

Analysis of Students' Problem-Solving Abilities in Solving HOTS Questions on Kinematics Topics

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Info article	Abstract
Article history: Received: December 3, 2025 Accepted: March 27, 2026 Published: May 3, 2026 Keywords: HOTS Physics education Polya Problem-solving ability This article is licensed under a Creative Commons Attribution-ShareAlike 4.0 International license © 2026 Jurnal Ilmiah Pendidikan Fisika	Problem-solving skills based on Higher Order Thinking Skills (HOTS) are very important in learning physics, but many students still have difficulty meeting the indicators of high-level thinking. The gap between understanding the problem and the ability to design a solution strategy shows the need for a more in-depth analysis of the students' thinking process. This study aims to analyze students' problem-solving abilities in answering physics questions based on HOTS using Polya's four problem-solving steps: understanding the problem, devising a plan, carrying out the plan, and looking back. The study employed a quantitative descriptive approach involving 32 eleventh-grade students during the second semester of the 2024/2025 academic year. The research instrument consisted of five HOTS-based essay questions that had been tested for validity using the Gregory technique. The analysis results showed a validity coefficient of 1.00, indicating that the instrument is highly valid and appropriate for measurement. In addition, the instrument also meets the reliability criteria, so it is declared suitable for use in the collection of research data, and the data were analyzed according to the students' performance in each problem-solving stage. The findings indicate that the "understanding the problem" stage was the most mastered aspect, with most students categorized as high and very high. In contrast, the "devising a plan" stage showed the lowest achievement, with the majority falling into the very low category. Overall, students' problem-solving abilities varied considerably, particularly in planning strategies and executing solutions. These results suggest the need for instructional practices that better develop students' strategic planning, systematic thinking, and higher-order reasoning skills.
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INTRODUCTION

Physics learning at the high school level has an important role in shaping students' scientific thinking, especially in dealing with problems that require logical reasoning and a deep understanding of concepts (Suarjana, 2023; Wulandari et al., 2025). Physics not only focuses on mastering formulas but also demands the ability of students to understand natural phenomena, analyze cause-and-effect relationships, and draw conclusions based on scientific data and principles (Dilfuza, 2025; Hamdi et al., 2024; Markawi, 2025). Therefore, learning physics is a strategic means to develop students' problem-solving abilities and higher-order thinking skills within the context of formal secondary education.

Problem-solving skills are one of the fundamental competencies in physics learning and are an important indicator of educational success in the 21st century because they

require students to be able to identify, analyze, and solve complex problems through a structured and reflective thinking process ([Adeoye et al., 2023](#); [Cynthia & Sihotang, 2023](#); [Mashudi, 2021](#)). In the context of the rapid development of science and technology, this ability is not only an academic demand but also an essential necessity to face real-life challenges that demand the application of concepts, high-level reasoning, and appropriate decision-making ([Purwanto et al., 2023](#)).

In the study of international science education, problem-solving skills are seen as core skills that must be developed through reasoning-based learning and concept understanding, not just mastery of mathematical procedures ([Sen et al., 2021](#); [Tan et al., 2023](#); [Wulandari et al., 2025](#)). [The National \(2012\)](#) emphasizes that effective science learning must be able to train students to formulate problems, develop models, and evaluate solutions reflectively. This shows that problem-solving is not just the end goal of learning but also part of the learning process itself.

Several international studies have also shown that students who have good problem-solving skills tend to be better able to transfer knowledge to new contexts and have higher cognitive resilience when facing complex problems ([Carmeli et al., 2021](#); [Robert & Gretzel, 2024](#); [Satyaprakash & Supinda, 2022](#)). This underscores the importance of learning physics, which not only emphasizes low cognitive achievement but also develops high-level thinking skills on an ongoing basis.

Physics learning specifically places problem-solving skills at the core of the learning process because the characteristics of physics materials are closely related to real phenomena, relationships between variables, mathematical models, and scientific reasoning processes. Students are required not only to understand concepts but also to be able to relate them to new situations, compile mathematical representations, and evaluate the correctness of the solutions obtained. Therefore, Higher Order Thinking Skills (HOTS) are an inseparable component in the modern physics learning ([Hajaroh, 2022](#); [Khoiriyah & Shaleh, 2025](#)).

In classroom learning practice, students' problem-solving skills often do not develop optimally because the learning process still focuses on delivering material and solving routine problems ([Rani & Antony, 2025](#); [Segening et al., 2022](#)). Students tend to follow the example given by the teacher without understanding the reasoning behind each step of completion ([Hew et al., 2023](#); [Ismaimuza, 2025](#)). This condition causes students to have difficulties when faced with questions with different contexts or questions that require a high level of reasoning. According to [Elvira et al. \(2025\)](#), [Sun et al. \(2022\)](#), and [Tasrif \(2022\)](#), HOTS in science learning not only includes the ability to answer difficult questions but also the ability to explain reasons, make generalizations, and reflect on thought processes. In the context of physics, this means that learners need to be trained to understand the physical meaning of each equation used, as well as the reasons for choosing a particular solution strategy.

HOTS includes the ability to analyze, evaluate, and create as the highest level in Bloom's revised taxonomy ([Anderson & Krathwohl, 2001](#)). In the realm of physics learning, HOTS is translated in the form of the ability to interpret phenomena, formulate mathematical models, connect concepts across topics, and produce new solutions to scientific problems ([Ragab et al., 2024](#); [Tasrif, 2022](#)). Recent science education studies show that students with a good level of HOTS mastery have higher learning independence, creativity, and reasoning skills ([Agung, 2025](#); [Fatmawati et al., 2024](#)).

However, the Programme for International Student Assessment (PISA) report shows that the ability of Indonesian students to solve reasoning-based problems is still below the average of OECD countries, especially in the aspects of analysis and evaluation ([OECD, 2019](#)). This condition indicates the need for evaluation and improvement in the science

learning process, including physics, to be more oriented towards the development of HOTS.

Therefore, physics learning plays a strategic role in fostering students' problem-solving abilities and higher-order thinking skills, particularly within structured classroom learning at the secondary school level. This condition is influenced by several factors, including the dominance of procedural-oriented learning, the lack of use of non-routine questions, the tendency to memorize formulas without understanding concepts, and an evaluation culture that emphasizes the final answer more than the thought process ([Ahmad & Tesol, 2023](#); [Celsah et al., 2025](#)). The findings are in line with research by [Fitriana & Stepanus \(2024\)](#), which shows that students' ability to solve physics HOTS problems is still in the low category, especially in analysis and evaluation indicators.

The low ability of HOTS shows that students are not used to developing systematic problem-solving strategies. Many students can write down information known from the questions but have difficulty in determining the right steps to solve them. This indicates that the students' thinking process needs to be further analyzed, not only from the result of the answer but also from the stages of thinking that are passed during problem-solving. International research by [Clarice & Wider \(2023\)](#) and [Winarti et al., \(2022\)](#) revealed that students' failure to solve physics problems is often not caused by weak mastery of concepts but by the inability to plan solution strategies and monitor the steps that have been taken. This shows the importance of analyzing the problem-solving process gradually.

Several problem-solving models, including the IDEAL model and metacognitive approaches, have been widely used in learning. However, the Polya model is selected in this study because it offers clear and systematic stages that enable a detailed analysis of students' problem-solving processes in solving HOTS problems. This model consists of four main stages: understanding the problem, developing a plan, executing the plan, and re-examining ([Arsandy et al., 2025](#); [Julianawati & Darmawan, 2025](#); [Leonisa & Soebagyo, 2022](#)). Each stage reflects the systematic thinking process required to solve HOTS-based physics problems. Findings ([Saiye et al., 2024](#)) shows that students experience the most difficulties at the stage of understanding the problem and formulating a solution strategy, while ([Irsyadi et al., 2022](#)) finds that the rechecking stage is the least performed and often overlooked stage. The Polya model is widely used in international research because it provides a clear framework for the analysis of students' thought processes, not just the final answer ([José et al., 2024](#); [Satyaprakash & Supinda, 2022](#)). Using this framework, researchers can identify specifically which stages are the main obstacles in solving physics problems.

Although there has been extensive research on HOTS and problem-solving, there remains a significant research gap, particularly the limited number of studies that specifically analyze students' ability to solve HOTS-based physics problems using the Polya framework in the context of high school learning ([Carmeli et al., 2021](#); [Tan et al., 2023](#); [Winarti et al., 2022](#)). Existing studies are more commonly conducted in mathematical contexts or tend to focus on general descriptive outcomes without providing a detailed stage-by-stage analysis of the problem-solving process ([Clarice & Wider, 2023](#); [Satyaprakash & Supinda, 2022](#)). Therefore, this study contributes to strengthening the academic literature in physics education by measuring students' problem-solving abilities based on the four stages of Polya in solving HOTS problems.

The analysis of problem-solving abilities based on the Polya stages allows for a more specific picture of students' weaknesses in solving HOTS-based physics problems. These findings can be used as a foundation for teachers in designing more targeted learning strategies, especially to train students' abilities in compiling a completion plan and evaluating the results obtained. On the other hand, studies that explicitly integrate HOTS,

physics problem-solving, and the Polya stages in the context of implementing the independent curriculum are still relatively limited. In fact, this curriculum emphasizes the development of competence, reasoning, and strengthening critical thinking skills, so that this research has a strong relevance to the needs and direction of current education policies.

This study aims to analyze in depth the problem-solving ability of students in solving HOTS problems in physics learning based on the Polya stages. The focus of the research is directed at mapping the level of mastery of students at each stage of problem-solving, identifying difficulties that arise, and analyzing pedagogical implications for physics learning strategies. Thus, the results of the research are expected to make a theoretical contribution to the development of the HOTS study and a practical contribution for teachers, schools, and curriculum developers in creating physics learning that is able to form critical, analytical, and creative students according to the demands of the independent curriculum.

This study offers a novel contribution by specifically analyzing students' problem-solving abilities in solving HOTS-based physics problems using the Polya framework at the high school level. Unlike previous studies that tend to focus on general problem-solving outcomes or are conducted in mathematical contexts, this research provides a detailed stage-by-stage analysis of students' thinking processes based on Polya's four steps. Furthermore, this study integrates the assessment of HOTS, physics problem-solving, and the implementation of the Independent Curriculum, which has rarely been examined simultaneously in previous research. Therefore, this study not only identifies students' difficulties but also provides a more comprehensive understanding of how problem-solving skills are developed in physics learning.

METHODS

This study adopts a descriptive quantitative approach, allowing for an objective analysis and description of students' problem-solving abilities based on numerical data. This approach was chosen to obtain a measurable picture of the stages of student problem-solving based on the Polya model. In addition, this approach provides convenience in identifying patterns of student achievement at each stage of problem-solving systematically.

The study was conducted in a formal secondary school setting involving high school students. The data collection process will be carried out in March 2025. The subjects of the study are students in class XI-2 at SMA Negeri 20 Gowa with a total of 32 students. The distribution of academic ability in the classroom is heterogeneous, covering high, medium, and low categories based on the previous semester's physics scores. The selection of classes is carried out purposively because the class has received material that is in accordance with the context of the HOTS questions being tested.

The research instrument is in the form of five questions based on HOTS, which are developed in accordance with the indicators of problem-solving steps according to Polya, namely understanding the problem, developing a plan, implementing a plan, and rechecking. The questions include the cognitive dimensions C4, C5, and C6 according to Bloom's revised taxonomy. The Gregory technique, the research instrument, has gone through a content validity test using the Gregory index method, and the test results show a validity coefficient of 1.0, which is included in the very high category. Thus, the research instrument is declared valid and feasible to be used as a data collection tool ([Arikunto, 2014](#); [Retnawati, 2016](#)).

To interpret students' problem-solving abilities, the obtained scores were categorized into several levels, namely very high, high, medium, low, and very low. The categorization was determined based on the percentage of the maximum score achieved by students in

each Polya stage. The criteria for each category are presented as follows: 81–100% (very high), 61–80% (high), 41–60% (medium), 21–40% (low), and 0–20% (very low).

Data collection was carried out through a written test with a duration of 90 minutes. The implementation procedure includes an explanation of filling procedures, providing test instruments, solving questions by students, and collecting answer sheets. The data was analyzed quantitatively with reference to the Polya indicator. To calculate the percentage of students' ability based on the total number of students who can answer questions based on the criteria that have been set based on the Polya indicator, the formula can be used (Moni et al., 2016):

$$P = \frac{f}{n} \times 100\% \quad \dots (1)$$

F is the frequency of students in each category and n the total number of students. The results of the analysis are presented in the form of frequency distributions, percentages, and graphs to clarify patterns of student achievements.

RESULTS AND DISCUSSION

This study aims to analyze students' problem-solving abilities in solving HOTS problems based on problem-solving steps in Polya theory. The data analyzed came from the results of the work on the description test questions by students that had been solved using the problem-solving steps in the Polya theory. The purpose of this test result data is to show how much ability the students have in solving problems.

After all students have completed the questions given, the researcher collects the answer sheets that they have filled in. Next, analyze the answers by carefully examining each answer sheet to obtain a score according to the criteria that have been set.

The classification of the results of the test analysis of students' ability to solve five physics questions based on HOTS-based physics was reviewed based on the answer score at each step of problem solving according to Polya, namely understanding the problem, planning, implementing the plan, and checking again. The score results on each Polya step can be classified in Table 1.

Table 1 Answer score of each Polya step

Question No.	Step 1 (Understanding the Problem)	Step 2 (Drawing up a plan)	Step 3 (Implementing the plan)	Step 4 (Checking back)	Total
1	2	11.5	6	0.5	20
2	2.5	7.5	4.5	0.5	15
3	2.5	9.5	7	1	20
4	3	8	12.5	1.5	25
5	3	9	7.5	0.5	20
Total Score	13	45.5	37.5	4	100
Average student score	10.89	8.29	8.69	0.97	

The results of the analysis showed that the ability of students to understand problems was in the high category, with an average score of 10.89 out of 13. These findings indicate that most students can identify information and demands about HOTS physics correctly. This condition reflects good initial readiness and shows that the stage of understanding the problem is not the main obstacle in the problem-solving process. These results are in line with research that states that students generally have an easier time mastering the early stages of problem-solving than the advanced stages that require complex reasoning (Faiziyah & Priyambodho, 2022; Kania & Ratnawulan, 2022; Purba et al., 2021).

In contrast to the achievement in the first step, the step of preparing a plan showed the lowest performance with an average score of 8.28 out of a maximum score of 45.5, and no students reached the medium category or above. This shows that students still have difficulties in designing a systematic completion strategy. The low achievement at this stage indicates a weakness in high-level thinking skills, especially analytical and planning skills, which are often not trained in conventional learning. These findings are consistent with studies that say that planning is the most difficult stage in solving HOTS problems because it demands the integration of concepts and strategies ([Alfiandari et al., 2022](#); [Julianawati & Darmawan, 2025](#); [Nadia et al., 2025](#)).

In the step of implementing the plan, there was a slight increase with an average score of 8.69 from a maximum score of 37.5, although many students were still in the low category. This condition shows that students are relatively more able to execute the completion procedure than to formulate a plan conceptually. The shift from the very low to low category indicates that direct experience in working on the questions has a positive impact on students' procedural abilities. This supports the view that problem-based practice and learning activities can help improve the skills of applying physics concepts ([Alfiandari et al., 2022](#); [Julianawati & Darmawan, 2025](#); [Saiful et al., 2024](#)).

The lowest achievement was found in the re-examination step, with an average score of only 0.97 out of a maximum of 4, and most learners were in the very low category. These findings show that students' reflective and evaluative abilities are still very limited. Students tend to stop after getting answers without checking or evaluating processes and results. This low ability emphasizes the need to strengthen learning that emphasizes metacognitive aspects, such as self-reflection and strategic evaluation, so that students are not only oriented to the final answer but also to their thinking process ([Arsandy et al., 2025](#); [Faiziyah & Priyambodho, 2022](#); [Nadia et al., 2025](#)).

Furthermore, each question in this study was designed to represent HOTS levels, namely C4 (analyzing), C5 (evaluating), and C6 (creating). The variation in students' achievement across the Polya stages reflects their differing abilities at each cognitive level. Students tend to perform better at the C4 level, particularly in understanding the problem, while difficulties are more evident at the C5 and C6 levels, especially in planning and evaluating solutions.

In addition, the differences in maximum scores across each Polya stage for each question are influenced by the level of difficulty and cognitive demands of the questions. Questions requiring more complex reasoning and multi-step solutions are assigned higher weights, particularly in the planning and implementation stages. This scoring design aims to proportionally represent the cognitive load and problem-solving processes required in each question.

Step 1: Understanding the Problem

A description of the level of problem-solving ability of students in the first step in solving physics problems of the Higher Order Thinking Skills (HOTS) type is presented in the table below. Through the presentation of this data, the distribution of students' abilities in each category can be known, thus providing a clearer picture of the strengths and weaknesses of students in the process of solving physics problems. The frequency distribution of categorization of students' problem-solving abilities in completing HOTS questions in step 1 is shown in Table 2.

In the initial stage of the research, which is the first step that focuses on the ability of students to identify problems, measurements are carried out through five questions. From the results of data analysis of 32 students, an average score of 10.89 was obtained from a maximum score of 13. This shows that, in general, students have a fairly good initial level

of understanding in identifying the core problems given in the question instruments ([Nurul, 2022](#); [Umami et al., 2021](#)). The frequency distribution showed that most of the students were in the very high category of 62.5% (20 students), followed by 18.75% (6 students) in the high category, 9.375% (3 students) in the medium category, 6.25% (2 students) in the low category, and only 3.125% (1 student) in the very low category.

Table 2 The frequency distribution of categorization of students' problem-solving ability in solving HOTS questions in step 1

Interval	Category	Frequency	Category
$10.4 < x \leq 13$	20	62.5	Very High
$7.8 < x \leq 10.4$	6	18.75	Tall
$5.2 < x \leq 7.8$	3	9.375	Keep
$2.6 < x \leq 5.2$	2	6.25	Low
$0 < x \leq 2.6$	1	3.125	Very Low
Sum	32	100%	

This condition illustrates that the majority of students already have cognitive readiness to understand and analyze the problems that are the focus of the learning ([Haryadi & Masjudin, 2025](#)). The high proportion of participants who fall into the very high and high categories indicates that a previously applied learning approach, or perhaps a previous learning experience, has contributed positively to their ability in the problem identification stage ([Junaid & Iqbal, 2025](#)). These findings provide an important foothold that learners have a solid foundation before moving on to more complex learning stages.

Step 2: Draw up a plan

The categorization of the level of students' problem-solving ability in the second step in solving physics problems of the Higher Order Thinking Skills (HOTS) type is presented in the Table 3.

Table 3 Frequency distribution of categorization of students' problem-solving abilities in solving HOTS problems in step 2

Interval	Number	Frequency	Category
$36.4 < x \leq 45.5$	0	0	Very High
$27.3 < x \leq 36.4$	0	0	High
$18.2 < x \leq 27.3$	0	0	Medium
$9.1 < x \leq 18.2$	6	18.75	Low
$0 < x \leq 9.1$	26	81.25	Very Low
Sum	32	100%	

The second step in the learning process focuses on the ability of students to systematically develop plans based on previously identified problems. The results of the analysis of the data showed that the average score achieved by 32 students was only 8.28 out of a maximum score of 45.5. The distribution of grades showed that as many as 81.25% or 26 students were in the very low category, while the remaining 18.75% or 6 students were in the low category. There are no students who can reach the medium, high, or very high categories.

This condition reflects that the majority of students have difficulty pouring ideas and solutions into a structured and logical form of planning ([Andini et al., 2025](#); [Midawati, 2022](#)). This can be due to a lack of experience in planning independent learning, a lack of systematic thinking skills, or perhaps the teacher's learning strategy is not optimal in

facilitating the development of planning skills ([Khasanah et al., 2025](#)). Therefore, these results are an early indicator that more specific and targeted learning interventions are needed in developing students' competencies at the planning stage.

Step 3: Execute the Plan

The categorization of the level of students' problem-solving ability in the third step in solving physics problems of the Higher Order Thinking Skills (HOTS) type is presented in Table 4.

Table 4 The frequency distribution of categorization of students' problem-solving abilities in solving HOTS questions in step 3

Interval	Number	Frequency	Category
$30 < x \leq 37.5$	0	0	Very High
$22.5 < x \leq 30$	0	0	Tall
$15 < x \leq 22.5$	1	3.13	Keep
$7.5 < x \leq 15$	24	75	Low
$0 < x \leq 7.5$	7	21.8	Very Low
Sum	32	100%	

The third step in this learning cycle is the implementation of a plan that has been prepared in advance by students. Based on the results of the analysis of the scores obtained from five implementation indicators, it is known that the average score of students is 8.69 out of a maximum score of 37.5. In terms of distribution, as many as 75% or 24 students were in the low category, 21.87% or 7 students were in the very low category, and only 3.13% (1 student) were in the medium category. There are no students who reach the high or very high categories.

Although the average scores of students have not shown high results, the shift from very low to low and medium categories when compared to the previous stage shows an improvement, especially in the aspects of practical skills and application. This shows that students are relatively more capable of implementing plans than compiling them ([Alfiandari et al., 2022](#); [Sri et al., 2025](#)). In other words, their procedural skills or concrete actions are more developed than conceptual skills in the planning stage. These results provide a positive signal that training or practice-based learning can be an effective strategy to improve the quality of the implementation of learning plans ([Diva et al., 2024](#); [Sholeh, 2023](#)).

Step 4: Double-Check the Results

The categorization of the level of students' problem-solving ability in the fourth step in solving physics problems of the Higher Order Thinking Skills (HOTS) type is presented in Table 5.

Table 5 Frequency distribution of categorization of students' problem-solving abilities in solving HOTS problems in step 4

Interval	Number	Frequency	Category
$3.2 < x \leq 4$	0	0	Very High
$2.4 < x \leq 3.2$	0	0	Tall
$1.6 < x \leq 2.4$	2	6,25	Keep
$0.8 < x \leq 1.6$	8	25	Low
$0 < x \leq 0.8$	22	68,75	Very Low
Sum	32	100%	

The fourth step in this study aims to measure students' reflective ability to examine and re-evaluate their work results. From the analysis of the five questions given, the average score of students was 0.97 out of a maximum score of 4. The score distribution showed that as many as 68.75% (22 students) were classified as very low, 25% (8 students) were in the low category, and only 6.25% (2 students) were included in the medium category. None of the students is in the high or very high category ([Haryono et al., 2021](#); [Malikah, 2023](#)).

These findings indicate that students' evaluative and reflective abilities towards their own work are still very limited. This shows the need for reinforcement in the aspect of metacognition, namely, the ability to think about their own thought processes ([Taufik & Ashari, 2025](#)). Low results in this stage can be an important signal for teachers to pay more attention to exercises that encourage students to evaluate their work, such as providing guided feedback or using assessment rubrics that can increase participants' evaluative awareness ([Purwowidodo & Zaini, 2023](#); [Salsabila et al., 2025](#)).

The ability of each student for each step of problem-solving is different. This is in accordance with the opinion of [Pradestya & Pujia \(2021\)](#) who state that each student has a different problem-solving process from each other and faces different difficulties. The highest ability of students can be seen in the step of understanding problems, which shows that most students are used to identifying information in the problem. This is in accordance with the research of [Budianti et al. \(2022\)](#) who stated that the highest indicator of problem-solving ability is understanding problems. However, the very low percentage in the step of preparing a plan indicates that many students still have difficulty in determining appropriate strategies to solve problems. This finding is consistent with [Rosmawanti et al., \(2021\)](#), who state that students with low mathematical ability tend to directly solve problems without first formulating a solution plan. Therefore, it is necessary to implement instructional interventions that explicitly train students in planning problem-solving strategies, such as problem-based learning (PBL), guided inquiry, and metacognitive strategy instruction. These approaches encourage students to analyze problems, identify relevant concepts, and systematically design solution steps before executing them.

CONCLUSION

The conclusion adequately addresses the research objectives. The findings indicate that students' problem-solving abilities in solving HOTS-based physics problems vary across each stage of Polya. Students demonstrate strong performance in understanding the problem; however, their abilities in planning, implementing, and re-examining solutions remain relatively weak. This suggests that the primary difficulty lies not in problem comprehension, but in the stages requiring strategic thinking and reflective evaluation. Theoretically, these findings highlight the importance of developing higher-order thinking skills that emphasize strategic planning and evaluative processes. Practically, the results imply the need for instructional approaches that explicitly train students in designing solution strategies and reflecting on their problem-solving processes. However, this study is limited to a single class with a relatively small sample size. Therefore, future research is recommended to involve a larger and more diverse sample, as well as to incorporate qualitative approaches to explore in greater depth the factors contributing to students' difficulties at each stage of problem-solving.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

The authors' contributions to manuscript preparation are defined by the following criteria: The authors contributed to the entire research process, from conceptualization, methodology, instrument development and validation, and data collection and analysis based on Polya's steps, to writing, reviewing, and refining the manuscript. The authors are responsible for the overall content and scientific integrity of this article.

AI DISCLOSURE STATEMENT

The authors used artificial intelligence (ChatGPT) during the preparation of this work for language editing and grammatical refinement. After using the tool, the authors thoroughly reviewed and edited the content as needed and take full responsibility for the content of the publication. The authors declare that the core research design, data collection, and analysis (including the use of Microsoft Excel) were conducted independently by the authors.

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