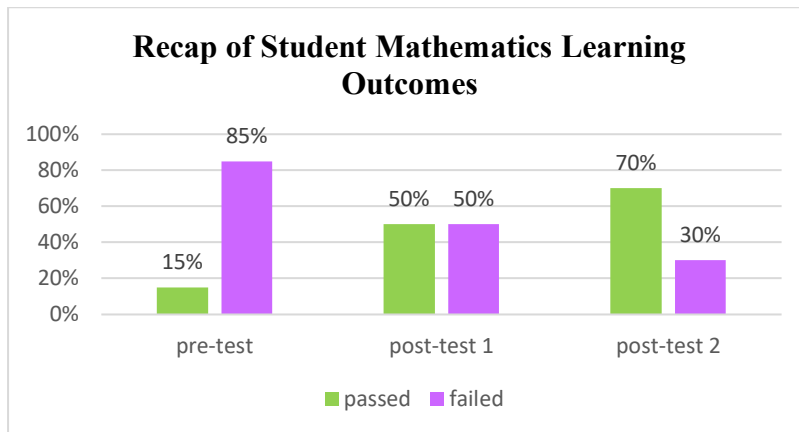
Figure 3: Recap graph of student math learning outcomes scores

The results of the research on the application of problem-based learning assisted by liveworksheets to improve the learning outcomes of mathematics students of SMK Budi Mulia Dua are said to be successful because they have met the success criteria set previously. The success criteria of this study have been exceeded, namely an increase in student math learning outcomes from the pre-test, post-test cycle 1 and post-test cycle 2. The average student math learning outcomes have also reached 76.92 above the predetermined KKM value of 73. Based on the results of the percentage of learning implementation, the results obtained are 85.7% and 92.9% which are included in the very good category and have met the minimum criteria for learning implementation above 75%.

From the results of the data analysis above, it can be concluded that the problem-based learning model assisted by liveworksheets can improve the mathematics learning outcomes of students of SMK Budi Mulia Dua. This corroborates the results of previous research that the problem-based learning model can improve students' mathematics learning outcomes (Mertayasmini, 2023; Mashuri, 2019; Fatkhurrohman, 2023; Sholikhakh, 2019) and the use of liveworksheets can improve students' mathematics learning outcomes (Faridi, 2023).

Conclusion

The application of a problem-based learning model assisted by liveworksheets to improve students' learning outcomes in mathematics on statistics material in Budi Mulia Dua Vocational High Schools has been successfully implemented. This can be said to be successful because it has met the research criteria that were set previously. (1) The average post-test score for mathematics exceeded the minimum score of 73. The average mathematics learning outcomes of students of SMK Budi Mulia Dua for statistics material have increased in each cycle. It increased from 44.52 during the pre-test, 70.83 for the cycle 1 post-test and rose to 76.92 in the cycle 2 post-test. (2) More than 60% of students exceeded the minimum passing grade. The number of percentage of completeness in statistics material increased from 15%, to 50% and 70% at the end of the cycle. (3) The percentage of learning implementation of PBL with liveworksheets reached the "good" category. It was 85.7% in cycle 1 and increased in cycle

2 to 92.9%. This means that PBL provided by liveworksheets can be implemented well and can improve the mathematics learning outcomes of Budi Mulia Dua Vocational High School students on statistics.

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