

THE IMPACT OF PROBLEM BASED LEARNING WITH GOOGLE SITES ON MATHEMATICS LEARNING OUTCOMES

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ABSTRACT

Mathematics learning outcomes remain an important concern in the learning process. However, in practice, many students still face difficulties, especially with the Pythagorean Theorem. These difficulties are generally related to a lack of conceptual understanding, inaccuracy in applying formulas, and difficulties in simplifying root forms. This study aims to examine the effect of Google Sites-assisted Problem-Based Learning (PBL) on learning outcomes for the Pythagorean Theorem. A quantitative approach with a one-group pretest-posttest design was used in this study, involving eighth-grade students at SMPN 3 Cikalong Wetan in the 2023/2024 academic year. One class was selected using saturated sampling. Data were collected through tests on learning outcomes of the Pythagorean theorem and questionnaires on students' interest in learning. The data were processed using a paired sample *t*-test, while the questionnaire data were analyzed based on descriptive statistics. The analysis results showed a significance value of 0.001, so that in a one-tailed test of 0.0005 (< 0.05) with a *t*-value of -19.426 . These results indicate a significant effect on students' mathematics learning outcomes after the application of this learning model. In addition, students' learning interest was in the good category. The findings of this study indicate that the application of Google Sites-assisted Problem Based Learning (PBL) has a positive effect on improving learning outcomes in the Pythagorean theorem material.

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Hasil belajar matematika masih menjadi perhatian penting dalam proses pembelajaran. Namun demikian, pada praktiknya masih banyak siswa yang menghadapi kesulitan, terutama pada materi Teorema Pythagoras. Kesulitan tersebut umumnya berkaitan dengan kurangnya pemahaman konsep, ketidaktepatan dalam menerapkan rumus, serta kendala dalam menyederhanakan bentuk akar. Penelitian ini bertujuan menelaah pengaruh Problem Based Learning (PBL) berbantuan Google Sites terhadap hasil belajar materi teorema Pythagoras. Pendekatan kuantitatif dengan desain one-group pretest–posttest digunakan dalam penelitian ini, dengan melibatkan siswa kelas VIII SMPN 3 Cikalong Wetan pada tahun ajaran 2023/2024. Adapun satu kelas yang dipilih dengan teknik sampling jenuh. Pengumpulan data melalui tes hasil belajar materi teorema Pythagoras dan angket minat belajar siswa. Data diolah menggunakan uji *t* sampel berpasangan, sedangkan data angket dianalisis berdasarkan statistika deskriptif. Hasil analisis menunjukkan nilai signifikansi sebesar 0,001, sehingga pada pengujian satu pihak sebesar 0,0005 ($< 0,05$) dengan nilai *t* sebesar $-19,426$. Hasil tersebut menunjukkan adanya pengaruh yang signifikan pada hasil belajar matematika siswa setelah penerapan model pembelajaran tersebut. Selain itu, minat belajar siswa berada pada kategori baik. Temuan penelitian ini menunjukkan penerapan Problem Based Learning (PBL) berbantuan Google Sites memberikan pengaruh positif terhadap peningkatan hasil belajar materi teorema Pythagoras.

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INTRODUCTION

Mathematics learning outcomes are one of the main indicators used to assess the success of the learning process in schools. Learning outcomes reflect the level of students' mastery of mathematical concepts, principles, and procedures that have been learned, and indicate the extent to which learning objectives can be achieved. In the context of education, learning outcomes are understood as learning achievements that are systematically designed and measured through an assessment process in accordance with predetermined learning objectives (Li & Al., 2024). Therefore, improving mathematics learning outcomes becomes an important focus in efforts to enhance the quality of mathematics education in schools.

However, in practice, mathematics learning still faces various challenges, especially when dealing with abstract material that requires strong conceptual understanding, such as the Pythagorean Theorem. Many students experience difficulties in understanding the relationships between the sides of a right triangle, determining the correct formula, performing calculations, and simplifying root forms. These difficulties often result in low mathematics learning outcomes. In addition, conventional learning practices that tend to be teacher-centered are considered less effective in facilitating students' active involvement and conceptual understanding during the learning process.

One learning model that is considered effective in improving mathematics learning outcomes is Problem Based Learning (PBL). Utami & Karo-karo (2023) state that the application of the PBL model can improve students' mathematics learning outcomes because students are actively involved in the learning process through contextual problem solving. This learning encourages students to think critically and understand mathematical concepts more deeply. In line with this, Hamzah (2024) found that the application of the Problem Based Learning approach has a positive impact on improving students' mathematics learning outcomes, as indicated by a significant difference between learning outcomes before and after the application of this model. Similarly, Yuniarti et al. (2022) reported that students who participated in Problem Based Learning obtained better mathematics learning outcomes compared to those who experienced conventional learning. Furthermore, a meta-analysis conducted by Asmiyunda (2023) show that Problem Based Learning consistently has a positive and significant effect on student learning outcomes in various subjects.

In addition to learning models, the use of technology-based learning media also plays an important role in improving mathematics learning outcomes. Digital learning media enable the presentation of learning materials in a more interesting, interactive, and accessible way. Lamaka et al. (2023) stated that the use of Google Sites-assisted learning media produces higher mathematics learning outcomes compared to conventional learning media. Google Sites allows teachers to present materials, example problems, learning videos, and practice exercises within one structured platform, thereby supporting students in learning the material more independently. Furthermore, research conducted by Pratiwi et al. (2024) shows that the application of Problem Based Learning supported by Google Sites is effective in improving

students' mathematical problem-solving skills because it allows flexible access to learning resources and supports active student engagement.

Although various studies have examined the effectiveness of Problem Based Learning and the use of Google Sites in mathematics learning, research that specifically integrates the PBL model with Google Sites to improve students' mathematics learning outcomes on the Pythagorean Theorem material at the junior high school level is still limited. Most previous studies have focused on the implementation of learning models or digital learning media separately and have not specifically examined their combined impact on the Pythagorean Theorem material, which requires strong conceptual understanding and problem-solving abilities.

Based on this background, this study aims to examine the effect of applying the Problem Based Learning (PBL) model assisted by Google Sites on students' mathematics learning outcomes. This research is expected to contribute empirically to the development of mathematics learning that integrates problem based learning models with digital technology. In addition, the findings of this study are expected to provide practical insights for teachers in implementing innovative and technology supported learning strategies, particularly in teaching the Pythagorean Theorem at the junior high school level.

METHOD

This study applied a quantitative research approach that focuses on collecting and analyzing numerical data through statistical procedures to examine the relationship and influence among research variables (Rauteda, 2025). The research employed a pre-experimental design, specifically a one-group pretest–posttest design. In this design, a group of participants is first given a pretest prior to the implementation of the treatment and then a posttest after the treatment in order to identify any changes in learning outcomes resulting from the intervention (Junaidi & Pratikno, 2024). Creswell (2014) explains that the one-group pretest–posttest design is frequently used in educational studies to assess the effectiveness of a learning strategy by comparing student performance before and after the treatment. This design was selected because the present study aimed to investigate the effect of implementing the Problem Based Learning (PBL) model supported by Google Sites on students' mathematics learning outcomes, particularly on the Pythagorean Theorem topic.

The research was carried out from October 19 to November 2, 2023, involving students of class VIII A at SMPN 3 Cicalong Wetan. The sampling method applied in this study was saturated sampling, in which all members of the population were included as research samples (Sari et al., 2022), resulting in a total of 30 participants. Data collection was carried out using tests and questionnaires. The test instruments were administered in the form of pre-tests and post-tests to measure students' mathematics learning outcomes, and the data obtained were analyzed using the Statistical Package for the Social Sciences (SPSS). Before testing the hypothesis, a normality test was conducted to check whether the data followed a normal distribution. The hypothesis was then tested using a paired sample t-test to identify differences in learning outcomes before and after the treatment. Furthermore, questionnaires were distributed to assess students' interest in learning in the implementation of the PBL model assisted by Google Sites. The questionnaire used a five-point Likert scale Rokeman (2024) and included several indicators such as enjoyment, interest, attention, and student participation during the learning process. The questionnaire data were analyzed descriptively to provide an overview of students' responses to learning activities.

RESULTS AND DISCUSSION

Result

The data on students' mathematics learning outcomes were analyzed using a paired sample t-test. Before testing the hypothesis, a normality test was conducted to verify whether the data met the assumptions required for parametric statistical analysis. The results of the normality test for the mathematics learning outcome data are shown in Table 1.

Table 1. Results of the Normality Test of Mathematics Learning Outcome

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	52.17	30	8.875	1.620
	Posttest	84.00	30	4.631	.846

According to the results of the Shapiro–Wilk test, the significance value for the pretest was 0.118, while the posttest produced a significance value of 0.175. Since both values are greater than 0.05 ($\text{Sig} > 0.05$), it indicates that the pretest and posttest data follow a normal distribution. Therefore, the assumption required to perform the paired sample t-test was satisfied.

Furthermore, descriptive analysis was carried out to identify the average mathematics learning outcomes of students before and after the application of the Problem Based Learning (PBL) model assisted by Google Sites. The results of the mean score analysis are presented in Table 2.

Table 2. Average Mathematics Learning Outcomes of Students

Tests of Normality					
Kolmogorov-Smirnov ^a			Shapiro-Wilk		
Statistic	df	Sig.	Statistic	df	Sig.
.137	30	.158	.944	30	.118
.173	30	.023	.951	30	.175

a. Lilliefors Significance Correction

The analysis results show that the average pretest score for eighth-grade students was 52.17, while the average posttest score was 84.00. The higher average posttest score compared to the average pretest score indicates a difference in students' mathematics learning outcomes before and after the implementation of the Google Sites-assisted PBL model. This improvement indicates that after participating in the learning process, students experienced an improvement in learning outcomes, particularly in the cognitive aspect, which includes understanding and applying mathematical concepts.

To clarify the differences in learning outcomes, a graph of students' mathematics learning outcomes is presented in Figure 1.

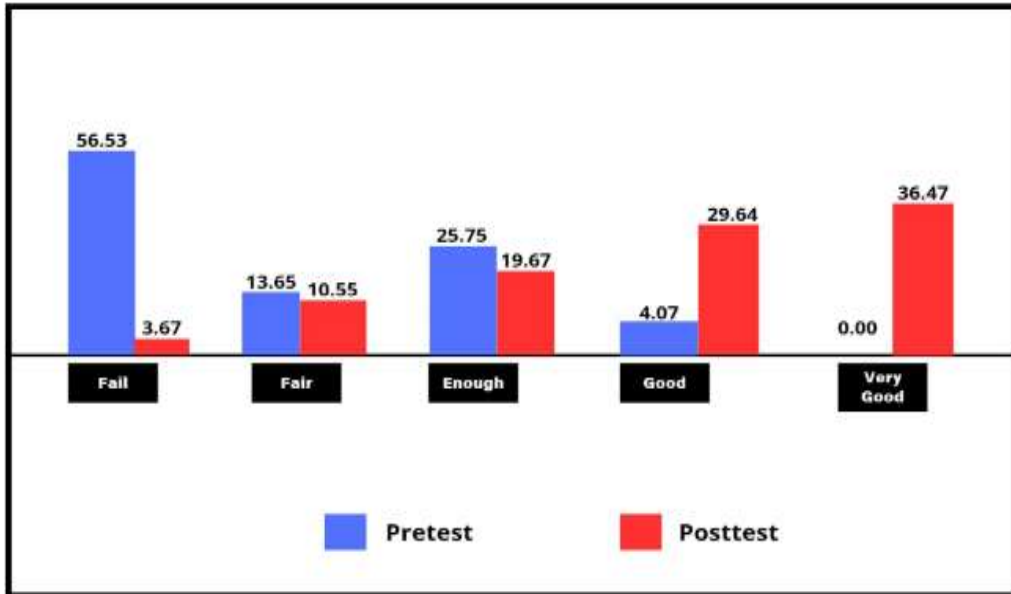


Figure 1. Categories of Students' Mathematics Learning Outcomes

Based on Figure 1, it can be seen that at the pretest stage, most students were in the low learning achievement category. This condition shows that before the implementation of learning, students had not achieved the expected learning outcomes. Conversely, at the posttest stage, almost all students were in the high learning achievement category. This shows that after the implementation of the Google Sites-assisted Problem Based Learning (PBL) model, there was a significant increase in students' mathematics learning outcomes.

To determine the relationship between pretest and posttest scores, a paired sample correlation analysis was conducted. The results of the correlation analysis are presented in Table 3.

Table 3. Paired Sample Correlation Analysis Results

Paired Samples Correlations		N	Correlation	Sig.
Pair 1	Pretest & Posttest	30	.239	.003

Based on Table 3, the analysis produced a correlation coefficient of 0.239 with a significance value of 0.003. Since the significance value is lower than 0.05 (Sig < 0.05), it indicates that a relationship exists between the pretest and posttest scores. Furthermore, the research hypothesis was examined using a paired sample t-test. In this study, two hypotheses were formulated. The null hypothesis (H_0) states that there is no difference in the average mathematics learning outcomes of students before and after the implementation of the Problem Based Learning (PBL) model assisted by Google Sites. In contrast, the alternative hypothesis (H_1) proposes that there is a difference in the average mathematics learning outcomes of students before and after the application of the Problem Based Learning (PBL) model assisted by Google Sites.

The results of the paired sample t-test are presented in Table 4.

Table 4. Results of the Paired Sample t-test for Mathematics Learning Outcomes

		Paired Differences							
		Mean	Std. Deviation	Std. Error	95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pretest - Posttest	-31.833	8.975	1.639	-35.185	-28.482	-19.426	29	.001

The results of the paired sample t-test showed a Sig. (2-tailed) value of 0.001. Since the hypothesis testing applied a one-tailed test, the significance value was divided by two, resulting in a Sig/2 value of 0.0005. Because this value is lower than 0.05 ($Sig < 0.05$), the null hypothesis (H_0) is rejected, while the alternative hypothesis (H_1) is accepted.

Furthermore, the calculated t-value of -19.426 indicates that the mean score of students in the posttest was higher than that of the pretest. These findings suggest that the implementation of the Problem Based Learning (PBL) model supported by Google Sites significantly improves the mathematics learning outcomes of eighth-grade students at SMPN 3 Cikalong Wetan.

Besides analyzing students' learning outcomes, the study also examined students' learning interest through descriptive analysis using a questionnaire. The results revealed that the overall percentage of students' learning interest reached 53.52%, which falls into the good category. A description of students' learning interest after the application of the Google Sites-assisted Problem Based Learning (PBL) model is illustrated in Figure 2.

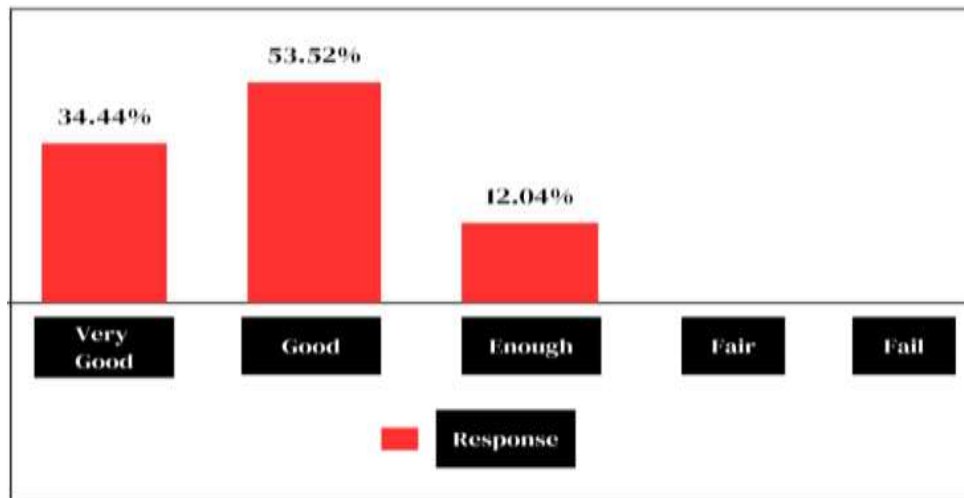


Figure 2. Results of the Analysis of Students' Learning Interest Responses

Furthermore, to provide a more detailed understanding, the distribution of students' learning interest based on each indicator, namely feelings of enjoyment, interest, attention, and student involvement, is presented in Figure 3.

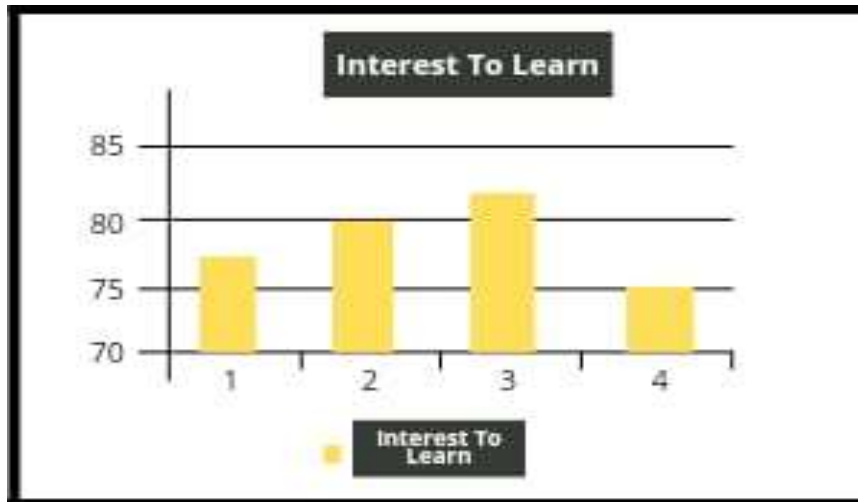


Figure 3. Student Learning Interest by Indicator

Based on Figure 3, students' learning interest can be observed through four indicators: sense of enjoyment, student interest, attention, and student involvement during the learning process. The results indicate that the student attention indicator shows the highest level among the four indicators, reflecting that students were able to maintain strong focus during the learning activities. The student interest indicator also demonstrates a relatively high level, indicating that the learning process using the Problem Based Learning (PBL) model assisted by Google Sites was able to attract students' interest in learning mathematics. Meanwhile, the sense of enjoyment indicator suggests that students generally felt comfortable and enjoyed the learning activities carried out during the lesson. The student involvement indicator, although slightly lower compared to the other indicators, still shows that students were actively engaged in the learning process. Overall, these findings indicate that the implementation of the PBL model assisted by Google Sites was able to support students' learning interest across several aspects, particularly in encouraging students' attention and interest during mathematics learning.

Discussion

The findings of this study indicate that Google Sites-assisted Problem-Based Learning (PBL) contributes positively to improving students' mathematics learning outcomes. This improvement is evidenced by the significant difference between the pretest and posttest scores achieved by students after participating in the learning process using the PBL approach integrated with Google Sites. The statistical analysis also confirms that the learning strategy applied has a significant influence on students' mathematics achievement. These results suggest that learning activities designed through a problem-based approach and supported by digital learning media can assist students in developing a deeper understanding of mathematical concepts. Through this approach, students are encouraged to participate more actively in the learning process, analyze given problems, and construct their own understanding based on the information and learning experiences they gain throughout the instructional activities.

This improvement in learning outcomes indicates that mathematics learning that integrates the Problem Based Learning (PBL) model with digital media can create a more meaningful learning process for students. In the PBL approach, students are actively involved in the process of identifying and solving contextual problems, which encourages them to construct knowledge independently and develop critical thinking skills. The learning process becomes more student-

centered because students are required to explore various possible solutions and discuss them with their peers. Meanwhile, Google Sites serves as a supporting medium that provides learning materials, instructional videos, sample questions, and exercises that are presented in a structured manner and are easily accessible to students. The availability of these learning resources helps students better understand the material and solve the problems given during the learning process. In addition, the use of digital learning media allows students to access learning materials repeatedly, which further strengthens their conceptual understanding of the mathematical topics being studied.

In its implementation, the application of the Google Sites-assisted Problem Based Learning (PBL) model is carried out through systematic and interrelated learning stages. These stages are designed to encourage active student engagement and help students understand mathematical concepts more deeply through a structured problem-solving process. Each stage of the PBL model plays an important role in guiding students from the initial understanding of the problem to the evaluation of the solutions they produce. Through this structured learning process, students not only focus on obtaining correct answers but also develop their reasoning abilities and problem-solving strategies.

The initial stage of learning is student orientation to the problem, where the teacher conveys the learning objectives listed in Google Sites and motivates students to actively participate during the learning process. At this stage, the teacher presents contextual problems related to students' daily lives as a starting point for learning activities. These contextual problems are intended to stimulate students' curiosity and encourage them to analyze situations that require mathematical reasoning. Problem Based Learning has the main characteristic of presenting contextual problems as a trigger for student learning activities (Borges et al., 2014). By presenting problems that are relevant to students' real-life experiences, learning becomes more meaningful and encourages students to actively explore possible solutions based on the knowledge they already possess.

The next stage is organizing students to learn, where teachers help students understand and define the problems they face by directing them to review the information available on Google Sites. At this stage, students are encouraged to identify important information, formulate the core problems, and plan strategies that can be used to solve the problems. This process aims to train students to understand problems comprehensively before determining the most appropriate solution strategy. In the PBL model, teachers play an important role in organizing and facilitating students' learning activities, including guiding them in reflecting on the learning material being studied (Putri et al., 2018). Through teacher guidance and the availability of learning resources on Google Sites, students are able to develop a clearer understanding of the problem-solving process before proceeding to the next stage of investigation.

The third and fourth stages consist of guiding the investigation and presenting the results of problem solving. At this stage, teachers guide students in collecting relevant data and information related to the problems given through the learning materials provided on Google Sites. Students are encouraged to explore various sources of information, analyze the data obtained, and use it as the basis for developing solutions to the problems being studied. After gathering sufficient information, students are directed to present the results of their problem-solving activities in written form by referring to the examples provided on Google Sites. During this process, the teacher acts as a facilitator and guide who helps ensure that students understand the mathematical concepts used in solving the problems. According to Rahmat (2018), the PBL model allows for authentic assessment because students directly discover and solve the

problems they encounter. Through these activities, students not only focus on finding answers but also develop the ability to communicate their reasoning and solutions systematically.

The final stage of learning is analyzing and evaluating the problem-solving process. At this stage, teachers and students reflect on the strategies used to solve the problems and evaluate the results obtained during the learning process. Students are encouraged to identify the difficulties they encountered and discuss alternative solutions that could be applied in similar situations. This reflection activity plays an important role in strengthening students' conceptual understanding and helping them recognize the relationships between mathematical concepts learned during the lesson. Through this evaluation process, students are able to develop a deeper understanding of the learning material and improve the quality of their mathematics learning outcomes.

The implementation of all stages of the Google Sites-assisted Problem Based Learning (PBL) model showed that students were systematically guided to analyze problems, gather relevant information, develop solutions, and evaluate the results of problem solving. This structured and student-centered learning process contributed to the improvement of mathematics learning outcomes, as indicated by the significant increase in posttest scores obtained by students after the learning activities were completed. These findings indicate that the integration of problem-based learning strategies with digital learning media can support the development of students' analytical and problem-solving skills in mathematics learning.

In addition to improving learning outcomes, the application of the Google Sites-assisted PBL model also had a positive effect on students' interest in learning. The results of the questionnaire analysis showed that most students were in the category of good to very good interest in learning. Students' interest in learning was reflected in their feelings of enjoyment, attention, involvement, and curiosity during mathematics lessons. These aspects indicate that students respond positively to learning activities that involve active participation and the use of digital media as a supporting learning tool.

The use of Google Sites as a learning medium helps create a more engaging and interactive learning environment. Through this platform, students can access learning materials, example problems, and practice exercises independently without being limited by time and place. This flexibility encourages students to review the material more frequently and increases their curiosity about the concepts being studied. The availability of various digital learning resources also makes the learning process more varied and interesting for students. This finding is in line with the opinion of Setiawati et al. (2020), who state that the appropriate learning model can increase students' interest in learning.

According to Apriyanto & Herlina (2020), indicators of learning interest include feelings of enjoyment, interest, attention, and student engagement in the learning process. The results of this study show that these four indicators appeared positively during the implementation of the Google Sites-assisted PBL model. Students showed enthusiasm when participating in learning activities, actively asked questions, and were involved in group discussions during the problem-solving process. These findings confirm that mathematics learning using the Google Sites-assisted Problem Based Learning (PBL) model is well accepted by students and can support the improvement of mathematics learning outcomes.

However, during the implementation of learning, several obstacles were encountered. Some students were not yet familiar with the Google Sites-assisted PBL learning model, which

required an adaptation process during the early stages of learning. In addition, limited internet access was also experienced by several students, which could potentially hinder their ability to access learning materials provided on Google Sites. To overcome these obstacles, teachers provided continuous guidance and assistance to students during the learning process. Teachers also facilitated internet access through portable hotspots for students who needed it so that all students could participate in the learning activities optimally.

Overall, the discussion of the research results shows that the integration of the Problem Based Learning (PBL) with Google Sites is capable of creating active, contextual, and student-centered mathematics learning. Learning designed through systematic PBL stages and supported by digital media contributes significantly to improving students' mathematics learning outcomes and their interest in learning mathematics. These findings indicate that the use of digital learning platforms combined with appropriate learning models can be an effective strategy to improve the quality of mathematics learning in schools.

CONCLUSION

Based on the findings from the data analysis and discussion, it can be concluded that the use of the Problem Based Learning (PBL) model supported by Google Sites positively influences students' mathematics learning outcomes on the Pythagorean Theorem topic among eighth-grade students at SMPN 3 Cikalong Wetan. The implementation of this learning approach encourages students to participate more actively in the learning process through problem-solving activities that are supported by digital learning media. Furthermore, the utilization of Google Sites as a learning platform helps increase students' learning interest by presenting instructional materials that are more interactive, easily accessible, and engaging. The combination of the PBL model with digital technology can foster a more meaningful learning experience, enhance students' conceptual understanding, and promote greater involvement during mathematics learning activities. Therefore, the integration of Problem Based Learning with Google Sites can serve as an effective alternative instructional strategy to enhance the quality of mathematics learning.

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