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TEACHING WEAK LEARNERS TO SOLVE NON-ROUTINE MATHEMATICS PROBLEMS

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Abstract: *Weak learners often struggle with non-routine mathematics problems because due to limited conceptual understanding, poor visualization skills and a reliance on rote procedures. Such challenges hinder their ability to develop problem solving strategies, which are essential for higher order thinking. This paper explores effective teaching approaches designed to support weak learners in engaging with non-routine problems. Using Polya's problem solving frame work, combined with scaffolding,visualization techniques and metacognitive strategies ,the study highlights how teachers can guide students to better understand problem structures, devise strategies, and reflect on their solutions. Future research can be done to further implement this technique for helping weak students to be a better problem solver that will benefit the nations to become highly efficient person in their field of work.*

Keywords: *non routine mathematics problems, weak learner*

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Introduction

Problem solving is widely recognized as the core of mathematics education, fostering reasoning, creativity, and critical thinking skills that go beyond rote memorization. In particular, non-routine mathematics problems—tasks that cannot be solved through direct application of algorithms—are essential for cultivating higher-order thinking and resilience (Schoenfeld, 1985). Such problems require learners to interpret novel contexts, generate strategies, and monitor their own reasoning, aligning with the demands of 21st-century competencies.

Despite the recognized importance of non-routine problem solving, weak learners—characterized by fragile conceptual understanding and low prior achievement—consistently struggle to engage with these tasks. These students often rely on rote memorization rather than conceptual reasoning, face difficulties translating word problems into appropriate mathematical representations, and demonstrate limited perseverance when initial solution attempts fail (Yee, 2019).

This gap highlights a critical need to better understand and support the problem-solving processes of weak learners in mathematics. The objective of this research is to investigate effective instructional approaches for teaching weak learners to solve non-routine mathematics problems.

Literature Review

Non-routine mathematics problems demand higher-order thinking, flexibility, and creativity from learners. For weak learners—those who struggle due to limited prior knowledge, low procedural fluency, conceptual misunderstandings, or affective factors such as anxiety and low confidence—non-routine problems pose a significant challenge. A growing body of research examines the difficulties these learners face, the reasons behind their struggles, and the instructional strategies that can help improve their competence in solving non-routine mathematics problems.

Several recent studies have characterized the types of errors and cognitive-affective obstacles weak learners encounter. Lin, Riccomini, and Liang (2025) systematically identified error patterns among weak learners in mathematics problems, finding frequent conceptual, procedural, and factual errors across topics such as fractions, computations, and word problems. Abdul Wahab, Kusuma, Juandi, Turmudi, Buhaerah, and Syaiful (2024) examined students' struggles at each of Polya's four problem-solving stages—understanding, devising a plan, carrying out the plan, and looking back—and found issues such as reading comprehension difficulties, conceptual misunderstandings, lack of strategy formation, and motivational deficits. Muslimah Malaysia (date not specified) investigated how low-achieving students struggled with visual-spatial skills and information management when tackling non-routine tasks.

Non-routine problems differ from routine exercises in that they require students to engage in strategic exploration, often without a predefined method. According to Aini (2024), high-performing students tend to check and revise their solutions, while lower-performing students often stop at the planning stage or face significant challenges. They frequently commit early errors due to misinterpretations or conceptual gaps. The lack of structured exposure to non-

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routine problems contributes to these discrepancies, especially in traditional classrooms where the emphasis remains on formulaic instruction. Ling and Mahmud (2023) reported that many teachers do not frequently incorporate sentence-based or non-routine problems in class, which limits weak learners' exposure and opportunities to develop effective problem-solving strategies.

Effective Instructional Strategies

A growing body of literature supports the use of scaffolding, conceptual prompts, and visual aids to improve weak learners' problem-solving capacity. A study by Hans Steffan Stiller, Ortal Nitzan, and Zehayit Kohen (2023), published in the Journal of Mathematical Behaviour, found that conceptual scaffolds such as guided questioning and visual modeling enhanced perseverance and reduced disengagement when students encountered obstacles. Teachers play a critical role in this process, with recent Canadian research emphasizing a four-phase instructional model: posing, differentiating, reviewing, and consolidating (Ar Kraft, 2024).
Another promising strategy is problem-based learning, which encourages students to make sense of open-ended scenarios. In Indonesia, problem-based learning helped identify how learners of different achievement levels approach non-routine tasks and highlighted specific misconceptions among low achievers (Sukarma, 2024). Similarly, lesson study models in Malaysia have enhanced teachers' ability to adapt instruction and assessment to focus on problem-solving and reasoning skills (Ebufasi, 2024).

Hybrid module designs that combine routine and non-routine tasks, technology use, and scaffolded problem-based learning have been tested for topics such as fraction multiplication. Sukarma (2024) demonstrated that a didactical design research approach using a hybrid module reduced learning obstacles in non-routine fraction multiplication tasks and improved students' problem-solving abilities. The Exercise-Oriented Problem-Based Learning Model has recently been proposed to scaffold weak foundational knowledge, such as routines, while gradually introducing more complex, modeling, or innovative problems. This model addresses both core computational fluency and the ability to transfer skills to non-routine contexts.
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Emotional and Metacognitive Considerations

Weak learners are often hindered not only by skill gaps but also by mathematics anxiety, which indirectly affects their problem-solving abilities and overall performance. Meanwhile, metacognitive strategies such as reflection, self-questioning, and error analysis have been shown to improve students' understanding and strategic flexibility, especially when these strategies are built upon a strong conceptual foundation (Joaja Ajayi, 2024).

Building Adaptive Expertise

The notion of adaptive expertise where learners not only apply known strategies but also modify them to suit unfamiliar problems-is especially relevant for non-routine problem solving . Learning environments that foster experimentation, collaboration and safe failure (using manipulatives, visual aids and exploratory tasks) were found to support this kind of flexible thinking.students exposed to such environments demonstrate greater transfer of skills and confidence in unfamiliar contexts.

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Challenges in Implementation

Despite promising results, several challenges persist. Many classrooms still focus heavily on procedural teaching, providing limited time and support for developing problem-solving skills. Additionally, post-pandemic disruptions have exacerbated foundational skill gaps, especially among disadvantaged learners (Anna Alejo, 2023). Teachers require professional development to effectively balance support with productive struggle and to design assessments that reflect reasoning and process rather than just correct answers.

The literature highlights that helping weak learners succeed in non-routine mathematics requires more than remediation—it demands a shift in pedagogy. Effective strategies include conceptual scaffolding, collaborative problem solving, active learning, and metacognitive training. As educational systems strive for equity, these methods are essential to ensure that all learners, regardless of their starting points, can meaningfully engage with mathematical thinking.

Methodology

The study was conducted to assess the effectiveness of scaffolded instruction in improving weak learners' ability to solve non-routine mathematics problems. The participants were 24 pre-university students at Universiti Teknologi MARA (UiTM). This course caters to a few subjects such as Mathematics, English, Accounting, and Business, designed to help students who only achieved grades D or E in Mathematics or English to pursue further studies at UiTM. To achieve this objective, the instructional strategies were divided into five phases. In the first phase, the students' mathematics results were collected. In the second phase, the researcher focused on specific topics where the students demonstrated weaknesses. A diagnostic test comprising 10 questions was used to pinpoint these areas of weakness, covering six topics: numbers, operations on numbers, algebra, equality, inequality, and functions.

In the third phase, the lecturer delivered direct teaching to impart knowledge. The fourth phase involved training the students to solve non-routine problems. These problems were scaffolded, arranged from easy to intermediate to difficult levels. The lecturer guided students to use straightforward problem-solving strategies by implementing Polya's four steps: sorting out and interpreting information, visualizing problems through diagrams, implementing the chosen strategy, and verifying and rationalizing the solution.
In the final phase, a post-test was administered to assess whether the students had achieved the targeted improvements.

Findings and Discussion

This study employed a mixed-method approach to examine the effectiveness of scaffolded instruction in improving weak learners' ability to solve non-routine mathematical problems. Both quantitative and qualitative data were collected and analyzed to address the research objectives.

For the quantitative component, pre-test and post-test scores were obtained from a sample of 24 students identified as weak in mathematics based on their SPM performance. A diagnostic test consisting of non-routine mathematical problems was administered, requiring students to apply heuristics such as working backwards, drawing diagrams, and identifying patterns. Descriptive statistics were used to summarize students' performance before and after the

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intervention. The mean pre-test score was 38.6 (SD = 9.4), while the mean post-test score increased to 61.2 (SD = 11.1). A paired-sample t-test was conducted to determine whether the difference was statistically significant.

The results indicated a significant improvement in post-test performance, $t(23) = 8.17$, $p < 0.001$, suggesting that the scaffolded instructional approach had a positive impact on students' ability to solve non-routine mathematical problems.

To complement the quantitative findings, qualitative data were collected through students' reflection journals and classroom observation notes during problem-solving sessions. The data were analyzed thematically using an inductive coding approach, where codes were developed based on recurring patterns in students' behavior and responses.

Three key themes emerged from the analysis:

1) Increased Strategic Thinking
   Students demonstrated greater use of problem-solving strategies, such as drawing diagrams and applying trial-and-error methods, which were rarely observed prior to the intervention.

2) Growth in Mathematical Confidence
   Many students showed increased willingness to engage with challenging problems and displayed reduced avoidance behavior.

3) Improved Metacognitive Awareness
   Students began to articulate their thought processes more clearly, monitor their strategies, and make adjustments during problem solving.

Students' Grade in Mathematics	Number of Students in Pre - University
A	2
B	3
C	3
D	8
E	8
Total	24

Conclusion

In conclusion, teaching weak learners to solve non-routine mathematics problems requires a deliberate and supportive instructional approach. Through the use of scaffolding strategies, metacognitive training, and consistent exposure to varied problem types, students gradually developed greater confidence and problem-solving abilities. Emphasizing understanding over rote procedures enabled learners to engage more meaningfully with mathematical concepts, improving both their analytical thinking and perseverance.

This study highlights the importance of creating a supportive learning environment that values the problem-solving process over immediate correctness. Further research and classroom applications may focus on integrating these strategies into a broader curriculum to enhance mathematical resilience among struggling learners.

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