

Research Article

Preview, Question, Read, Reflect, Recite, Review Learning Strategy on Mathematical Problem-Solving Ability with the Assistance of Mural Software

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ABSTRACT

The low level of students mathematical problem-solving ability remains a challenge in mathematics education, often resulting from limited engagement, lack of active reading, and ineffective instructional strategies. This study aimed to investigate the effect of the PQ4R (Preview, Question, Read, Reflect, Recite, Review) learning strategy on students mathematical problem-solving ability, supported by Mural software as a digital learning aid. The research employed a quantitative approach using a quasi-experimental design involving two tenth-grade classes at SMA Negeri 1 Kuta Makmur. The experimental group received instruction using the PQ4R strategy integrated with Mural software, while the control group was taught using conventional methods. Data were obtained through pretest and posttest consisting of essay questions based problem-solving indicators. The Mann-Whitney U test was used for hypothesis testing. The findings show that the PQ4R learning strategy, when assisted by Mural software, has a significant effect on students mathematical problem-solving ability.

Keywords: Mural software; PQ4R strategy; Problem-solving

1. INTRODUCTION

Mathematics is a discipline closely associated with logical reasoning, involving concepts of form, quantity, structure, and interrelation (Wulandari et al., 2024). Therefore, mathematics education is not limited to acquiring formulas and procedures but involves deep conceptual understanding and the ability to apply knowledge to solve problems. This is in accordance with research Hidayat (2025) which states that the role of mathematics is important in developing abilities as a basis for making decisions in life. As noted by Fatimah (2023) mathematics should equip students with the problem-solving skills needed to navigate real life situations. The National Council of Teachers of Mathematics (NCTM, 2000) emphasizes five key mathematical competencies, including problem-solving, reasoning and proof, communication, connections, and representation. Among these, problem-solving is central as it requires students to analyze unfamiliar situations, plan effective strategies, and apply appropriate methods (Rosfarianti et al., 2021). According to Ramadhan & Kusuma (2025) Problem solving is not only about teaching students to find solutions to certain problems but also about training to think logically and systematically. This is in line with Syahrudin (2021) research which states that problem-solving skills are one of the skills that students must master in learning mathematics, because problem-solving is the ability to observe and solve problems according to applicable rules.

Based on the results of the Program for International Student Assessment (PISA), Indonesia students continue to underperform in mathematics, ranking 73 out of 79 participating countries in 2018 and 69 out of 80 countries in 2022 (Siregar & Hasratuddin, 2022). These PISA outcomes indicate that Indonesia has not yet achieved optimal levels of mathematical understanding. The findings suggest that students particularly struggle with solving contextual and non-routine problems that require higher-order thinking skills (Rosehana & Haerudin, 2023). In addition to the data obtained from the PISA results, a preliminary observation was also conducted through interviews with the mathematics teacher at SMA Negeri 1 Kuta Makmur. The interviews revealed that students tend to consider mathematics as a difficult subject, especially when dealing with problems that involve indicators of mathematical problem-solving ability. Furthermore, an initial assessment was carried out by giving story problems that reflect indicators of problem-solving ability to find out the extent of students' mathematical problem-solving ability at the school. The indicators of problem-solving ability applied are the indicators developed by Polya, namely understanding the problem, devising a plan, carrying out the plan, looking back (Syahrudin et al., 2021).

Analysis of student responses showed frequent errors in identifying known and unknown information, choosing and applying formulas, and checking final answers. Specifically, among 15 students tested, 46.7% failed to understand the problems, 80% struggled with planning solutions, 86.7% encountered difficulties in executing their plans, and 80% failed to review their work correctly.

According to Nufus & Mursalin (2020) one of the reasons for the low mathematics learning outcomes of students is because many students consider math difficult to learn and the characteristics of mathematics are abstract so that students consider math a difficult lesson. This is supported by Interviews with mathematics teachers confirmed that students tend to perceive mathematics as difficult, especially when presented in a problem-based or contextual format. The most common teaching approach used is expository, which relies heavily on lectures with minimal student interaction. As a result, students do not have the opportunity to be actively involved in the problem-solving process. To address this issue, teaching strategies that support active learning are needed. One such method is the PQ4R (Preview, Question, Read, Reflect, Recite, Review) learning strategy, which encourages students to become more engaged readers and critical thinkers. According to Hasanah (2023), one strategy that is suitable for guiding students to be more diligent in reading, asking questions, and repeating lessons is the PQ4R learning strategy. The PQ4R learning strategy is a learning strategy that helps the teaching and learning process in the classroom by reading books and exploring the ability to build thinking structures before reading, by presenting questions that function as guides for students in analyzing the information needed from the text (Refariza et al., 2020). According to Lutfianasari & Nasikah (2024), the use of the PQ4R strategy also influences students' critical thinking skills and learning independence.

P stands for Preview (skimming quickly), Q is Question (asking questions), and 4R stands for Read (reading), Reflect (informing), Recite (repeating orally), Review (repeating the whole) (Mutazam, 2020). According to Saputra & Diana (2022) the advantages of the PQ4R learning strategy are that it can help students improve their learning process skills, can help students with weak memory to memorize concepts in learning, and is easily applied to every level of education. The disadvantages are that it requires the availability of interesting reading materials and students with low interest in reading often have difficulty completing the read and reflect steps due to lack of motivation (Saputra & Diana, 2022). Solutions that can be applied to overcome the shortcomings of the PQ4R learning strategy are using interesting and relevant reading materials, conducting introductory activities such as ice breaking to arouse students' enthusiasm, and using interesting media for students.

In addition to using the PQ4R learning strategy, learning media is also used for optimization during the learning process. This is in accordance with Fitri (2024) which states that learning associated with digital media can improve each student's abilities in skills more effectively. One of the digital media that can help students, especially in solving mathematical problems and can remember and repeat learning is mural software. Mural is a collaborative visual platform that allows students to create and share interactive notes, diagrams, and ideas in real-time, resulting in a more dynamic and engaging learning experience (University, 2024). Thus, the use of mural software has very efficient benefits so that students can repeat lessons by making interesting notes. Moreover, mural software is not only used on computer devices, but can also be used on mobile phones. Based on these considerations, this study aims to test the effect of the PQ4R learning strategy supported by Mural software on students' mathematical problem-solving abilities.

2. RESEARCH METHOD

The type of research used in this study is experimental research with a quantitative approach. According to Sugiyono (2021), experimental research is a type of research conducted by experimenting. This study aims to determine the effect of the PQ4R (Preview, Question, Read, Reflect, Recite, Review) learning strategy assisted by Mural software on students' mathematical problem-solving abilities. The design in this study used a quasi-experimental design with the design form being Nonequivalent Control Groups Design. The Nonequivalent Control Groups Design model is as follows:

Table 1. Research Design

| Groups | Pretest | Treatment | Posttest |
|------------|---------|-----------|----------|
| Experiment | O_1 | X | O_2 |
| Control | O_1 | | O_2 |

Source: Modification (Sugiyono, 2021)

Description:

- O_1 = Pretest of experimental class and control class
- O_2 = Posttest of experimental class and control class
- X = Learning with PQ4R strategy assisted by mural

Two classes were selected as research subjects using purposive sampling. One class was designated as the experimental group that received learning using the PQ4R strategy integrated with Mural software, while the other class became the control group taught through conventional lecture methods. To measure students' mathematical problem-solving abilities, a test was given consisting of essay-shaped questions before and after the intervention. The questions were developed based on indicators of problem-solving abilities, including understanding problems, making plans, implementing plans, and

reviewing solutions. In addition to the test, observations were carried out to document class implementation and student involvement during the learning process.

The research instrument was tested for feasibility through expert review and statistical tests. The instrument's feasibility test was in the form of a validity test using Pearson's Product Moment correlation, whereas the Cronbach Alpha formula was used to measure dependability. To make sure the test was appropriate, items were also examined for discriminatory power and degree of difficulty. SPSS version 25 was used to analyze the data. To choose the best statistical approach, normality and homogeneity tests were performed prior to testing the hypothesis. The Independent Sample T-Test is a parametric test that will be used if the data is homogeneous and regularly distributed. To examine the variation in posttest scores between the experimental and control groups, a non-parametric test the Mann-Whitney U test will be used if the data is not normally distributed. The results of the analysis were then interpreted to determine whether the PQ4R strategy, supported by Mural software, had a statistically significant effect on students' mathematical problem-solving performance.

3. RESULTS AND DISCUSSION

3.1 Results

After the feasibility test of the mathematical problem-solving instrument was conducted, three valid essay items were selected to measure students mathematical problem-solving ability. These test items were administered during the pretest phase to determine the students initial abilities before the implementation of the learning interventions. Following the pretest, both classes underwent the teaching and learning process according to their respective treatments. The experimental class was taught using the PQ4R (Preview, Question, Read, Reflect, Recite, Review) learning strategy assisted by Mural software, while the control class received instruction through an expository teaching strategy. At the end of the treatment period, a posttest was administered to assess whether the applied instructional strategy had a significant effect on students mathematical problem-solving ability. The posttest data that has been obtained will be calculated the prerequisite testing of the hypothesis.

3.1.1 Descriptive Statistics of Pretest and Posttest

The pretest and posttest results of the students' mathematical problem-solving abilities were used to do descriptive analysis in this study. There were 20 students in the control group and 24 students in the experimental group. The following graphic displays the pretest and posttest data gathered based on the findings of the conducted research:

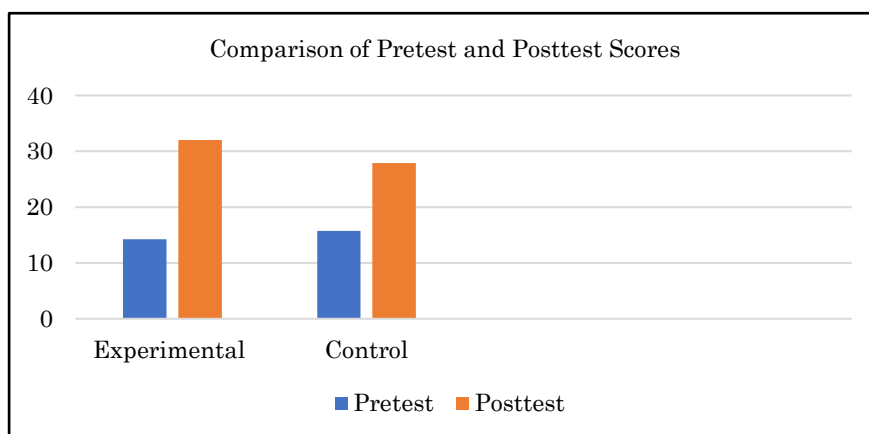


Figure 1. Comparison of Pretest and Posttest Scores

Based on Figure 1, obtained the average value of student pretest in the experimental class of 14.25 while in the control class of 15.75. The average posttest score of students in the experimental class was 32.04 while in the control class it was 27.90. The descriptive data indicate that both groups started with similar problem-solving abilities, but the experimental group achieved substantially higher posttest scores after the intervention.

3.1.2 Normality Test

The normality test is carried out to determine whether the data obtained is normally distributed or not. The criteria for making data normality test decisions use a significant level of $\alpha = 0,05$. The provisions for the significant value of the normality test used in this study are as follows:

- 1) Significant value of $sig \geq 0,05$, then H_0 is accepted and the data is normally distributed.
- 2) Significant value of $sig < 0,05$, then H_0 is rejected and the data is not normally distributed.

The normality test was carried out using SPSS software version 25. The following are the results of the normality test of posttest data on students' mathematical problem-solving skills.

Table 2. Normality Posttest Data

| Group | Df | Statistics | Sig |
|------------|----|------------|-------|
| Experiment | 24 | 0,631 | 0,000 |
| Control | 20 | 0,922 | 0,109 |

Based on **Table 2**, it is obtained that the significant value (*sig*) of the control class is obtained at 0.109, in accordance with the normality test criteria, it is concluded that the control class posttest data is normally distributed. Furthermore, the significant value (*sig*) of the experimental class was obtained at 0.000, in accordance with the normality test criteria, it was concluded that the experimental class posttest data was not normally distributed. If the data is not normally distributed, then proceed with a non-parametric test with the Mann-Whitney U test.

3.1.3 Hypothesis Test (Mann-Whitney U Test)

Hypothesis testing is done to see if a conjecture is accepted or rejected. Based on the results of the normality test on the experimental class posttest data, it was found that it was not normally distributed, so it was continued with non-parametric hypothesis testing. The non-parametric test used is the Mann-Whitney U test to compare two groups, especially when the data does not meet the assumption of normality. Statistical hypothesis testing in this study is as follows:

$$H_0: \mu_1 = \mu_2$$

$$H_1: \mu_1 \neq \mu_2$$

Description:

H_0 = There is no effect of PQ4R learning strategy on mathematical problem-solving ability assisted by mural software.

H_1 = There is an effect of PQ4R learning strategy on mathematical problem-solving ability assisted by mural software.

μ_1 = Average value of students mathematical problem-solving ability in the experimental class.

μ_2 = Average value of students mathematical problem-solving ability in the control class.

The criteria for making data hypothesis test decisions using a significant level of $\alpha = 0,05$ are as follows:

- 1) Significant value of $sig > 0,05$, then H_0 is accepted and H_1 is rejected
- 2) Significant value of $sig \leq 0,05$, then H_0 is rejected and H_1 is accepted

Table 3. Mann-Whitney U Posttest Data

| | |
|------------------------|---------|
| Mann-Whitney U | 86,500 |
| Wilcoxon W | 296,500 |
| Z | -3,636 |
| Asymp. Sig. (2-tailed) | 0,000 |

Based on **Table 3**, the results of the Mann-Whitney U test calculation obtained by the posttest results of students' mathematical problem-solving skills with a significant level value (*sig*) of 0.000. In accordance with the criteria for hypothesis testing, H_1 is accepted. Therefore, it can be concluded that there is an effect of PQ4R learning strategy on mathematical problem-solving ability with the help of mural software.

3.2 DISCUSSION

According to the Mann-Whitney U hypothesis test results, H_0 was rejected and H_1 was accepted. This suggests that the PQ4R learning technique, with the help of Mural software, significantly improves students' ability to solve mathematical problems. This demonstrates that there is a statistically significant difference in the outcomes between the two groups. Compared to students in the control group who received traditional instruction, students in the experimental group who learned using the PQ4R technique with the aid of mural software achieved noticeably higher posttest scores. This finding shows that the structured learning stages in the PQ4R strategy support students in processing information more effectively. The steps Preview, Question, Read, Reflect, Recite, and Review guide students to actively engage with the learning material, improve their understanding, and internalize concepts, all of which are important in solving mathematical problems. Hasanah (2023) also concluded that the PQ4R strategy helps improve students' focus and understanding by encouraging them to review the content through various learning stages. In the PQ4R learning strategy, students understand the material more quickly and easily and understand how to solve problems better (Fitriyanti et al., 2021). The results of research from Artuti (2023) stated that the PQ4R learning strategy has an effect on students' mathematical problem-solving abilities compared to expository learning strategies. This is in line with the results of Mutazam (2020) research which stated that there was a significant increase in mathematical problem-solving abilities after the implementation of the PQ4R learning strategy.

In addition, the integration of Mural software provides an additional layer of support through its interactive and visual features. Students are able to organize ideas, visualize problem-solving steps, and collaborate more easily in a digital

environment. This is in line with Fitri (2024), which states that digital platforms contribute positively to students' cognitive engagement and performance in mathematics learning. Mural's flexibility across devices allows students to interact with content both during and outside of class, further strengthening the problem-solving process. The observed results in the experimental group can also be attributed to the active learning environment created by the implementation of the PQ4R learning strategy with the help of Mural. Students not only followed the procedural steps but also found it easier to remember and understand the content of the roof reading problem-solving (Saputra & Diana, 2022). Observational data during the implementation supported this, indicating that students in the experimental group were more engaged in reading the instructions, identifying the problem, and evaluating the correctness of their solutions compared to the control group. These findings reinforce the importance of adopting learner-centered strategies and technology integration in mathematics classrooms. This is reinforced by Fitri (2024) research which states that the use of digital media in learning can encourage more active student participation and involvement. Therefore, the PQ4R strategy supported by Mural helps to overcome these challenges by fostering student independence, critical thinking, and sustained engagement. In conclusion, the results of this study support the idea that the PQ4R learning strategy, when combined with collaborative digital tools such as Mural, can significantly impact students' mathematical problem-solving abilities. This combination offers a practical and effective alternative to conventional instruction, especially in contexts where students struggle with higher-order thinking skills.

4. CONCLUSION

Based on the results of data analysis and hypothesis testing, it can be concluded that the PQ4R (Preview, Question, Read, Reflect, Recite, Review) learning strategy assisted by Mural software has a significant influence on students' mathematical problem-solving skills. This conclusion is supported by the posttest results which show that the experimental group obtained a higher average score (32.04) compared to the control group (27.90). Furthermore, hypothesis testing using the Mann-Whitney U test produces a significance value of 0.000 in accordance with the hypothesis test criteria if $sig \leq 0,05$, then H_0 is rejected and H_1 is accepted. This means that the PQ4R (Preview, Question, Read, Reflect, Recite, Review) learning strategy assisted by Mural software has a significant effect on students' mathematical problem-solving ability. In addition, the results also showed a statistically significant difference between the two groups. The findings of this study suggest that the structured and reflective nature of the PQ4R strategy, combined with the interactive and visual support provided by the Mural software, helps students to better understand and apply the steps of problem-solving.

RECOMMENDATIONS

Future research can measure other abilities by using the PQ4R learning strategy and can conduct research at different levels. Future researchers can also use a more optimal mural software to help visualize ideas and understand concepts better.

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