



The Effectiveness of Problem-Based Learning Supported by Semarang Chinatown-Based Digital Materials on Problem-Solving Skills

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Abstract

Problem-solving skills are essential skills in the 21st century. However, the problem-solving skills of students in Indonesia remain low. This study aimed to examine the effectiveness of Problem-Based Learning supported by Semarang Chinatown-based digital materials in improving students' problem-solving skills. This study employed a quantitative approach using a one-group pretest-posttest design. The research was conducted in April 2024 involving eighth-grade students at SMPN 11 Semarang. Through simple random sampling, Class VIII A, consisting of 29 students, was selected as the research sample. The results showed that: (1) the average score of students' problem-solving skills exceeded the Actual Mastery Threshold (BTA); (2) the proportion of students achieving mastery in problem-solving skills was above 75%; and (3) students' problem-solving skills improved after the implementation of the learning model. Since all three criteria were fulfilled, the findings suggest that Problem-Based Learning supported by Semarang Chinatown-based digital materials was effective in improving students' problem-solving skills, with a moderate N-gain of 0.56.

Keywords: problem-solving skills, Problem Based Learning, Semarang Chinatown culture

1. Introduction

The 21st century is characterized by rapid advancements in science and technology, which have brought significant changes to various aspects of human life, particularly through the emergence of the Fourth Industrial Revolution (Mahrunnisya, 2023). These developments have accelerated progress in connectivity, artificial intelligence, digital systems, and virtual technology (Fitriani & Aziz, 2019). In this context, problem-solving skills have become one of the essential competencies that students must master in the 21st century. The Partnership for 21st Century Learning also emphasizes the importance of problem-solving skills as a key competency required for students to face contemporary challenges (Partnership for 21st Century Skills, 2019). Therefore, educational approaches that support the development of students' problem-

solving skills are increasingly needed.

Problem-solving is an effort to find solutions to difficult problems and is considered one of the essential aspects of higher-order thinking skills (Polya, 1973). According to Saad & Ghani (2008), problem-solving skills refer to students' ability to carry out a systematic and planned process to obtain solutions to problems that cannot be solved immediately. Furthermore, problem-solving skills involve students' ability to apply their knowledge and skills to solve non-routine problems that do not have direct solution procedures (Intan & Putra, 2022). Therefore, problem-solving skills are essential competencies that enable students to solve problems in an organized and directed manner.

Although problem-solving skills are essential in the 21st century, Indonesian students' problem-solving skills remain relatively low. The low level of students' mathematical problem-solving skills can also be seen in the results of the Programme for International Student Assessment (PISA). In this assessment, students are required to demonstrate strong mathematical problem-solving skills to solve the given tasks (Agustina & Imami, 2022). In 2022, Indonesia obtained a mathematics score of 366, which was lower than the average score of participating countries, namely 472 (OECD, 2023). Moreover, this score decreased compared to Indonesia's 2018 score of 379 (OECD, 2019). Therefore, the PISA results indicate that Indonesian students' problem-solving skills are still relatively low.

According to Arends (2008), Problem-Based Learning is a student-centered approach that engages students in solving real-world problems. Therefore, the Problem-Based Learning model is considered an appropriate approach to improve students' problem-solving skills. Students actively identify and formulate problems, study relevant materials, and present solutions collaboratively (Wiyoko et al., 2022). Previous studies have also shown that Problem-Based Learning can enhance students' problem-solving skills (Ningsih et al., 2023). Therefore, Problem-Based Learning, which emphasizes collaborative learning and contextual problems, can effectively improve students' problem-solving skills.

One of the learning resources that can be developed to address this issue is digital teaching materials. Teaching materials are learning resources designed to support the learning process and help students achieve the intended competencies (Magdalena et al., 2020). In addition, Nabilah & Siregar (2023) stated that digital teaching materials can

improve students' problem-solving skills.

Cultural integration also plays an important role in improving students' problem-solving skills. Ethnomathematics is an approach that integrates local culture with mathematical concepts in the learning process (Muhammad, 2023). In mathematics learning, students' prior knowledge and everyday experiences are important foundations for understanding formal mathematical concepts (Sumayani et al., 2020). Previous studies have shown that ethnomathematics can enhance students' problem-solving skills in mathematics learning (Cahyadi et al., 2020). One of the cultural contexts that can be integrated into learning is Semarang Chinatown. Therefore, integrating the cultural context of Semarang Chinatown into learning activities can support the improvement of students' problem-solving skills.

Sofiyani & Zaenuri (2023) implemented Problem-Based Learning, integrated with ethnomathematics to improve problem skills, but the cultural context and teaching materials were not as specific as those in the present study, which integrates the Semarang Chinatown cultural context into digital teaching materials. Furthermore, Andayani & Pratama (2022) investigated the implementation of Problem-Based Learning supported by teaching materials to improve problem skills, but the materials were not integrated with ethnomathematical contexts. Therefore, there remains a research gap in integrating Problem-Based Learning, Semarang Chinatown-based digital teaching materials, and ethnomathematics into a single learning approach to improve students' problem-solving skills.

Problem-solving skills are essential competencies in the 21st century. However, students' problem-solving skills in Indonesia remain relatively low, as indicated by the results of the Programme for International Student Assessment (PISA) 2022. Problem-Based Learning actively engages students in collaborative problem-solving activities. In addition, Semarang Chinatown-based digital learning materials can support the improvement of students' problem-solving skills. Therefore, this study aims to examine the effectiveness of Problem-Based Learning supported by Semarang Chinatown-based digital learning materials in improving students' problem-solving skills.

2. Research Methods

This study employed a quantitative research approach. The research design used was a pre-experimental design in the form of a one-group pretest–posttest design, as shown in Table 1. A one-group pretest–posttest design is a research design in which a pretest is administered before the treatment and a posttest is administered after the treatment (Sugiyono, 2021). The population of this study consisted of eighth-grade students of SMP Negeri 11 Semarang in the second semester of the 2023/2024 academic year. Through a simple random sampling technique, class VIIIA was selected as the sample. The sample consisted of 29 students. This study was conducted in April 2024.

Table 1. One-Groups Pretest-Posttest Design

Pretest	Treatment	Posttest
O_1	X	O_2

Description:

O_1 : pretest of class VIII A

X : the implementation of Problem-Based Learning supported by Semarang Chinatown-based digital teaching materials

O_2 : posttest of class VIII A

The feasibility of the digital learning materials was validated by one expert and one practitioner. The evaluation covered four aspects: content, presentation, language, and instructional innovation. As shown in Table 2, the digital learning materials obtained a feasibility score of 92, indicating that they were suitable for use in the learning process. In addition, the problem-solving test instrument was validated by an expert and achieved a validity score of 89.4, indicating that the instrument was appropriate for use in this study.

Table 2. The Feasibility of Digital Learning Materials

Validator	Content	Presentation	Language	Instructional Innovation	Result
Expert	55	55	56	19	92.5
Practitioner	54	56	55	18	91.5
				Average	92

The data collection technique in this study was a problem-solving skills test, consisting of a pretest and a posttest. The collected data were then analyzed using descriptive and inferential statistical methods to examine the effectiveness of the

treatment. The effectiveness criteria were determined based on three hypotheses presented in Table 3. In addition, this study employed the Actual Mastery Threshold (BTA) because it provides a more appropriate benchmark for measuring students' actual learning achievement (Sudjana, 2016).

Table 3. Effectiveness Criteria and Statistical Tests

Hypothesis	Test
The average score of students' problem-solving skills is above the Actual Mastery Threshold (BTA).	One sample t-test
The proportion of students achieving mastery in problem-solving skills is greater than 75%.	One sample z-test
There is an improvement in problem-solving skills.	Paired sample t-test

3. Results and Discussion

The mathematical problem-solving skills of eighth-grade students at SMPN 11 Semarang were analyzed using descriptive statistics based on the pretest and posttest results, including the mean, maximum, and minimum scores. Based on Table 4, the mean pretest score was 44.48, with a maximum score of 60 and a minimum score of 20. The mean posttest score was 75.68, with a maximum score of 100 and a minimum score of 45. Overall, these results indicate that students' problem-solving skills improved after the treatment compared to before the treatment.

Table 4. Recap of Pretest and Posttest Results

	Mean	Maximum	Minimum	SD
<i>Pretest</i>	44.48	60	20	11.04
<i>Posttest</i>	75.68	100	45	11.70

Table 5 shows the results of the normality test on the pretest and posttest data. The significance value for the pretest data is 0.07, which indicates more than 0.05, so the pretest data is normally distributed. The significance value for the posttest data is 0.27, which is greater than 0.05, so the posttest data is normally distributed. Therefore, parametric statistical tests were conducted to examine the effectiveness of the intervention.

Table 5. Summary of Normality Test Results for Pretest and Posttest Data

	sig
<i>Pretest</i>	0.07
<i>Posttest</i>	0.27

Actual Mastery Threshold (BTA) can serve as a reference for the minimum achievement in learning. BTA can be determined with $\bar{x} + \frac{1}{4}s$ with $\bar{x}$ and s being the average pretest score and the standard deviation of the pretest scores, respectively. Accordingly, the calculated BTA was $44.48 + \frac{1}{4}(11.04) = 47.24$.

Table 6 presents the results of the one-sample t-test conducted to determine whether the mean score of students' problem-solving skills was higher than the Actual Mastery Threshold (BTA) of 47.24. The results showed that $t_{stat} = 13.87 > 1.70 = t_{table}$, indicating that the hypothesis was supported. This means that the mean students' problem-solving skills score was higher than the BTA of 47.24.

Table 6. Result of One Sample t-test

<i>n</i>	<i>μ</i>	<i>s</i>	<i>$\bar{x}$</i>	<i>dk</i>	<i>t_{stat}</i>	<i>t_{table}</i>
29	47.24	11.04	75.68	28	13.87	1.70

Table 7 shows the results of the one sample z-test. This test was conducted to determine whether the proportion of students achieving mastery is more than 75% or 0.75. In this test, it was found that $z_{stat} = 2.68 > 1.65 = z_{table}$, thus indicating that the hypothesis is fulfilled, namely that the students' mastery proportion is more than 75%.

Table 7. Result of One Sample z-test

<i>n</i>	<i>π</i>	<i>p</i>	<i>z_{stat}</i>	<i>z_{table}</i>
29	0.75	0.96	2.68	1.65

Table 8 shows the results of the paired sample t-test. This test was conducted to analyse whether there was an improvement in problem-solving ability after treatment was given. In this test, it was found that $t_{stat} = 14.75 > 2.05 = t_{table}$, so it can be concluded that there is an improvement in problem-solving skills. The improvement can be seen from the N-Gain average of 0.56, which is in the medium category.

Table 8. Result Paired Sample t-test

	$\bar{x}$	t_{stat}	t_{table}	Mean N-Gain
Pretest	44.48	14.75	1.70	0.56
Posttest	75.68			

Although the mean N-gain score was 0.56, indicating a moderate improvement, the practical significance of the intervention was further examined using effect size analysis. As presented in Table 9, the effect size based on Cohen's d was 2.74. Similarly, Table 10 shows that the effect size calculated from the paired-sample t-test was also 2.74, indicating consistent results across both methods. According to Cohen's criteria, this value represents a very large effect size. These findings suggest that Problem-Based Learning supported by Semarang Chinatown-based digital learning materials had a substantial positive impact on students' problem-solving skills.

Table 9. Effect Size Based Cohen's d

SD_{pre}	SD_{post}	SD_{pooled}	$\bar{x}_{pre}$	$\bar{x}_{post}$	Cohen's d
11.04	11.7	11.38	44.48	75.68	2.74

Table 10. Effect Size Based Paired t-test

t_{stat}	n	d
14.75	29	2.74

The three hypotheses were tested, and all were accepted. The fulfilled hypotheses are: (1) the mean students' problem-solving skills score is higher than the Actual Mastery Threshold (BTA); (2) the proportion of students achieving mastery in problem-solving skills is greater than 75%; and (3) there is an improvement in students' problem-solving skills. Therefore, the effectiveness criteria were met, indicating that Problem-Based Learning supported by Semarang Chinatown-based digital learning materials is effective in improving students' problem-solving skills.



Figure 1. Learning with Problem-Based Learning Supported by Semarang Chinatown-Based Digital Learning Materials

In Problem-Based Learning (PBL), learning begins with the problem-orientation stage, during which the teacher presents authentic real-world problems. In this study, the problems were contextualized within Semarang Chinatown culture, enabling students to connect mathematical concepts with meaningful real-life situations. As illustrated in Figure 1, this contextual approach encouraged students to construct their understanding and develop problem-solving strategies. The integration of ethnomathematics into mathematics learning has been shown to enhance students' problem-solving skills by making learning more meaningful and relevant to their daily experiences (Kencanawaty et al., 2020; Andriyanti & Prihasti, 2023). These findings are consistent with the improvement in students' problem-solving skills observed after the implementation of the intervention.

Lev Vygotsky's constructivist theory is closely related to Problem-Based Learning (PBL), which emphasizes the importance of social interaction in the learning process to construct new knowledge through collaboration and discussion (Salsabila & Muqowim, 2024). Vygotsky's constructivist theory states that learning occurs through social interaction. PBL encourages students to develop their own understanding of the world by solving real-world problems relevant to their daily lives (Sofyan, 2016). Therefore, Problem-Based Learning is strongly aligned with Vygotsky's constructivism in supporting students' independent problem-solving skills.

Students are required to conduct investigations and are expected to develop and present their findings with teacher guidance (Fitriyani & Lestari, 2023). This process encourages students to actively develop their problem-solving skills. Previous studies have shown that problem-solving skills can be improved through Problem-Based

Learning (Oktaviana & Haryadi, 2020; Andriyanti & Prihasti, 2023).



Figure 2. Digital Teaching Materials

Figure 2 illustrates the digital learning materials designed to facilitate students' problem-solving skills. The learning process begins with a problem stimulus presented through a video, followed by guided problem investigation with teacher facilitation. This sequence encourages students to identify problems, analyze relevant information, and develop appropriate solution strategies independently. Consequently, digital learning materials not only support students' understanding of mathematical concepts but also promote active engagement throughout the problem-solving process. Previous studies have reported that digital learning materials effectively enhance students' conceptual understanding (Nopiani et al., 2021) and improve their problem-solving skills by providing interactive and contextual learning experiences (Lubis et al., 2022; Rahmaniah & Zainuddin, 2023).

4. Conclusion

The findings of this study suggest that Problem-Based Learning supported by Semarang Chinatown-based digital teaching materials has the potential to improve students' problem-solving skills. This is indicated by the fulfillment of the three research hypotheses: (1) the mean problem-solving skills score exceeded the Actual Mastery Threshold (BTA); (2) more than 75% of students achieved mastery; and (3) students' problem-solving skills improved after the learning intervention. However, these findings are limited to the context of this study and should not be generalized without further investigation. Practically, the findings suggest that culturally contextualized digital teaching materials can support mathematics learning. Future research should involve larger and more diverse samples and examine the implementation of these teaching materials in different learning contexts.

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