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OPTIMIZING STUDENTS' MATHEMATICAL PROBLEM SOLVING SKILLS THROUGH PROBLEM-BASED LEARNING AND TEACHING AT THE RIGHT LEVEL

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ABSTRACT

Penelitian ini dimaksudkan untuk mengoptimalkan kemampuan peserta didik dalam memecahkan masalah matematis melalui penerapan model pembelajaran berbasis masalah (*Problem-Based Learning)* yang dipadukan dengan pendekatan *Teaching at the Right Level* (TaRL). Penelitian ini dilakukan menggunakan metode Penelitian Tindakan Kelas (PTK) yang dilaksanakan dalam dua siklus pada peserta didik kelas XI di SMKN 2 Indramayu, dengan teknik pengumpulan data berupa observasi, dokumentasi, serta tes. Untuk menemukan perbaikan berkelanjutan dalam proses pembelajaran, setiap siklus mencakup fase perencanaan, pelaksanaan kegiatan, pengamatan, dan refleksi. Dengan skor rata-rata 84, ketuntasan belajar siswa pada siklus pertama adalah 67%, yang lebih tinggi dari kondisi pra-siklus, tetapi belum mencapai indikator ketuntasan minimum 75%. Ada peningkatan yang signifikan pada siklus kedua, karena ketuntasan mencapai 84% dan skor rata-rata 88, yang secara efektif melampaui target. Selain meningkatkan hasil pembelajaran, hasil penelitian ini menunjukkan bahwa PBL dan TaRL dapat membantu siswa menjadi lebih terlibat, terlibat, dan mampu mengatasi masalah saat belajar matematika. Terlepas dari kekurangan penelitian ini seperti durasi dua siklus dan fokus satu kelas hasilnya menunjukkan harapan untuk memajukan terciptanya pendekatan yang lebih efisien, fleksibel, dan berpusat pada siswa terhadap pendidikan matematika.

This research is intended to optimize students' ability to solve mathematical problems through the application of Problem-Based Learning model combined with Teaching at the Right Level (TaRL) approach. This research was conducted using the Classroom Action Research (PTK) method carried out in two cycles on class XI students at SMKN 2 Indramayu, with data collection techniques in the form of observation, documentation, and tests. To find continuous improvement in the learning process, each cycle includes phases of planning, implementation of activities, observation, and reflection. With an average score of 84, student learning completeness in the first cycle was 67%, which was higher than pre-cycle conditions, but had not yet reached the minimum completeness indicator of 75%. There was a significant improvement in the second cycle, as the completeness reached 84% and the average score was 88, which effectively exceeded the target. In addition to improving learning outcomes, the results of this study show that PBL and TaRL can help students become more engaged, involved, and able to overcome problems when learning mathematics. Despite the shortcomings of this study such as the duration of two cycles and the focus of one class the results show hope for furthering the creation of a more efficient, flexible, and student-centered approach to mathematics education.

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1. INTRODUCTION

The rapid progress of the 21st century has had a profound impact on education, among other areas. To give the next generation the skills they need to face the challenges of the modern world, the education system must innovate and adapt. Today, education is more focused on developing skills and competencies that are in line with the needs of the times, rather than being limited to the mere delivery of information or knowledge (Santoso & Suasti, 2024). The development of 21st century skills, such as critical thinking, problem solving, communication, teamwork, and creativity, are the main goals of 21st century education (Rosmana et al., 2022). Mathematics plays an important role in the development of these skills, because it not only trains analytical and logical abilities, but also encourages students to find innovative solutions and work together to solve problems effectively (Umbaryati, 2016). In addition, because it has an abstract object of study, mathematics is often difficult for students to understand. The abstract nature of mathematics, coupled with the complexity of its concepts, makes the material in this subject difficult to understand and reduces the interest of many students in learning it (Murdiani, 2018). One of the main skills that students need to have in order to master mathematics is the ability to solve mathematical problems (Muna et al., 2024).

One of the many fundamental skills that students need to have in order to face the challenges of the 21st century is the ability to solve mathematical problems. The ability to solve problems is a person's skill in using their knowledge to find a solution to a problem (Hidayat et al., 2022). Problem solving ability is a cognitive process that requires learners to actively receive and respond to questions, thus enabling them to solve problems effectively (Hartinah et al., 2019). This competency includes the ability to apply mathematics in real-life situations and solve various complex problems by using critical, analytical, and creative thinking skills, in addition to emphasizing knowledge of mathematical concepts alone (Ariani et al., 2020). In the process of learning mathematics, students are expected to be able to think critically in order to understand how to solve a problem (Sari et al., 2023). This ability is very important because it not only deepens understanding of mathematical concepts, but also trains critical, analytical, and creative thinking skills that are fundamental in various fields of work.

According to NCSM (National Council of Supervisors of Mathematics), the main reason for learning mathematics is to equip students with skills in solving problems (Mulyati, 2016). It has been proven that the scientific approach and Indonesian Realistic Mathematics Education (PMRI), which emphasizes the involvement of direct experience and a deep understanding of the material, can improve students' cognitive abilities (Dharmayanti & Wijaya, 2018). However, the reality in the field shows that there are still many students who have difficulty understanding and solving math problems that require advanced cognitive abilities, especially in statistics (Dewi et al., 2020). This challenge cannot be separated from the prevalence of traditional learning methods that are less effective in fostering students' problem-solving skills (Tukan et al., 2024).

Based on implementation, mathematics learning still faces a number of very complex challenges. Based on the results of the initial posttest in class XI on statistics, it appears that the majority of students face obstacles in mastering the basic concepts of statistics, ranging from data processing and presentation to interpretation of results. In addition, they also seem unable to use these concepts to solve problem-based problems that require critical and analytical thinking. To overcome this problem, it is important to innovate a learning framework that improves students' concept understanding and critical thinking skills.

One of the models that can be applied is Problem-Based Learning (PBL). Research (Nst et al., 2023) shows that the Problem-Based Learning (PBL) model acts as an educational approach that focuses on the active involvement of students in solving real problems in order to build a deep understanding of concepts and hone higher-level thinking skills. Through the PBL process, learners are guided to identify problems, research data, develop solutions, and assess results, thus improving their critical and creative thinking skills. To optimize the effectiveness of PBL, it should be integrated with the Teaching at the Right Level (TaRL) strategy. Although TaRL was originally developed by the Pratham Education Foundation in India, many studies have examined its applicability in the Indonesian education system.

TaRL underscores the need for diagnostic evaluation to determine learners' initial skills and offer learning that matches their current abilities, not just their grade level. By combining PBL and TaRL approaches, learners receive not only contextual problem-solving challenges but also educational experiences tailored to their individual abilities. This combined strategy aims to increase engagement in learning, strengthen conceptual understanding, and develop thinking skills at a more complex level, ultimately leading to positive outcomes for learners in mathematics learning achievement.

Many related studies support the efficacy of both methods. (Sukmayanti, 2020) showed that the use of the Problem-Based Learning (PBL) framework improved learners' problem-solving skills. In addition, research by (Dzahabiyyah et al., 2024) showed that the application of the Teaching at the Right Level (TaRL) method resulted in improved learning outcomes among learners. In addition, research by (Mangesthi et al., 2023) verified that the application of TaRL successfully minimized the skill gap among learners in the classroom, thus promoting a more inclusive and effective learning environment. This study aims to significantly improve the field of education, particularly in the area of teaching secondary school mathematics.

By combining the TaRL Approach with a problem-based learning framework, this strategy can increase the appeal and enjoyment of mathematics education. When learners find mathematics manageable, they tend to become more enthusiastic and engaged in their studies, leading to increased interest in learning. Furthermore, this research assists educators in customizing their teaching methods to suit the varying ability levels of their learners, which promotes a more effective and inclusive learning environment. Consequently, the findings of this study are anticipated to improve the overall standard of mathematics education.

2. METHODS

2.1. Research Subjects

To measure the problem-solving ability of students, this research applies a quantitative approach using Classroom Action Research (PTK) methodology. The subjects of this study were 30 students of class XI APHPI 2 SMKN 2 Indramayu, which was conducted in April 2025. To

ensure that the sample taken truly reflects the entire population, the rundom sampling technique is used.

2.2. Data Collection

The tools used in this study for data collection include observation sheets, documentation, and tests. The stages of PTK will follow the framework established by Kemmis and Mc. Taggart (Sukmawati et al., 2025), starting with problem identification, continuing to the design stage, then observation, followed by evaluation, and ending with reflection. This PTK research will involve several cycles until there is an overall improvement in the problem solving skills of the learners.

The first action taken by the researcher was to diagnose the problem through observation in the pre-cycle by conducting a diagnostic test. After identifying the challenges in the classroom, the researcher continued with action planning to design solutions and create LKPDs along with learning activities through the PBL model with the TaRL approach. This stage involved the formation of groups categorized into highly proficient, proficient, and those needing assistance, based on learners' achievement levels determined from the diagnostic assessment completed during the problem diagnosis phase. Next, the intervention using the PBL model with the TaRL approach is implemented for 2 learning meetings. During the observation phase, the researcher will monitor the activities and interactions between learners in their groups. The researcher will also document the progress of learners' skills as well as any challenges that occur during the learning journey. After the initial cycle ends, the researcher will collect and analyze data from the observations and learner questionnaires. The findings from this analysis will inform the evaluation of how effective the strategy was. The researcher will assess whether there was any improvement in learners' problem-solving skills. Following this evaluation, there will be a process of reflection on the actions taken, which will include evaluating the success of the TaRL PBL model and identifying elements that require improvement. The researcher will also consider learner feedback to improve the next action plan. If the desired results are still not achieved, the next cycle will start with the same procedure until learners' problem-solving skills show progress.

Data collection methods in this study include the use of notes, direct observation, and assessment. Assessments were used to evaluate learners' skill level in solving mathematical problems. At the same time, observation sheets served as a tool to systematically document data during observation sessions. The purpose of these observations was to gather qualitative information about the implementation of PBL-oriented instruction in the classroom, specifically looking at learner participation and the dynamics between teachers and learners during the educational experience. Furthermore, documentation involves collecting various materials related to the learning activities, which are then analyzed to gain a deeper insight into the learning process. Using documentation, researchers can assess how well learners understand the content, their patterns of engagement in learning, and identify various challenges that occur during the course. The insights gathered from this documentation play an important role in evaluating the achievements and shortcomings of the actions taken, while also serving as a basis for planning improvements in future research cycles.

2.3. Data Analysis

The analysis method used in this research includes qualitative and quantitative descriptive analysis. The main measure of success in this study was the achievement of a classical completion rate of at least 75% of the total number of learners in class XI APHPI 2 SMKN 2 Indramayu, with each learner obtaining a minimum score of 75 or more. Information regarding learners' writing performance was sourced from their cognitive ability, which was determined by calculating the average score of learning completeness. Qualitative insights gained from observations were then correlated with quantitative data to provide a basis for describing the effectiveness of learning activities, as reflected in the improvement of learners' mathematical performance.

3. RESULTS AND DISCUSSION

3.1. Results

The results of observations made of the mathematics learning of students in class XI APHPI 2 SMKN 2 Indramayu who have not achieved the basic competencies of statistics are referred to as the realization of the first stage of class action research. The observation results show that the performance of students is still not optimal, this is related to various problems that occur during the learning process, such as the lack of interest of students in mathematics, so that students quickly despair and want to end learning immediately. Therefore, at this planning stage, a strategic plan is prepared to increase the effectiveness of learning improvement. The implementation of learning 1 pre-cycle was carried out on Wednesday, April 16, 2025, with a duration of 2 x 45 minutes or 2 learning hours, divided into initial, core, and final activities carried out directly or face-to-face. The pre-cycle aims to assess learners' basic skills and evaluate their engagement in mathematics education.

Implementation of lesson 2 or cycle 1 was carried out on Wednesday, April 23, 2025, for 2 x 45 minutes or 2 learning hours. According to the guidelines in the teaching module, learning activities are conducted in three main stages: preparation, core, and closing. The teacher welcomes learners, who then give a favorable response, selects one learner to lead the prayer, and records attendance. Thirty learners are present during the introduction phase. The teacher then explains the learning objectives to be met after giving an overview of the preparation content through a question and answer session. The teacher introduces the basic activities by providing the LKPD, which includes inquiry exercises, inference, and assessment of the prepared problem. The division of groups in cycle 1 is with heterogeneous division of various abilities of learners. After completing the learning in groups, learners reported the results of their discussions. After that, the teacher uses PowerPoint to reinforce the topic and provides learning assessment to measure each learner's understanding of the material learned through individual written projects. The teacher makes a direct conclusion of the learning activity in the closing activity rather than leading a reflection session. The activity ends with a collective prayer and greetings, and the teacher also provides information on the subject matter that will be covered in the next meeting.

On Friday, April 25, 2025, cycle 2 of learning was implemented in an effort to address a number of issues that arose during the pre-cycle and cycle 1. According to the teaching module, the learning activities were divided into three stages: introduction, core, and closing. This was

done using the Problem-Based Learning model and the TaRL approach. The division of groups in cycle 2 was based on learners' abilities. Group discussions were carried out more successfully in this cycle compared to the previous cycle. The discussion process in this cycle the teacher provided reading materials to be a reference for students through a flipbook. Along with reflecting on the learning, the instructor closed the activity by giving some important things to the learners. The observation and evaluation results from cycles 1 and 2 show that the Problem Based Learning approach was successfully implemented. With the help of technology, the material was presented according to the learners' abilities, the learning process went according to plan, and the learners were actively involved. Teaching at the Right Level is a methodical way to teach math. Teachers increase cooperation and engagement by grouping learners according to their abilities. The simple LKPD also helps learners complete the task well.

Based on the results of the initial pre-class skills test, only seven out of thirty students who completed the test were able to obtain a minimum score of 75. Therefore, 23% was the proportion of classical completeness. The test was given at the end of the lesson to measure students' understanding of the content covered, based on the evaluation findings from cycles 1 and 2. Table 1 displays the data from the cycle 1 assessment results, and Table 2 displays the cycle 2 evaluation findings.

Table 1. Cycle 1 Results of Learners

Description	Learner Score
Average value	84
Number of students who participated in the activity	30
Number of students who are complete	20
Number of students who did not complete	10
Percentage of learning completeness	67%

Table 2. Cycle 2 Results of Learners

Description	Learner Score
Average value	88
Number of students who participated in the activity	30
Number of students who are complete	25
Number of students who did not complete	5
Percentage of learning completeness	84%

3.2. Discussion

The integration of *Problem-Based Learning* (PBL) with the *Teaching at the Right Level* (TaRL) approach has proven effective in enhancing students' mathematical problem-solving abilities, as evidenced by an increase in learning mastery from 67% to 84% among Grade XI students at SMKN 2 Indramayu. This result highlights the potential of combining exploratory and differentiated strategies to address heterogeneous student competencies in the classroom. PBL plays a vital role in promoting active engagement, critical thinking, and conceptual understanding, as supported by previous studies in mathematics and science education (Sukmayanti, 2020; Rehman et al., 2023; Suhar, 2022). Pedagogically, PBL aligns

with constructivist learning theory, where students build knowledge through structured and reflective problem-solving activities (Vygotsky, 1978).

Complementing PBL, the TaRL approach facilitates adaptive instruction by grouping students according to their diagnosed competency levels. This method reduces learning gaps and accelerates cognitive progress, particularly among lower-performing students (Wikriyah, 2021). Furthermore, TaRL resonates with broader trends in personalized and adaptive learning, increasingly supported by educational technologies. For example, Haelermans (2022) showed that group differentiation based on students' learning strategies—measured using the *Motivated Strategies for Learning Questionnaire* (MSLQ)—can enhance motivation, metacognition, and academic performance. This concept is extended through the *Personalized Exercise Group Assembly* (PEGA) method proposed by Yang et al. (2023), which employs multi-objective evolutionary algorithms to generate practice groups based on students' cognitive profiles. Similarly, Imamah et al. (2024) combined ant colony optimization with *Item Response Theory* (IRT) to create dynamic personalized learning paths, while Peng (2024) applied optimized K-means clustering to categorize learners by behavioral patterns in university-level English instruction. In parallel, Osakwe et al. (2024) utilized reinforcement learning to support real-time self-regulated learning (SRL), further demonstrating the potential of intelligent systems to personalize instruction and promote learner autonomy.

Field observations during the two-cycle intervention also revealed significant increases in student participation, idea sharing, and collaborative problem-solving. These improvements indicate that the PBL–TaRL integration positively impacted not only cognitive outcomes but also affective and social dimensions of learning. This finding is consistent with Dzahabiyyah et al. (2024), who demonstrated that level-based instruction fosters active participation by aligning content with students' readiness. However, one emerging challenge relates to the dominance of high-achieving students in heterogeneous groups, which often suppresses participation from peers with lower competencies. While heterogeneous grouping has been shown to foster rich social interaction and collaborative problem-solving (An & Zhang, 2024), it may also perpetuate imbalances in contribution. In this context, TaRL's level-based regrouping presents a more equitable alternative. Kanika et al. (2022) reported that grouping by competence increases students' comfort and engagement in discussion. Nevertheless, this approach is not without limitations. Research has shown that lower-level groupings can result in emotional or behavioral issues (Papachristou et al., 2021) and potentially disrupt peer dynamics and motivation (Belfield & Rasul, 2020). Moreover, while homogeneous grouping promotes equity within groups, mixed-ability groups offer the advantage of diversity and inclusiveness. Thus, the effectiveness of any grouping strategy must be context-sensitive and guided by close teacher monitoring and responsive classroom practices.

In summary, this study not only reinforces the empirical effectiveness of PBL and TaRL independently but also contributes to the theoretical development of their integration as an adaptive, problem-centered instructional model for mathematics education in vocational high schools. This combined approach offers a promising direction for designing responsive learning environments that address learner diversity while fostering 21st-century

competencies such as critical thinking, collaboration, and self-regulation (Rosmana et al., 2022). To ensure successful and sustainable implementation, institutional support, continuous professional development for teachers, and policy frameworks that prioritize equitable and adaptive instruction are essential components of a future-ready educational ecosystem.

4. CONCLUSIONS

This study concludes that integrating *Problem-Based Learning* (PBL) with the *Teaching at the Right Level* (TaRL) approach significantly improves students' mathematical problem-solving skills. Learning mastery increased from 67% to 84% across two action research cycles, highlighting the effectiveness of combining contextual problem-solving with level-based instruction.

PBL encouraged active exploration and critical thinking, while TaRL supported differentiated learning tailored to students' actual abilities. Grouping students by competence level improved participation equity and learning outcomes.

Despite limitations in duration and scope, this study offers practical insights for implementing adaptive, student-centered learning models in mathematics classrooms. Future research should explore broader contexts and deeper metacognitive outcomes.

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