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Beyond Numbers: Realistic Mathematics Education in Mathematics in Action to Enhance Students' Problem-Solving Skills

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Abstract
This research aims to improve the mathematical problem-solving abilities of class XII Langsa State High School students through the application of the Principles of Realistic Mathematics (PMR). The research method used is Classroom Action Research (PTK) with three cycles. The research subjects were 28 students. Data was obtained through problem-solving ability tests, observation of teacher activities, and student activities in learning. The research results show that the application of PMR is effective in improving students' problem-solving abilities. In cycle I, the students' average score reached 65.43 with classical completeness of 53.57%. This value increased to 72.86 in cycle II with classical completeness of 75.00%, and in cycle III it increased again to 80.23 with classical completeness of 89.28%. Apart from that, teacher activity in learning with PMR also increased from cycle to cycle, with the average value of teachers' ability to manage learning increasing from 3.00 in cycle I, to 3.25 in cycle II, and 3.45 in cycle III. Student learning activities also show an increase. In cycle I, the percentage of student activity was 62.50% (sufficient category), increased to 70.83% in cycle II (good category), and reached 78.57% in cycle III (active category). Students are more active in understanding contextual problems, discussing to find solutions, and summarising learning results. With these results, it can be concluded that the PMR approach can improve students' mathematical problem solving, student learning activities, and the effectiveness of teacher learning management. Therefore, PMR is recommended as a learning strategy that can be applied in mathematics learning at the high school level.

Keyword: Mathematics in Action, Problem Solving, Realistic Mathematics

Abstrak
Penelitian ini bertujuan untuk meningkatkan kemampuan pemecahan masalah matematis siswa kelas XII SMA Negeri Langsa melalui penerapan Prinsip Matematika Realistik (PMR). Metode penelitian yang digunakan adalah Penelitian Tindakan Kelas (PTK) dengan tiga siklus. Subjek penelitian berjumlah 28 siswa. Data diperoleh melalui tes kemampuan pemecahan masalah, observasi aktivitas guru, dan aktivitas siswa dalam pembelajaran. Hasil penelitian menunjukkan bahwa penerapan PMR efektif meningkatkan kemampuan pemecahan masalah siswa. Pada siklus I nilai rata-rata siswa mencapai 65,43 dengan

ketuntasan klasikal 53,57%. Nilai tersebut meningkat menjadi 72,86 pada siklus II dengan ketuntasan klasikal 75,00%, dan pada siklus III meningkat lagi menjadi 80,23 dengan ketuntasan klasikal 89,28%. Selain itu, aktivitas guru dalam pembelajaran dengan PMR juga mengalami peningkatan dari siklus ke siklus, dengan rata-rata nilai kemampuan guru dalam mengelola pembelajaran meningkat dari 3,00 pada siklus I, menjadi 3,25 pada siklus II, dan 3,45 pada siklus III. Aktivitas belajar siswa juga menunjukkan peningkatan. Pada siklus I persentase aktivitas siswa sebesar 62,50% (kategori cukup), meningkat menjadi 70,83% pada siklus II (kategori baik), dan mencapai 78,57% pada siklus III (kategori aktif). Siswa lebih aktif dalam memahami permasalahan kontekstual, berdiskusi untuk mencari solusi, dan merangkum hasil pembelajaran. Dengan hasil tersebut dapat disimpulkan bahwa pendekatan PMR mampu meningkatkan pemecahan masalah matematis siswa, aktivitas belajar siswa, dan efektivitas pengelolaan pembelajaran guru. Oleh karena itu, PMR direkomendasikan sebagai salah satu strategi pembelajaran yang dapat diterapkan dalam pembelajaran matematika di tingkat sekolah menengah atas.

Kata Kunci: ***Mathematics in Action, Pendekatan Realistik, Pemecahan Masalah,***

Introduction

Problem-solving ability in mathematics is a crucial skill for students to face academic challenges and real-life situations (Ahdhianto et al., 2020; Baldry et al., 2022; Sudarsono et al., 2022). However, various reports indicate that secondary school students still struggle to apply mathematical concepts to more complex situations (Fitriani et al., 2023; Wahyuni et al., 2023). According to the 2022 Program for International Student Assessment (PISA) results, Indonesian students' mathematics scores remain below the international average, particularly in problem-solving aspects. This finding suggests that mathematics education in schools has not yet fully equipped students with the critical and analytical thinking skills needed in real-world contexts (Ukobizaba et al., 2021; Wahyuni et al., 2023). Therefore, it is necessary to explore more effective instructional approaches to improve students' problem-solving abilities (Fauza et al., 2022; Fitriani et al., 2023; Ulya et al., 2023; Wahyuni, 2022).

Previous studies suggest that context-based approaches, such as Realistic Mathematics Education (RME), have the potential to enhance conceptual understanding and problem-solving skills (Gravemeijer, 2013; Treffers, 1987; Zulkardi et al., 2020). However, most research has been limited to primary and lower secondary education, while the implementation of RME in *Mathematics in Action* at the senior high school level has not been

thoroughly examined (Azis et al., 2021; Rulyansah, 2021; Sari et al., 2023). Additionally, there is a need for more in-depth studies on the influence of RME on students' social interactions during the learning (Nurhayati & , Langlang Handayani, 2020). Furthermore, there is still ongoing debate regarding the effectiveness of RME in increasing student engagement in learning and the extent to which this approach can foster sustainable problem-solving skills.

Several prior studies, have demonstrated that RME can enhance students' conceptual understanding of mathematics and make learning more meaningful (Hakim & Setyaningrum, 2024; Palinussa et al., 2021; Prahmana et al., 2023; Van den Heuvel-Panhuizen & Drijvers, 2020; Wijaya & Irianti, 2021). Additionally, that RME could actively engage students in the learning process (Nugraha, 2025). However, other studies suggest that without optimal teacher guidance, students may still struggle to connect abstract mathematical concepts with practical applications (Prahmana et al., 2023; Rulyansah, 2021; Sari et al., 2023) . Therefore, further investigation is needed to explore how the implementation of RME in *Mathematics in Action* can address these challenges and enhance the effectiveness of mathematics instruction at the senior high school level.

Based on these identified issues, this study seeks to answer the primary research question: To what extent can the implementation of the Realistic Mathematics Education approach in *Mathematics in Action* improve students' problem-solving skills? Additionally, this study will explore how this approach influences student engagement in the learning process and the effectiveness of teachers' instructional strategies. The research aims to fill the existing gap in the literature by empirically evaluating the effectiveness of RME in *Mathematics in Action* at the senior high school level.

Theoretically, this study will provide new insights into the application of realistic approaches in mathematics education and how they can be optimally implemented. Practically, the findings are expected to serve as a reference for educators in designing more innovative and context-based

teaching strategies to significantly enhance students' problem-solving skills. Thus, this research not only bridges the gap in previous studies but also provides concrete recommendations for improving the quality of mathematics education in schools. A detailed discussion of the research methodology will be presented in the subsequent section.

Methods

This study employs a quantitative approach using the Classroom Action Research (CAR) method, aiming to improve students' problem-solving abilities through the implementation of the Realistic Mathematics Approach (PMR) within Mathematics in Action. The CAR method was selected as it allows the research to be conducted in a step-by-step manner through reflective cycles, focusing on enhancing classroom teaching practices. The study was conducted at SMA Negeri 2 Birem Bayeun with a total of 28 twelfth-grade students, selected based on preliminary observations indicating that their mathematical problem-solving skills were still relatively low.

The research design consists of three cycles, each comprising four main stages: (1) Planning, which involves preparing PMR-based learning tools, including Lesson Plans (RPP), teaching materials, and assessment instruments; (2) Implementation, which refers to the application of PMR-based learning strategies in the teaching and learning process; (3) Observation, carried out to analyze student engagement, teacher activities, and the development of problem-solving skills through observation sheets and formative tests; and (4) Reflection, where learning outcomes are analyzed to determine necessary improvements for the following cycle.

To collect data, the study utilized several instruments: a problem-solving ability test to measure students' improvement before and after the intervention, observation sheets for student and teacher activities to assess classroom engagement and teaching effectiveness, and student response questionnaires to capture their perceptions of the applied method. Prior to

use, all instruments were validated by three experts in mathematics education to ensure content validity, evaluating the appropriateness of each item in relation to the intended indicators. Empirical validity of the test instruments was examined using the Pearson Product Moment correlation, with items considered valid if the correlation coefficient exceeded the critical value. Instrument reliability was tested using the Cronbach's Alpha formula, with coefficients ≥ 0.70 considered acceptable. The reliability of observation sheets and questionnaires was assessed through internal consistency checks and inter-rater reliability analysis.

The collected data were analyzed using descriptive quantitative. Descriptive analysis involved calculating the mean scores of the problem-solving tests and the percentage of students meeting the minimum mastery criteria. Additionally, improvements in students' problem-solving abilities across cycles were evaluated by comparing mean scores and mastery percentages to identify progressive learning gains throughout the intervention.

Result

In a study conducted at SMA Negeri 2 Birem Bayeun, the Realistic Mathematics (RM) approach was used as a learning method to improve students' mathematical problem-solving abilities. The results showed an increase from cycle to cycle, reflecting the effectiveness of reality-based learning strategies in helping students understand mathematical concepts more deeply.

Table 1 Research Results

Cycle	Average Score	Classical Mastery Percentage
I	65.43	53.57%
II	72.86	75%
III	80.23	89.28%

In Cycle I, the average value of students' problem-solving abilities was 65.43, with classical completeness of 53.57%. Teaching reflection showed

that many students had difficulty in understanding problems and planning solution strategies.

In Cycle II, there was an increase in the average value to 72.86, with classical completeness reaching 75.00%. From the results of teaching reflection, it can be seen that students are starting to get used to identifying information in questions and are more confident in choosing solution strategies. However, several obstacles were still found, especially in the aspect of implementing the planned strategy.

In Cycle III, the results obtained showed a significant increase with an average value of 80.23 and classical completeness reaching 89.28%. Teaching reflections show that students have been able to understand problems more quickly and accurately, and can choose more efficient strategies in solving them.

Discussion

The results of this study indicate that the application of the Realistic Mathematics Approach (PMR) gradually improves students' mathematical problem-solving abilities. This improvement is observed from cycle to cycle, both in terms of average scores and classical completeness. Reflections from each cycle provide insights into the challenges faced by students and the solutions implemented to address these issues.

In Cycle I, many students struggled to understand the problems and plan problem-solving strategies. These difficulties were caused by several factors, including a procedural learning habit that focused solely on memorizing formulas without understanding the underlying concepts. As a result, students became confused when faced with contextual or non-routine problems. Additionally, a lack of skills in identifying key information in problems made it difficult for them to formulate problem-solving strategies. Another contributing factor was their reluctance to engage in discussions and explore different possible solutions, as they were accustomed to a more passive learning approach. To address these challenges, the teacher introduced more contextual problems and encouraged group discussions so

that students could actively engage in understanding concepts and developing problem-solving strategies (Azis et al., 2021; Palinussa et al., 2021). This aligns with Vygotsky's social constructivist theory, which emphasizes the role of social interaction in cognitive development. Moreover, the teacher provided more intensive guidance in understanding the problem-solving steps by emphasizing conceptual understanding rather than mere memorization of formulas (Agusdianita et al., 2021; Sharma et al., 2021; Uyen et al., 2021).

In Cycle II, students began to become accustomed to identifying information in the problems and showed increased confidence in selecting problem-solving strategies. However, challenges remained regarding calculation accuracy and a low habit of reviewing their answers, which led to errors in the final results. Referring to the Van Hiele model of thinking stages, some students were likely still at the visualization or analysis stages, causing difficulties in performing abstract reasoning or reflecting on their answers without assistance. Moreover, the students' habit of reviewing their answers remained low, making them unaware of the mistakes they had made. The variety of problem-solving strategies used was also limited, as some students only applied the most common methods without attempting alternative approaches.

To address these issues, the teacher provided more intensive practice related to problem-solving strategies and techniques for reviewing answers (Lestari et al., 2023; Mangelep, N. O., Trifena Tarusu, D., Ngadiorejo, H., Fajrin Jafar, G., & Kambey, 2023). Students were also given problems with varying difficulty levels to enhance their critical thinking skills (Ariati & Juandi, 2022). Furthermore, the teacher encouraged students to present their answers and reflect on their problem-solving processes, enabling them to learn from their own mistakes as well as those of their peers (Rulyansah, 2021). This helped students progress to the informal deduction stage in the Van Hiele model, where they begin to justify the strategies, they use and evaluate various approaches.

In Cycle III, the significant improvement in scores and mastery indicates that students began to understand problems more quickly and were able to choose more efficient strategies. This change was driven by more active group discussions, greater variety in problem types, and the development of the habit of reviewing answers. This process demonstrates that students started to construct their understanding independently, as emphasised in the core principle of constructivist theory, that meaningful learning occurs when students are actively engaged through relevant experiences. The habit of reviewing answers also began to be adopted by most students, which improved their accuracy in solving problems. To sustain this improvement, the teacher assumed more of a facilitator role, guiding students to think independently and reflectively. The teacher provided challenging problems with a higher level of difficulty and encouraged students to explore various solution methods (Suryani et al., 2020; Wahyuni et al., 2023). Moreover, the teacher provided more in-depth feedback to help students identify their strengths and weaknesses in their strategies (Baldry et al., 2022; Ukobizaba et al., 2021; Wilkie & Roche, 2022).

Overall, the findings of this study demonstrate that the PMR approach is effective in enhancing students' mathematical problem-solving abilities. The increasing emphasis on concept exploration and problem-solving reflection by teachers, along with students' growing engagement in discussions and critical thinking, were key factors in improving learning outcomes. This aligns with previous research, such as the study conducted by Rulyansah (2021), which showed that PMR can enhance students' conceptual understanding and develop their critical and reflective thinking skills.

These findings also reinforce the study by Zulkardi (2020), which revealed that PMR encourages students to be more active in understanding concepts and connecting them to real-life situations, significantly improving their problem-solving skills. Additionally, the research by Aziz (2021) confirmed that while PMR enhances conceptual understanding, students still need training in other cognitive aspects, such as accuracy and reflection on

the solutions they create. From a pedagogical perspective, this study confirms that the effectiveness of PMR highly depends on how teachers manage learning and support students' thinking processes. The shift in the teacher's role from an information provider to a facilitator allows students to construct their own understanding and improve their ability to solve problems independently. This supports the findings of Gravemeijer (2013), who stated that in PMR, teachers must create a learning environment that enables students to construct their understanding through relevant contexts.

Furthermore, the implementation of group discussions in PMR has also proven effective in improving students' mathematical communication skills. The results of this study align with the research of Fitriani, Herman & Fatimah (2023), which found that discussion-based learning in PMR can enhance mathematical communication skills, an essential aspect of problem-solving. When students engage in discussions, they not only understand concepts better but also learn to construct logical arguments and systematically explain their thought processes.

The findings of this study also have implications for classroom teaching strategies. The increased student engagement in the learning process indicates that PMR can be an effective method for addressing students' passive learning habits in mathematics. By providing more context-based problems and encouraging the exploration of various problem-solving strategies, students become more accustomed to critical and reflective thinking challenges. This supports the findings of Treffers (1987), who stated that PMR not only helps students better understand concepts but also fosters independence in thinking and problem-solving.

Overall, this study strengthens previous findings that highlight the effectiveness of PMR in enhancing mathematical problem-solving skills. Moreover, the results of this study emphasize that the success of the PMR approach does not only depend on providing contextual problems but also on how teachers manage discussions, provide feedback, and adjust teaching strategies to meet students' needs. Therefore, a well-structured PMR

implementation, supported by effective teaching reflections, can serve as an efficient method for helping students develop conceptual understanding as well as critical and reflective thinking skills in solving mathematical problems.

Conclusion

Based on the research conducted at SMA Negeri 2 Birem Bayeun, the Realistic Mathematics Approach (PMR) has proven effective in improving students' mathematical problem-solving abilities. Significant improvements were observed from cycle to cycle, particularly in understanding problems, planning solution strategies, implementing strategies, and reflecting on answers. In Cycle I, many students faced difficulties in understanding problems and planning solutions, primarily due to their learning habits, which were more focused on memorizing formulas rather than understanding concepts. Through interventions such as the use of contextual problems and group discussions, improvements were observed in Cycle II, where students became more accustomed to identifying information within problems and gained confidence in selecting solution strategies. However, challenges remained in terms of calculation accuracy and the habit of reviewing their answers.

In Cycle III, significant progress was recorded, with the majority of students demonstrating quicker comprehension, improved accuracy in calculations, and a stronger habit of reflecting on their problem-solving strategies. With the teacher acting as a facilitator and implementing active discussion methods, students became more engaged in exploring mathematical concepts and showed increased motivation to learn.

The findings of this study align with previous research, which has shown that the PMR approach enhances conceptual understanding, critical thinking skills, and student motivation. Therefore, it can be concluded that the Realistic Mathematics Approach is an effective teaching method for improving students' mathematical problem-solving skills. Hence, the

implementation of PMR is recommended as a teaching strategy that helps students develop logical and analytical thinking skills, which are beneficial both in academic contexts and in real-life situations.

Although the results are promising, this study has limitations in scope, as it was conducted in only one school and within a limited timeframe. Moreover, the potential role of local culture in enriching the learning context was not a primary focus. Therefore, future researchers are encouraged to explore how integrating local cultural elements into PMR can enhance student engagement and make learning more meaningful. Such an approach not only has the potential to improve mathematical abilities but also fosters an emotional connection to the learning material and strengthens local identity within the educational process.

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