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Analysis of problem-solving ability: Pólya's strategy and positive attitude

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ABSTRACT

Problem-solving is essential for individuals to face various challenges in the 21st century. Therefore, problem-solving has become a primary goal in mathematics curricula worldwide. However, despite its importance, problem-solving remains one of the most challenging aspects to grasp in mathematics education. Several studies have shown that appropriate strategies and a positive attitude toward problem-solving can help improve students' problem-solving abilities. In this study, the author will examine the implementation of Pólya's mathematical problem-solving strategy. Additionally, the study will explore students' attitudes toward problem-solving and how these attitudes influence their performance. Finally, the research will assess the combined impact of Pólya's strategy and students' attitudes on their problem-solving abilities. This study employs a qualitative approach using content analysis methods. The results show that the top ten students from one of the best schools in Siak Regency still struggle to solve simple problems. This failure is attributed to inappropriate strategies and a lack of a positive attitude toward problem-solving. The study concludes that mastering problem-solving strategies and fostering a positive attitude are crucial for students to become effective problem solvers.

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ABSTRAK

Pemecahan masalah adalah keterampilan penting yang dibutuhkan individu untuk menghadapi berbagai tantangan di abad ke-21, sehingga menjadi tujuan utama dalam kurikulum matematika di banyak negara. Meskipun penting, aspek ini tetap menjadi bagian yang paling sulit dipahami dalam pendidikan matematika. Penelitian terdahulu menunjukkan bahwa secara terpisah, strategi yang tepat serta sikap positif terhadap pemecahan masalah, dapat meningkatkan kemampuan pemecahan masalah siswa. Penelitian ini bertujuan untuk mengkaji penerapan strategi Pólya dalam pemecahan masalah matematika. Selain itu, penelitian ini juga akan mengeksplorasi sikap siswa terhadap pemecahan masalah dan bagaimana sikap tersebut mempengaruhi kinerja mereka. Akhirnya, penelitian ini akan menilai dampak gabungan dari strategi Pólya dan sikap siswa terhadap kemampuan pemecahan masalah mereka. Penelitian ini menggunakan pendekatan kualitatif dengan metode analisis konten. Hasilnya menunjukkan bahwa sepuluh siswa terbaik di salah satu sekolah terkemuka di Kabupaten Siak masih kesulitan menyelesaikan masalah sederhana. Kesulitan ini disebabkan oleh penggunaan strategi yang kurang tepat dan sikap positif yang rendah terhadap pemecahan masalah. Penelitian ini menyimpulkan bahwa penguasaan strategi pemecahan masalah dan pengembangan sikap positif secara bersamaan sangat penting agar siswa dapat menjadi pemecah masalah yang lebih efektif.

Kata Kunci: *heuristic pólya; pemecahan masalah matematika; sikap positif.*

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INTRODUCTION

Problem-solving is a skill that every individual needs to possess to overcome various life challenges in the 21st century. It is unavoidable and fundamental for human survival (Rahman, 2019). In mathematics education, various literatures indicate that problem-solving is the essence of learning mathematics; indeed, mathematics itself is a body of knowledge that provides tools for solving problems (Han & Huang, 2023; Kaur, 1997). Similarly, Liljedahl, in a book titled "*Problem solving in Mathematics Education*" stated that problem-solving is believed to play a significant role in mathematics (Jonassen, 1997; Szabo et al., 2020). The main objective of teaching mathematics is to investigate mathematics itself and identify where it can be applied to solve everyday problems. Halmos stated that problem-solving is the heart of mathematics (Halmos, 1980). Similarly, Problem-solving became a focus of mathematics education; much research has been conducted to improve teaching, develop higher-level skills, emphasize formative character, and evaluate student learning (Lester & Cai, 2016; Olivares et al., 2021). Problem-solving has become a primary goal of mathematics curricula in various countries, yet each education system has different methods for achieving this, resulting in diverse evaluation outcomes (Burkhardt, 2014; Fülöp, 2021). Specifically, the objectives of problem-solving in the mathematics curriculum are to enhance students' willingness to attempt problems and their persistence in solving them, improve students' self-concept regarding their problem-solving abilities, make students aware of problem-solving strategies, make students aware of the value of a systematic approach to problems, make students aware that many problems can be solved in more than one way. Improve students' ability to select appropriate solution strategies, improve their ability to accurately apply solution strategies, and increase student's ability to obtain more correct answers to problems (Ahdhianto et al., 2020; Aydoğdu & Ayaz, 2008).

Unfortunately, despite its importance, mathematical problem-solving is also the most challenging aspect to understand in mathematics education (Tambychik & Meerah, 2010). Problem-solving is the most fundamental goal in teaching mathematics, yet it is also the hardest to achieve. Many students give up and avoid mathematical problem solving. Empirical evidence shows that problem-solving has yet to fully become a characteristic of mathematics education in schools, especially in Indonesia. Students' low problem-solving abilities are also evident in Indonesia's consistently low PISA scores over the years, particularly in mathematics (Bilad et al., 2024). This is due to the lack of emphasis from the government on how teachers should train students' problem-solving skills in the classroom (Fitria & Sukirman, 2023). When designing lesson plans, teachers tend to focus more on the content elements of learning outcomes. They formulate learning objectives and organize them into a sequence of learning goals. Meanwhile, the process elements essential for developing problem-solving skills are often not integrated into the lesson plans.

Additionally, the complex nature of problem-solving tasks, which are often difficult to teach and understand, poses challenges (Ling & Mahmud, 2023). There needs to be clear guidelines on how teachers and students should approach problem-solving tasks, resulting in these skills being treated as supplementary, usually taught only at the end of the learning process. Meanwhile, students often need clarification when faced with problem-solving tasks, unsure of where to start, and ultimately, the teacher solves the problem on the board. Students need more understanding in breaking down problems, which may be due to limited practice with non-routine problems and a lack of approaches that encourage independent thinking. With the right strategies, students tend to rely on the teacher, and the opportunity to develop critical thinking and independent problem-solving skills is improved (Tambychik & Meerah, 2010). Before the concept of 21st-century skills became widely recognized, Pólya, a mathematician, introduced general problem-solving strategies, particularly in mathematics. The strategies offered by Pólya are general strategies that can be applied to various problems. Mathematics educators received Pólya's heuristics well at the time, and this finding became a valuable resource for enhancing students' problem-solving abilities. Many

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researchers, including Tjoe in a book titled "*Mathematical Problem Solving (chapter: Looking back to solve differently: Familiarity, fluency, and flexibility)*" have utilized Pólya's strategies to address more specific issues by breaking down Pólya's heuristic steps into more detailed steps (Szabo et al., 2020; Zheng et al., 2013). However, the use of these strategies appears to be poorly understood in mathematics problem-solving classes, especially in Indonesia.

On the other hand, students' positive or negative attitudes toward mathematics influence their achievement in mathematics. Students' beliefs and expectations regarding the difficulty of mathematical tasks, their perceptions of the value of success, and their perceived control over outcomes are significantly related to their achievements in mathematics (Singh et al., 2002; Wen & Dubé, 2022). A positive attitude is a crucial learning goal in many school subjects, particularly mathematics, and it strongly correlates with improved performance (Aiken, 1970; Berger et al., 2020). The author is interested in exploring students' problem-solving abilities from two perspectives, often addressed separately in previous studies. The first perspective is problem-solving strategies, and the second is students' attitudes toward mathematics. By combining these two aspects, the author aims to understand better how both factors influence students' abilities to solve mathematical problems.

The school where this research is conducted has independently implemented the Kurikulum Merdeka. Specifically in mathematics instruction, teachers design lesson plans by replicating the teaching materials available on the *Platform Merdeka Mengajar* (PMM), the primary source of information regarding implementing the Merdeka Curriculum for schools adopting it independently. It can be observed from the teaching materials on the platform that mathematics instruction focuses more on content elements without addressing the process elements, particularly mathematical problem-solving. This study focuses on the problem-solving abilities of high school students in Riau Province, Indonesia, particularly in Exponents, Sequences, and Series. In this study, the author will examine the application of Pólya's strategy in mathematical problem-solving. Additionally, the study will explore students' attitudes toward problem-solving and how these attitudes influence their performance. Finally, the research will assess the combined impact of Pólya's strategy and students' attitudes on their problem-solving abilities.

LITERATURE REVIEW

Pólya's Problem-solving Strategy

Mathematicians have long strived to find the best strategies to assist students in problem-solving. The most famous and widely used problem-solving strategy in mathematics is Pólya's Heuristic, introduced by George Pólya in his book "*How to Solve It*" in 1945. Despite debates about its effectiveness in problem-solving, this book has become one of the most cited. It has significantly influenced subsequent research by followers who applied this approach in their work (Szabo et al., 2020). According to Pólya, there are four main steps in solving a problem. The first step is understanding the problem. This is crucial because one cannot solve a problem without comprehending it (Michener, 1978; Smith et al., 2021). Strategies to achieve this include rereading the problem if it is not understood, identifying keywords, disregarding irrelevant information, and attempting to rewrite it in one's own words. The second step is devising a plan, which involves selecting strategies that might help solve the problem (Schoenfeld, 1979; Smith et al., 2021).

The strategies include representing the problem with pictures or diagrams, eliminating possibilities, working backward, solving a more straightforward analogous problem, considering exceptional cases, guessing and checking, and trial and error. The third step is implementing the plan, where the devised solution is implemented carefully (Garofalo & Lester, 1985; Smith et al., 2021). This involves selecting the strategy believed to be appropriate and switching to another if the initial strategy proves ineffective, with the understanding that effort is well-spent in problem-solving. The fourth step is looking back. Obtaining a

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solution does not mean the problem-solving process is complete. The next step is to review the solution process to ensure correct reasoning or arguments (Haddaway et al., 2020; Silver et al., 1995). Finding alternative solutions to the same problem is essential as these can be valuable for future problem-solving (Haddaway et al., 2020; Silver et al., 2005). Among Pólya's four steps, the third step is the easiest to evaluate in terms of outcomes, as the success of the curriculum can be observed through the results of this step. In contrast, the first, second, and fourth steps are supportive phases that are not the primary targets of any mathematics curriculum, as stated by Tjoe in a book titled "*Mathematical Problem Solving (chapter: Looking back to solve differently: Familiarity, fluency, and flexibility)*".

Positive Attitude Towards Mathematical Problem-Solving

Mathematics is taught sequentially, with each topic building upon previously learned material. Therefore, mastery of new topics heavily depends on understanding prerequisite knowledge. Due to this complexity, initial interest and a positive attitude toward learning mathematics are essential (Bakker et al., 2021; Singh et al., 2002). Research indicates that numerous interrelated variables influence students' success in problem-solving. Many of these variables are tied to home and family environments, making them difficult to change as they are beyond the control of educators. However, there are school-related variables that can influence educational interventions, such as student academic engagement, perceptions and attitudes, and awareness of the role of mathematics/science achievement in future career opportunities. As a result, understanding the impact of factors such as motivation, interest, attitude, and academic engagement on mathematics and science achievement has garnered significant attention in recent years.

Other research indicates that attitude variables such as self-concept, belief in problem-solving, interest and motivation, and self-efficacy have emerged as significant predictors of success in problem-solving (Eccles & Jacobs, 1986). Many researchers argue that success in mathematical problem-solving is influenced by the social environment's attitude towards mathematics, such as teachers' and parents' attitudes towards students as learners, affecting students' attitudes towards mathematical problem-solving. The most tremendous success occurs when there is self-awareness and intrinsic motivation to learn (London et al., 2022; Skaalvik & Rankin, 1995). Attitude is not something people are born with; it is developed over time. Fundamentally, an attitude is personal to the individual. However, it cannot be directly observed, as it manifests indirectly through observable behaviors. Attitudes primarily form during early childhood and are influenced by parents and peers. Life experiences, cultural background, and social interactions inevitably play a role in shaping attitudes. Distinct attitudes are often retained in a person's memory. They can significantly impact their future behavior, as Sölpük stated in a book titled "The effect of attitude on student achievement". Educators are pivotal in shaping students' intrinsic problem-solving motivation (Bakker et al., 2021; Singh et al., 2002). This intrinsic motivation can be reflected in a positive attitude towards problem-solving, including a belief in the practical benefits of problem-solving, enthusiasm for tackling problem-solving tasks, sustained interest in problem-solving questions, and perseverance and confidence in addressing these challenges.

METHODS

This study employs a qualitative approach to explore the depth and complexity of students' experiences and thought processes during problem-solving. Qualitative research focuses on understanding human behavior and the reasons that govern such behavior, and findings will be presented based on field data and data analysis, which will then be thoroughly described in the research report (Creswell et al., 2007). In this context, it allows us to examine not only the observable problem-solving actions of students but also their perceptions and attitudes. The research uses content analysis methods, a systematic technique for coding and categorizing qualitative data to interpret patterns and themes, as stated by Mayring in a

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book titled "Qualitative content analysis: theoretical background and procedures". Specifically, content analysis helps extract insights from students' responses and reflections regarding applying Pólya's problem-solving strategies.

The research began by identifying the target group- five males and five females—the top ten tenth-grade students from one of the best public high schools in Siak Regency, Riau Province. These students were selected based on their academic performance in mathematics. Each student was given two problem-solving questions about exponents and sequences/series, designed to be non-routine and not require complex mathematical computations. These questions were selected from the mathematics learning outcomes outlined in Phase E of the Kurikulum Merdeka, as stated in the decision of the Badan Standar, Kurikulum, dan Asesmen Pendidikan (BSKAP), Number 032/H/KR/2024. The aim was to focus the students' attention on the problem-solving process rather than the final answer.

The problem-solving process was observed through Pólya's four stages: understanding the problem, devising a plan, carrying out the plan, and looking back. While the execution of the plan could be assessed quantitatively through scores, the other three stages were more abstract. These were assessed qualitatively through questionnaires and observations designed to estimate students' familiarity with Pólya's stages. The students were encouraged to reflect on their steps during the problem-solving process, noting alternative strategies where applicable. No time limit was imposed on completing the problems, although most students finished within an hour.

Data collection concluded once all responses were gathered. The qualitative data was then coded and analyzed to identify common patterns, strategies, and the impact of students' attitudes on their problem-solving abilities. Finally, the results were synthesized into findings and conclusions, highlighting how well students applied Pólya's strategies and the role of their attitudes in influencing their performance.

RESULTS AND DISCUSSION

The Implementation of Pólya's Strategy in Mathematical Problem Solving

A questionnaire was used to assess the implementation of Pólya's strategy in mathematical problem-solving, as shown in **Table 1**. The table presents questions designed by the students to measure the application of each stage of Pólya's problem-solving strategy, along with question codes that facilitate data analysis.

Table 1. Questions Measure Implementation Polya's Strategy

Pólya's Stages	Question Description and Assessment	Code
Understand the Problem (U)	1. Understanding the problem's intent. (2 = understands, 1 = somewhat understands, 0 = does not understand)	U1
	2. Reading the problem multiple times. (2 = more than 2 times, 1 = 2 times, 0 = 1 time)	U2
	3. Writing down the known information from the problem. (2 = if included, 1 = if included but not accurate, 0 = if not included)	U3
Devising a plan (D)	1. Rewriting the problem in one's own words, using a diagram or table. (2 = if included, 1 = if included but not accurate, 0 = if not included)	D1
	2. Considering multiple solution alternatives. (1 = yes, 0 = no)	D2
Carrying out the plan (C)	Answering the three given problems. (1 = correct, 0 = incorrect)	C1a, C1b, C2
Looking back (L)	1. Reviewing the completed solution. (1 = reviewed, 0 = not reviewed)	L1
	2. Creating an alternative solution for the same problem. (1 = created, 0 = not created)	L2

Source: Research Result 2024

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The test and interview results can be seen in **Table 2**.

Table 2. The Summary of Test and Interview Results

Initial	Understanding Problem			Devising a Plan		Carrying Out the Plan			Looking Back		Report Grade 1st Semester
	U1	U2	U3	D1	D2	C1a	C1b	C2	L1	L2	
A25	2	1	0	1	0	1	0	0	2	0	85
J27	1	2	2	1	0	1	0	1	1	0	85
N04	2	1	0	1	0	1	0	0	2	0	80
N31	2	1	2	1	1	0	0	0	2	0	83
R19	2	1	2	1	1	1	0	0	2	0	84
A23	2	1	2	1	0	0	0	0	1	0	85
C21	2	2	2	1	0	1	0	0	2	1	85
I19	2	0	1	1	1	1	0	0	2	0	85
L10	2	2	1	1	1	1	0	0	2	1	91
S13	2	2	2	1	1	0	0	1	1	0	80

Source: Research Result 2024

Understanding the problem stage helps help students begin their problem-solving processes. In this stage, students identify the nature of the question (Michener, 1978). The author posed three questions regarding the students' comprehension of the problem, the frequency with which they read it, and their knowledge of the given information. The questionnaire results (U1) show that all students claimed to understand the given problem. However, at this stage, we must determine whether the students' understanding is accurate or still erroneous. The second question inquired about the intensity of their reading of the problem, revealing that one student read the problem only once while the rest read it two or more times. This indicates that students tried to understand the problem by reading it repeatedly. Six students were aware of the third question about the knowledge provided in the problem to solve it and could articulate it well. Two students wrote answers that still needed to be more accurate, and two others could not write them at all. Looking at the students' responses to questions U1, U2, and U3, it is evident that students made an effort to comprehend the problem before solving it. Although when asked if they were familiar with Pólya's stages in problem-solving, they unanimously answered no, they still tried to understand the problem before solving it.

In the second stage of Pólya, devising a plan, the author asked students to rephrase the problem questions into their sentences or mathematical sentences, create diagrams/tables that are easier to understand, and write down the strategies they thought of to solve the problem before deciding on one correct strategy. Pólya discussed many problem-solving strategies, such as working backward, drawing diagrams, solving simpler, etc. (Schoenfeld, 1979; Topal & Yenmez, 2024). At this stage, all students encountered difficulties. Writing down the thought strategies is not as straightforward as writing down problem solutions. Students admitted that they did not immediately find the solution to the problem, so they had to consider other strategies to solve it. When asked to create sentences that are easier to understand, students generally paraphrased the problem sentences rather than simplifying or identifying key points.

In the third stage, carrying out the plan, success in the problem-solving process is gauged by the solutions obtained. Tjoe, in a book titled "_Mathematical Problem Solving (chapter: Looking back to solve differently: Familiarity, fluency, and flexibility)_" stated that this stage involves executing the plan, which is crucial to carry out each part of the plan meticulously and to ensure that the progression of each step is logically sound. Since problem-solving steps are the target of the mathematics curriculum, school instruction often focuses only on this aspect. The survey showed that students concentrated more on answering the "C" questions than the other parts. Although students were informed that the survey aimed to examine the steps taken during problem-solving, they primarily focused on solving C1a, C1b, and C2 before addressing

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sections U, D, and L. However, no student successfully answered all three problem-solving questions. Seven students solved problem C1a, two solved C2, and none solved C1b. This discrepancy suggests that students did not fully understand the problems, contradicting their responses to U1, where they claimed comprehension. During problem-solving, the researcher allowed students to ask clarifying questions, yet only one student inquired, "What does 3-on-3 mean?" indicating a lack of deeper engagement.

Of the three given problems, C1a and C2 were pure problem-solving, while C1b tested the student's ability to connect the problem with the material learned, drawing conclusions that could be broadly applied. All students should have made this connection between the problem and the previously learned exponent material. Additionally, it was evident that all students relied solely on reasoning without involving algebra in their problem-solving process. Despite the instructional focus on problem-solving strategies, the results indicate a significant gap in the student's abilities. The failure to solve problem C1b illustrates their inability to connect the given problems and the concepts they had previously learned, particularly regarding exponents. This highlights a critical area for improvement, as the reliance on reasoning without incorporating algebra further suggests a lack of foundational understanding necessary for effective problem-solving. Consequently, this raises concerns about the effectiveness of current teaching strategies and underscores the need for a more integrative approach that emphasizes conceptual understanding alongside procedural skills. The findings indicate that students will struggle to apply the material to solve problems without a deeper engagement with the material. This suggests that instructional methods require reevaluation to better support students in developing robust problem-solving skills.

In looking backstage, none of the students considered exploring alternative solutions despite having ample opportunities to apply algebra alongside their reasoning. The only method they used to verify the correctness of their solutions was repeating their calculations. Responses to questions L1 and L2 revealed that students rarely sought alternative solutions for the same problem during the solving process. The curriculum's lack of emphasis on the ability to identify multiple solutions means that teachers are not incentivized to encourage this practice among students, as stated by Tjoe in the book "*Mathematical Problem Solving (chapter: Looking back to solve differently: Familiarity, fluency, and flexibility)*". However, developing alternative solutions indicates a deeper understanding of the problem (McKenney & Reeves, 2021; Michener, 1978). Data collection in this study also involved classical interview methods with ten respondents. These interviews were conducted after the students were informed that the questions they answered were indicators of using Polya's problem-solving steps. The students were reminded that since middle school, they have often written the sections "given," "asked," and "answer" when solving word problems in mathematics and physics. Although this is essentially part of the "understanding the problem" stage in Polya's method, the students felt that writing these sections was more of a burden than a benefit.

Additionally, the students were asked about the difficulties they encountered in solving the problems and answering the questionnaire. They agreed that documenting the stages they went through during the problem-solving process was more challenging than writing the steps to solve the problem. They were not accustomed to procedural questions in mathematics, as procedural texts are usually learned in English or Indonesian language classes. When asked why most of them failed to solve the problems despite understanding and reading them multiple times, they explained that their understanding needed to be more accurate. They admitted that the problems presented were not complex and knew the basic mathematical operations to solve them, but they needed to comprehend them fully. When guided to read the problems sentence by sentence, they realized that their solutions were only partially based on the given information. For instance, in problem C2, it was stated that at the beginning of the following year, workers receive an annual bonus of Rp 8,500,000.00. However, many students wrote in their solutions that the annual bonus was received from starting employment. Only two students managed to solve this problem correctly.

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Students' Attitude Toward Problem Solving

After completing the problem-solving questions, respondents were asked to complete a questionnaire regarding their attitudes toward problem-solving. They were given five questions to indicate students' positive attitudes toward problem-solving. These questions were created using a Likert scale of 1-5, where a higher score indicates a more positive attitude toward problem-solving. Four items regarding their attitude included enthusiasm, awareness of the benefits, resilience, confidence, and one question about teacher support in problem-solving. The result is shown in **Table 3**.

Table 3. The Scores of Attitude and Teacher Motivation Towards Problem Solving

Initials	Attitude Towards Problem solving				Teacher Motivation
	Enthusiasm	Benefits	Resilience	Confidence	
A25	2	3	2	1	2
J27	2	3	4	3	5
N04	1	1	2	2	2
N31	1	4	3	2	5
R19	3	4	4	2	3
A23	2	3	2	1	2
C21	3	4	5	2	4
I19	1	3	3	2	4
L10	4	4	3	2	5
S13	2	4	3	2	2
Total	**21**	**33**	**31**	**19**	**34**
Average	**2,1**	**3,3**	**3,1**	**1,9**	**3,4**
Mode	**2**	**4**	**3**	**2**	**2**

Source: Research 2024

Regarding enthusiasm for problem-solving, the average score of only 2.1 out of 5 indicates that students need more enthusiasm in this area. This is further reinforced by the mode score 2, showing that most students could be more enthusiastic about tackling mathematical problem-solving. When asked, students generally preferred structured math problems over problem-solving tasks, often finding it challenging to translate real-world problems into mathematical language. This aligns with research that suggests that real-world problems often have vague or ambiguous conditions requiring a transfer process between the real world and mathematics, not quickly resolved by simply applying mathematical operations to the given data (Blum, 2015; Blum & Niss, 1991; Kaiser, 2017).

Regarding the perceived benefits of problem-solving for life, more than half of the students believe that mathematical problem-solving benefits their future. However, they tend to focus more on the content's relevance to their daily lives. For example, when problems do not relate to their everyday experiences, such as determining the half-life of a radioactive substance, students find less value in solving them. Problem-solving skills should ideally be routine skills that can be practiced in an open environment, regardless of their direct relevance to the student's lives. This approach fosters creativity and investigative strengths, which are highly valuable in the 21st century (Schoenfeld, 2010; Stacey, 2005).

Regarding resilience in problem-solving, the average score of 3.1 with a mode of 3 indicates that students' resilience could be stronger and stronger. Mathematical resilience reflects a student's attitude of approaching mathematics with initiative, perseverance, and a willingness to discuss, reflect, and investigate, as explained by Lee and Johnston-Wilder in "_The Routledge International Handbook of Dyscalculia and Mathematical Learning Difficulties_" titled _"Mathematical resilience: what is it and why is it important_?". Among the various resilient attitudes, students reported higher levels of perseverance and willingness to discuss than initiative, reflection, and investigative enjoyment. Students exhibit moderate resilience in problem-solving, suggesting a need for further support to enhance their initiative and investigative skills.

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Lastly, students' confidence in problem-solving remains below average, with a mode score of 2. This lack of confidence is due to their frequent experiences of failure rather than success in solving problems. Confidence is crucial for becoming a proficient problem solver (Akbari & Sahibzada, 2020; John & Edwin, 2009). Furthermore, students' confidence can predict their future development (Hannula et al., 2004; Khaira et al., 2023). The stark lack of confidence among students, with a mode score of 2, indicates a cycle of failure that impedes their development as proficient problem solvers.

Discussion

This study reveals that mathematical problem-solving has yet to become a focal point in school mathematics education. Most students need help to solve problems effectively despite acknowledging that the problems presented are simple and should be solvable through basic reasoning and calculations. Students need clear guidance and are unfamiliar with Polya's problem-solving strategies or other methods. While they understand the problems, their understanding could be more profound. They tend to rush and do not try to comprehend the information given sentence by sentence. In the planning stage, students need to be well-practiced in rephrasing the problem into their own words, noting key points, and creating diagrams or tables. When thinking of strategies, students often focus on a single strategy and sometimes give up quickly, asking the teacher for a solution instead (Chen & Techawitthayachinda, 2021). In this stage, students must think creatively and connect their knowledge with the goal. Some habits that should be cultivated to enhance students' creative thinking skills include training them to investigate the problem from all angles, taking a break when they cannot think of a solution, and allowing ideas to come unexpectedly later (Sadler-Smith, 2015).

In the implementation stage, students performed well, demonstrating a solid understanding of the mathematical concepts. However, their persistence in trying alternative methods when the initial steps do not lead to a solution needs to be improved. Many students tend to give up quickly when faced with obstacles, often failing to explore different approaches or strategies that could help them reach a solution (Rosyiddin et al., 2023). This tendency indicates a lack of confidence in their problem-solving abilities and suggests they may benefit from further training in resilience and creative thinking. Encouraging students to embrace a mindset that values trial and error as part of learning could significantly enhance their problem-solving skills. Additionally, providing structured opportunities for practice in which they are explicitly encouraged to devise multiple solutions may foster more remarkable persistence and flexibility in their problem-solving approach. In the review stage, teachers should appreciate students who solve problems using multiple alternative methods (Hang & Van, 2020). This demonstrates a deeper understanding and provides more significant opportunities for those students to solve other problems. Sometimes, due to a lack of understanding, some teachers do not accept solutions that differ from the methods they have taught. Such attitudes hinder students' problem-solving abilities. Besides training students to solve problems using Polya's steps, motivating them to maintain a positive attitude in problem-solving will significantly impact their problem-solving skills.

CONCLUSION

The results indicate that the top ten students from one of the best schools in Siak Regency still need to meet expectations regarding their problem-solving abilities. This underperformance is attributed mainly to inappropriate strategies and a need for a positive attitude toward problem-solving. The findings suggest that students' struggles stem from unfamiliarity with problem-solving methods, particularly Pólya's steps, and their lack of resilience, confidence, and enthusiasm during the problem-solving process. To address these issues, teachers must introduce Pólya's strategy in their teaching practices while also seeking strategies to improve students' positive attitudes towards problem-solving. Teachers can enhance

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students' problem-solving skills and confidence in mathematics by fostering a supportive learning environment that emphasizes the relevance of problem-solving strategies and cultivates a constructive mindset.

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