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# Improving Mathematical Literacy Skills of Grade X Vocational Students Through Project Based Learning

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**ABSTRAK**

Penelitian ini bertujuan meningkatkan literasi matematika siswa kelas X SMKN 1 Aek Nabara Barumun melalui model Project-Based Learning (PjBL). Menggunakan desain one group pretest-posttest, intervensi dilakukan selama empat pertemuan pada semester genap 2024/2025 dengan 16 siswa. Hasil analisis menunjukkan peningkatan signifikan skor pretest ke posttest, dengan rata-rata N-Gain sebesar 0,57 (kategori sedang). Temuan ini menunjukkan efektivitas PjBL dalam mendorong pembelajaran aktif dan pemecahan masalah, serta layak dipertimbangkan sebagai alternatif pendekatan oleh guru matematika di SMK.

**Kata Kunci**: Literasi Matematika; Pembelajaran Matematika; Project Based Learning.

**ABSTRACT**

This study aims to improve the mathematical literacy of tenth-grade students at SMKN 1 Aek Nabara Barumun through the Project-Based Learning (PjBL) model. Using a one-group pretest-posttest design, the intervention was conducted over four meetings in the even semester of 2024/2025 with 16 students. The analysis showed a significant increase in pretest-posttest scores, with an average N-Gain of 0.57 (moderate category). These findings demonstrate the effectiveness of PjBL in encouraging active learning and problem-solving, and are worthy of consideration as an alternative approach for mathematics teachers in vocational high schools.

**Keywords**: Mathematical Literacy; Mathematics Learning; Project-Based Learning.

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## 1. INTRODUCTION

Mathematical literacy is the ability of individuals to formulate, apply and interpret mathematics in various contexts, including the ability to reason mathematically and use mathematical concepts, procedures, facts and tools to describe, explain or predict phenomena

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or events (Kusumawardani, 2018). Mathematical literacy skills help a person to understand the role or use of mathematics in everyday life while using it to make the right decisions as a constructive, caring and thinking citizen (Makhmudah, 2018).

According to Jannah (2021), mathematical literacy is an important factor in the learning process. (Astuti & Wardodno, 2022) Mathematical literacy refers to a person' s ability to understand, apply, and analyze mathematics across different real-life situations and research (Harisman dkk., 2023) Mathematical literacy problems involve the ability to calculate and solve mathematical problems encountered in everyday life.

This is because mathematical literacy involves not only understanding basic mathematical concepts, but also students' ability to apply this knowledge in solving real-life problems. By improving mathematical literacy, students will be better prepared to face challenges that require critical thinking, analytical thinking, and the ability to make the right decisions in various contexts (Sektiwulan et al. 2025).

Currently, students' ability in mathematical literacy is still low (Ramadhan dkk., 2023). The results of the PISA survey in 2022 Indonesia's mathematical literacy ability (KLM) ranked 70th out of 81 countries with an average score of 366 points (Suhengrin & Sukestiyarno, 2024). Based on the results of Wisnu Hapsari research (2023), it is also known that according to the indicators of mathematical literacy, the least students master the correct interpretation of information, namely 49.96%.

The change of the 2013 curriculum to the Merdeka Curriculum is a new gate for Indonesia to improve PISA scores through more optimal learning. Therefore, planning is needed to improve mathematical literacy, one of which is through learning models (Feriyanto, 2022). According to Daga (2021), the responsibility of teachers in responding to the independent learning policy is to implement learning innovations and provide a learning environment that is independent and in line with the academic demands of both students and teachers.

Based on interviews with mathematics teachers at SMKN 1 Aek Nabara Barumun, students' mathematical literacy is still very low. It is shown that students have difficulty in identifying, understanding, applying and using mathematical concepts in everyday life because there are still many students who are not aware that mathematical literacy has an important role in life. Actually, in the learning process the teacher always gives contextual examples and uses teaching materials with simple language but there are still many students who are categorized as not understanding in learning.

One of the steps so that students can develop mathematical literacy skills is with project-based learning, according to Prendergast (2016) math projects as a whole have the aim of teaching mathematics by providing real understanding. Project-based learning is a learning method that uses projects/activities as media (Kumalaretna & Mulyono, 2017) Project Based

Learning helps students to be more active in learning by exploring, interpreting, synthesizing, and analyzing information in completing a project. Learning based on student experience in conducting activities in the field to collect information (Fadillah et al. 2021).

According to (Nurfitriyanti, 2016) explains that the project-based learning model can foster a more disciplined student learning attitude and can make students more active and creative in learning, and has tremendous potential to make the learning experience more enjoyable and meaningful. Project-based learning also facilitates students in investigating, solving problems, is student centered, and produces real products in the form of project results (Rati et al. 2017). In addition, this learning model encourages collaboration between students and improves critical thinking and problem solving skills (Sa' diyah et al. 2023).

With a student-centered approach, Project Based Learning allows them to be more independent in designing, developing, and completing projects according to the problems they face. This is also in line with efforts to improve 21st century skills, such as communication, creativity, and collaboration, which are needed in the world of work and everyday life (Undari et al. 2023). This is reinforced by research conducted (Jannah dkk., 2021) project-based learning model (PjBL) is suitable for improving students' mathematical literacy because students not only learn theory but also real-world practices. In addition, according to (Maysarah dkk., 2024) that mathematical literacy can be improved if it is addressed with a realistic scientific approach using a Project Based Learning-based learning model.

Although past studies suggest that the Project-Based Learning (PjBL) approach supports the development of key 21st-century skills such as creativity, collaboration, and critical thinking, most of these studies focus on general education and rarely specifically evaluate the impact of PjBL on mathematical Literacy in the context of vocational education. This creates a significant gap, given that learning in Vocational High Schools has unique characteristics that require skills, problem-solving abilities, and adaptability to the demands of the workplace.

This study aims to address the limitations by evaluating the implementation by evaluating the implementation of the PjBL model in mathematics learning in grade x of vocational high schools. This approach is designed to directly connect mathematical concepts with the workplace context, thereby encouraging the development of mathematical literacy that is applicable and relevant to vocational needs. This, this study not only contributes to expending empirical research on the effectiveness of PjBL buat also provides prcktical, contextual recommendations for educators in optimizing Mathematics learning in the independent Curriculum era.

## 2. METHOD

The study adopted a quantitative approach with a quasi-experimental design to investigate the effectiveness of the Project-Based Learning (PjBL) model in improving students' mathematical literacy. The independent variable is the PjBL model, and the dependent variable is students' mathematical literacy skills (Maysarah dkk., 2023). This research was conducted at SMKN 1 Aek Nabara Barumun District Aek Nabara Barumun Padang Lawas Regency North Sumatra Province Kodepos 22755.

The population in this study were all class X students of SMKN 1 Aek Nabara Barumun consisting of 4 rombel and 3 different majors. The sampling technique uses random sampling where each student is given the same opportunity to become a research sample Sumargo in (Zuhri, 2021). This study used a one group pretestt-posttest design. Only one group was trated, measured before and after the intervention. This design was chosen due to ethnical and practical limitations of having a control group. Providing a treatment deemed benefical to only one group is considered unfair in a school setting (Astria dkk., 2021).

The instrument used in this study was a test to measure mathematical literacy skills. The test questions were made based on indicators of students' mathematical literacy skills which were arranged in the form of description questions consisting of 4 questions (Safitri dkk., 2024). One example question "My father spent Rp240.009 to buy two types of fruit, each weighing 17 kg. If the price of 1 kg of watermelon is Rp12.000 and the price of 1 kg rambutan is Rp15.000, how many kg of rambutan did my father buy?" This quest measures the ability to formulate problems and apply concepts and arithmetic operations in real-world situations.

This study uses data analysis in two ways, namely descriptive and inferential. Descriptive data analysis explains data related to certain samples and populations through graphs, charts, or tables. While inferential analysis aims to draw conclusions about the entire population consisting of prerequisite tests and hypothesis tests.

The prerequisite test in this study is the normality test using the Liliefors formula which functions to see whether the data is normally distributed or not. (Indah, 2016). While hypothesis testing uses t-test and N-Gain. The hypothesis test is carried out to check the normality of the data, with the main aim of evaluating whether the Project Based Learning model effectively improves students' mathematical literacy skills by comparing their pretest and posttest average scores

Accordingly, N-Gain can be determined using the formula (Siregar, 2022):

$$N - GAIN = \frac{(skor\ maks - skor\ pretest)}{(skor\ postest - skor\ prettest)}$$

From this formula, it can be known whether the N-Gain value is high or low based on the following criteria:

Table 1. N-Gain Criteria

| N-Gain Value | Criteria |
|---|---|
| N-Gain ≥ 0.70 | High |
| 0.30< N-Gain <0.70 | Medium |
| N-Gain ≤ 0.30 | Low |

Then, a paired sample t-test was used to test the significance of score improvements. This test overcomes the limitations of a sigle-group by analyzing students' internal change before and after treatment. The test was conducted at a 5% significance level, assuming the data were normally distributed.

## 3. RESULT AND DISCUSSION

The descriptive analysis results indicated an improvement in mathematical literacy among students in the experimental class who were taught using the project-based learning model. Based on the mathematical literacy tests given to students in the pre- and post-treatment classes, the data can be seen in Table 2.

Table 2. Summary of Mean Pretest, Posttest, and N-Gain Scores

| Class | Average Score | | | |
|---|---|---|---|---|
| Experiment | Pretest | Posttest | N-Gain | Criteria |
| | 30.88 | 70.81 | 0.57 | Moderate |

Table 2 shows that the average pretest score was 30.88, while the posttest average increased to 70.81. This indicates that students' mathematical literacy improved following the implementation of the PjBL model. Prior to conducting hypothesis testing using a parametric statistical method (t-test), a normality test was carried out as a prerequisite. The results of the normality test are summarized in Table 3.

Table 3. Summary of Normality Test

| Class | Test | $L_{Count}$ | $L_{Table}$ | Description |
|---|---|---|---|---|
| Experiment | Pretest | 0.122 | 0.213 | Normal |
| | Posttest | 0.160 | 0.213 | Normal |

The data normality test of the experimental class uses Liliefors which aims to determine whether the data from the research results have a normally distributed data distribution. The sample is normally distributed if L < L_Table at the α =0.05 level. but if L_Count > L_Table then the sample is not normally distributed.

Table 3 indicates that the data distribution related to the improvement of students' mathematical literacy skills using the PjBL model follows a normal distribution. It can be seen that each Liliefors test resulted in L_Count (0.414) < L_Table (0.416) Thus, it can be continued using the t-test because the normality test requirements using the Liliefors formula have been met.

Table 4. Summary of t-test

| t-Test: Paired Two Sample for Means | | |
|---|---|---|
| | Pretest | Posttest |
| Mean | 30.875 | 70.813 |
| Variance | 35.85 | 86.70 |
| Observations | 16 | 16 |
| Pearson Correlation | -0.022 | |
| Hypothesized Mean Difference | 0 | |
| Df | 15 | |
| t-Stat | -14.289 | |
| P(T<=t) one-tail | 0.000 | |
| t Critical one-tail | 1.753 | |
| P(T<=t) two-tail | 0.000 | |
| t Critical two-tail | 2.131 | |

From Table 4. it can be seen that the results of the independent sample t-test show that there is a significant increase between the mean scores of the pretest and posttest ($p < 0.05$). These findings support the conclusion that the PjBL model is effective in strengthening students' mathematical literacy abilities.

Specifically, mathematical literacy indicators that improved during project-based learning include:

1. Mathematical problem formulation

Students are able to identify and formulate problems from real-world contexts, such as determining the selling price and profit of a simple product in a project. They begin to understand how SPLDV can be used in contexts that they themselves experience.

2. Using mathematical concepts, procedures, and facts

There was an increase in students' ability to use various methods of solving SPLDV appropriately (elimination, substitution, graphing), with logical reasoning and according to the context of the problem being worked on.

3. Mathematical reasoning and argumentation

During group discussions, students were able to provide explanations and defend their opinions using appropriate mathematical language. They were also able to compare solution strategies between groups.

4. Mathematical communication

During the project presentation, students were able to convey solutions, explain steps, and visualize the results of their work in a relevant manner. This shows an increase in the ability to convey ideas mathematically.

Based on classroom observations during the use of the Project Based Learning (PjBL) model for teaching Systems of Linear Equations in Two Variables (SPLDV), there were significant changes in student learning behavior, both in terms of activity, independence, and understanding of mathematical concepts.

At the beginning of learning (cycle I), most students still looked passive, tended to wait for the teacher's direction, and were less involved in group discussions. But over time, especially when students began to enter the planning and implementation stages of the project, there was a significant increase in involvement. Students began to show initiative in completing tasks, asking active questions, and discussing to agree on steps to solve problems associated with the project they were working on (snack stall project), such as making financial or sales planning simulations.

According to (Wati dkk., 2024), the PjBL model encourages students to become active learners who are able to think critically and solve problems through real and relevant projects. This is in line with the findings in this study, where students began to demonstrate learning independence, characterized by their ability to search for additional information independently, develop work plans, and complete group projects cooperatively.

This is in accordance with research conducted by Hamidah in (Maysarah, 2023), the use of project-based learning models has a significant effect on students' mathematical literacy skills. Because students must both grasp the concept and apply it through relevant projects to strengthen their understanding. This improvement is also in line with the results of research by (Ruddin, 2024) which states that the application of PjBL can increase students' involvement in learning and help them understand mathematical concepts more deeply because learning is contextual and student-centered.

This research shows that the application of this learning model has a positive impact on students' mathematical literacy, especially on indicators of problem solving, reasoning, and application of concepts in real-life contexts. To ascertain whether the improvement that occurred between the experimental and control classes was statistically significant, inferential analysis was conducted through appropriate statistical tests. This research is aquasi-experimental quantitative research, using a one group pretest-posttest design. The population in this study were class X students of SMK Aek Nabara Barumun, because these students studied the material of the system of linear equations of two variables.

Overall, the results of this study show that project-based learning provides a more meaningful learning experience, encourages students to be active, independent and improves mathematical literacy in a context that is relevant in their lives (Saragih et al. 2023). These result reindorce the urgency of implementing contextual learning such as PjBL, especially in vocational high schools, where the connection between mathematical material and the real world is crucial. According to the PISA study, Indonesia still falls below the OECD average in mathematical literacy, particular in contextul problem solving.

The PjBL model cam be an alternative solution because it llaces students in real-world situations that require the application of mathematical concepts to solve problems. This study has limitations, including, including: it used a one group pretestt-posttest design, resulting in the lack of a control group to allow for stronger comparisons. The number of participant was only 16 students from one class, so generalization of the results should be done with caution.

## 4. CONCLUSION

This study, carried out in a vocational education setting, revealed that the implementation of the Project-Based Learning (PjBL) model contributed to a measurable improvement in students' mathematical literacy, as indicated by an N-Gain score of 0.57, categorized as moderate. This suggests that PjBL is particularly beneficial for vocational students, whose learning needs often involve practical, contextual problem-solving.

To implement PjBL effectively, teachers are encouraged to design projects that align with students' vocational majors, integrating real-life tasks that reflect workplace challenges. Schools should also provide support through interdisciplinary collaboration and flexible scheduling to accommodate project timelines. However, this study has limitations. It was conducted in only one vocational school with a relatively small sample and without a control group, which limits the generalizability of the findings. Further research involving diverse settings and larger samples is needed to strengthen the evidence.

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