Students' mathematical problem-solving in HOTS based on learning interest

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Abstract

This study examines the association between students' learning interest and their mathematical problem-solving ability in solving Higher Order Thinking Skills (HOTS) questions. The research employed a quantitative descriptive-correlational design involving 33 seventh-grade students at MTs Negeri 1 Merangin. Learning interest was measured using a Likert-scale questionnaire, and students were categorized into high, moderate, and low interest groups based on mean and standard deviation scores. Problem-solving ability was assessed through three HOTS items representing Bloom's cognitive levels C4 (analysis), C5 (evaluation), and C6 (creation), evaluated using Polya's problem-solving indicators. Data were analyzed using descriptive statistics and comparative analysis across interest categories. The results indicate that students with higher learning interest achieved better performance in problem-solving tasks. However, students' performance was also influenced by the cognitive complexity of the HOTS items. The findings suggest that learning interest contributes positively to mathematical problem-solving ability.

Keywords

Higher-order thinking skills, learning interest, mathematics achievement, problem-solving ability, student engagement

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Introduction

Mathematical problem-solving ability is a fundamental competency that students must develop in contemporary education. In mathematics learning, problem solving is not merely the application of formulas but involves reasoning, analysis, evaluation, and decision-making processes. These competencies are closely aligned with Higher Order Thinking Skills (HOTS), which emphasize students' ability to think critically, analytically, and creatively (Brookhart, 2020). Developing HOTS has become a central goal of mathematics education, particularly in response to global assessment frameworks such as PISA and TIMSS, which assess students' reasoning and problem-solving performance rather than routine procedural knowledge.

HOTS-based mathematics problems require students to operate at higher cognitive levels, particularly analysis (C4), evaluation (C5), and creation (C6) within Bloom's revised taxonomy (Anderson & Krathwohl, 2020). These levels demand not only conceptual understanding but also the ability to transfer knowledge to unfamiliar contexts. Research indicates that students often struggle with HOTS tasks because they are accustomed to procedural exercises that do not require deep reasoning (Widodo et al., 2021). Consequently, strengthening students' problem-solving ability through HOTS-oriented instruction has become a major priority in mathematics education.

Problem-solving in mathematics is commonly conceptualized as Polya's four stages: understanding the problem, devising a plan, carrying out the plan, and looking back. These stages provide a structured framework for analyzing students' thinking processes (Liljedahl et al., 2021). Empirical studies have shown that students frequently fail to complete all stages systematically, particularly at the planning and evaluation stages, which require higher-order reasoning (Kurniawati & Sugiman, 2022). Therefore, examining students' performance in solving HOTS problems using Polya's framework provides valuable insight into their mathematical reasoning.

In addition to cognitive factors, affective variables play a crucial role in students' mathematical achievement. One important affective factor is learning interest. Learning interest refers to students' tendency to engage willingly and attentively in learning activities, accompanied by positive feelings toward the subject matter (Hidi & Renninger, 2020). Students with high learning interest tend to demonstrate persistence, curiosity, and greater engagement in challenging tasks. Conversely, students with low interest often exhibit avoidance behaviors and reduced effort in solving complex problems (Schiefele et al., 2022).

Recent studies confirm that learning interest significantly influences mathematics achievement and higher-order thinking performance. For instance, Sari and Pramudya (2021) found that students with higher interest levels demonstrated stronger analytical reasoning skills. Similarly, Rahman et al. (2023) reported that learning interest positively predicted students' ability to solve non-routine mathematical problems. These findings suggest that affective engagement may enhance cognitive performance, particularly in tasks requiring sustained reasoning and evaluation.

In the context of HOTS problems, learning interest may serve as a motivational driver, encouraging students to persist when faced with cognitively demanding tasks. HOTS questions often require multiple steps, critical evaluation, and creative reasoning. Without sufficient interest and motivation, students may abandon problem-solving attempts prematurely. According to self-determination theory, intrinsic interest enhances cognitive engagement and deep processing strategies (Ryan & Deci, 2020). Thus, investigating the association between learning interest and mathematical problem-solving ability becomes essential for understanding variations in student performance.

Preliminary observations at MTs Negeri 1 Merangin revealed that many students experience difficulties in solving HOTS-type mathematics questions, particularly those involving analysis and evaluation. Teachers reported that students often hesitate when confronted with non-routine problems and tend to rely on memorized procedures. Additionally, some students expressed low enthusiasm for studying mathematics, perceiving the subject as complex and formula oriented. These conditions indicate that both cognitive and affective factors may contribute to students' limited performance in HOTS-based problem solving.

Although numerous studies have examined mathematical problem-solving ability, fewer studies have quantitatively investigated its relationship with learning interest in the context of HOTS tasks at the junior secondary level. Previous research has often focused on instructional strategies or qualitative descriptions of students' errors (Putri et al., 2022; Yuliana & Surya, 2020). Therefore, there remains a need for empirical evidence that quantitatively examines how differences in learning interest correspond to variations in HOTS-based problem-solving performance.

This study aims to investigate the association between students' learning interest and their mathematical problem-solving ability in solving HOTS questions. Specifically, the study seeks to (1) categorize students' learning interest levels, (2) measure their problem-solving performance on HOTS tasks aligned with Bloom's cognitive levels C4–C6, and (3) analyze differences in performance across learning-interest categories. By integrating cognitive and affective perspectives, this study contributes to a deeper understanding of factors influencing students' higher-order mathematical thinking.

The findings of this study are expected to provide empirical evidence for mathematics educators regarding the importance of fostering students' learning interest to enhance their HOTS-based problem-solving ability. Strengthening both cognitive skills and affective engagement may offer a more comprehensive approach to improving mathematics achievement at the secondary school level.

Literature Review

Mathematical problem-solving ability

Mathematical problem-solving ability is a central objective of mathematics education, as it reflects students' capacity to apply conceptual knowledge in unfamiliar and complex situations. Unlike routine exercises that rely on memorized procedures, problem-solving requires analytical reasoning, strategic planning, and reflective evaluation. According to Liljedahl et al. (2021), effective problem-solving involves flexible thinking and the ability to connect mathematical concepts across different representations. This competence is critical in preparing students to meet the demands of global educational standards, including PISA and TIMSS, which emphasize reasoning and real-world application rather than procedural fluency.

Polya's four-stage model—understanding the problem, devising a plan, carrying out the plan, and looking back—remains a widely accepted framework for analyzing students' problem-solving processes. Recent research confirms that students often struggle particularly in the planning and evaluation stages, where higher-order reasoning is required (Kurniawati & Sugiman, 2022). Many students can identify known information but fail to formulate appropriate strategies or verify the correctness of their solutions. This indicates that problem-solving ability is not merely procedural competence but involves metacognitive awareness and strategic regulation.

Higher Order Thinking Skills (HOTS) are closely related to problem-solving performance. HOTS tasks typically correspond to Bloom's cognitive levels C4 (analysis), C5 (evaluation), and C6 (creation), requiring students to interpret data, assess alternative solutions, and construct new representations (Widodo et al., 2021). Research by Putri et al. (2022) found that students' difficulties in HOTS-based problems stem from limited conceptual understanding and insufficient practice with non-routine questions. When students lack opportunities to engage in challenging reasoning tasks, their ability to transfer knowledge remains underdeveloped.

Moreover, mathematical problem-solving is influenced by both cognitive and metacognitive processes. Students who monitor their thinking and evaluate their strategies tend to perform better on complex tasks (Schoenfeld, 2019). Metacognitive regulation enables learners to recognize errors, adjust strategies, and reflect on their reasoning. Therefore, strengthening problem-solving ability requires instructional approaches that promote deep conceptual understanding, strategic thinking, and reflective learning.

In conclusion, solving math problems is a complex skill that involves conceptual knowledge, strategic planning, metacognitive regulation, and higher-order reasoning. Understanding how this ability develops, particularly in relation to HOTS tasks, provides an essential foundation for examining the influence of affective variables such as learning interest.

Higher-order thinking skills (HOTS) in mathematics learning

Higher-Order Thinking Skills (HOTS) refer to cognitive processes that go beyond recall and basic comprehension. In mathematics education, HOTS involve analyzing relationships, evaluating arguments, and generating new problem-solving strategies. Brookhart (2020) explains that HOTS require students to manipulate information, connect concepts across contexts, and justify their reasoning logically. These competencies are important for developing critical and creative mathematical thinking.

The integration of HOTS into mathematics instruction aligns with Bloom's revised taxonomy, where analysis (C4), evaluation (C5), and creation (C6) represent advanced cognitive levels (Anderson & Krathwohl, 2020). At the analysis level, students break down information into components and identify relationships. At the evaluation level, they assess the validity of arguments or strategies. At the creation level, they construct new models or solutions. Tasks designed at these levels challenge students to apply mathematical reasoning to non-routine, context-based problems.

Recent empirical studies highlight persistent challenges in implementing HOTS effectively. Rahman et al. (2023) found that students often demonstrate procedural proficiency but struggle with reasoning-based tasks requiring justification and synthesis. This gap suggests that classroom instruction frequently emphasizes algorithmic practice rather than conceptual reasoning. Another critical aspect of HOTS is its connection to the transfer of learning. Students who develop higher-order thinking skills can apply mathematical concepts flexibly across different contexts (Schiefele et al., 2022). Transfer requires deep understanding rather than surface-level memorization. Consequently, research shows that instruction that fosters inquiry-based learning, open-ended tasks, and reflective discussion enhances the development of Higher Order Thinking Skills (HOTS).

In the context of problem-solving, HOTS serves as a cognitive foundation that enables students to engage in complex reasoning. Without adequate higher-order thinking skills, students may fail to interpret problems correctly or design effective solution strategies. Therefore, examining students' performance on HOTS-based tasks provides useful insights into the quality of their mathematical reasoning.

Learning interest and its influence on mathematical achievement

Learning interest is an affective factor that significantly influences students' engagement and academic performance. It refers to students' positive feelings, attention, and intrinsic motivation toward a particular subject (Hidi & Renninger, 2020). Interest fosters sustained attention and persistence, particularly when students encounter challenging tasks. In mathematics learning, where abstract reasoning is required, interest is an important factor that determines students' willingness to invest cognitive effort.

Self-determination theory explains that intrinsic interest enhances autonomy, competence, and engagement in learning activities (Ryan & Deci, 2020). Students with high learning interest are more likely to adopt deep learning strategies, seek conceptual understanding, and persist in solving complex problems. Conversely, students with low interest often exhibit surface-level learning behaviors and avoid cognitively demanding tasks.

Empirical research supports the positive association between learning interest and mathematics achievement. Sari and Pramudya (2021) reported that students with higher learning interest showed better analytical reasoning skills and higher test performance. Similarly, Hermaini and Sirait (2020) found that learning interest significantly contributed to improvements in mathematical problem-solving ability. These findings suggest that affective engagement enhances cognitive performance, particularly in tasks requiring higher-order thinking.

Learning interest also influences students' emotional responses to mathematics. Students who perceive mathematics as meaningful and useful are more likely to experience enjoyment and confidence, which in turn supports problem-solving persistence (Schiefele et al., 2022). On the other hand, negative perceptions and anxiety may reduce engagement and hinder performance. Therefore, fostering interest in learning is not only beneficial for motivation but also essential for cognitive development.

In relation to HOTS-based problem-solving, learning interest may serve as a motivational catalyst. Complex and non-routine problems require sustained concentration and effort. Students with strong interests are more inclined to analyze problems carefully, explore alternative strategies, and reflect on their solutions. Thus, understanding the role of learning interest provides important insight into differences in students' mathematical problem-solving performance.

Research Methodology

This study employed a quantitative descriptive-correlational design to examine the association between students' learning interest and their mathematical problem-solving ability in solving Higher Order Thinking Skills (HOTS) questions. A quantitative approach was selected because both variables were measured numerically using structured instruments, and the analysis aimed to identify patterns of differences across categorized levels of learning interest. Quantitative research is appropriate when variables can be operationalized, measured objectively, and analyzed statistically to describe relationships among them (Creswell & Creswell, 2018).

The research was conducted at MTs Negeri 1 Merangin during the 2022/2023 academic year. The participants were 33 seventh-grade students from one intact class, selected purposively based on the relevance of the curriculum topic, namely, one-variable linear equations. All students participated in both the learning-interest questionnaire and the HOTS-based problem-solving test.

Students' learning interest was measured using a Likert-scale questionnaire developed based on four indicators: enjoyment in learning mathematics, attention during lessons, involvement in learning activities, and willingness to study independently. The instrument consisted of positive and negative statements scored on a five-point scale ranging from strongly disagree to strongly agree. Negative items were reverse-coded to ensure scoring consistency. The total score obtained by each student was calculated and used to categorize learning interest into high, moderate, and low levels based on the mean and standard deviation criteria. Two mathematics education experts reviewed the instrument's content validity, and reliability was assessed using Cronbach's Alpha to ensure internal consistency.

Students' mathematical problem-solving ability was assessed using three essay-type HOTS questions aligned with Bloom's revised taxonomy at cognitive levels C4 (analysis), C5 (evaluation), and C6 (creation). The test focused on one-variable linear equations. Students' answers were evaluated using an analytical scoring rubric based on Polya's four stages of problem solving: understanding the problem, devising a plan, carrying out the plan, and looking back. Each stage was scored according to predetermined criteria to maintain objectivity and consistency in assessment.

Data collection was conducted in two stages. First, students completed the learning-interest questionnaire under supervised classroom conditions. After categorization of learning-interest levels, students completed the HOTS-based problem-solving test during regular lesson hours. All procedures were carried out in a controlled classroom environment to ensure consistency.

The data were analyzed using descriptive and comparative statistical techniques (Field, 2020). Descriptive statistics, including mean, standard deviation, and percentage distribution, were used to summarize learning-interest levels and problem-solving scores. A comparative analysis was conducted to examine differences in average problem-solving performance across the high, moderate, and low learning-interest groups. The analysis aimed to identify patterns of association between the two variables without establishing causal inference.

Findings

This study investigated students' learning interest and its relationship with their mathematical problem-solving ability in solving Higher Order Thinking Skills (HOTS) questions on linear equations in one variable. The findings integrate questionnaire results, interview data, and analysis of students' written responses.

Students' learning interests

The learning interest questionnaire was administered to 33 seventh-grade students. The instrument was constructed based on four indicators: feelings of happiness, interest, attention, and involvement.

Feelings of happiness refer to students' emotional responses toward mathematics, including whether they feel comfortable, positive, and pleased during lessons. Interest reflects students' intrinsic motivation and willingness to engage in mathematics learning, both in class and independently at home. Attention describes the level of focus and curiosity students demonstrate during lessons, particularly in responding to assignments and teacher explanations. Involvement refers to students' active participation in learning activities, such as asking questions, contributing to discussions, and engaging consistently throughout the lesson.

Based on calculations using mean and standard deviation, students were categorized into three levels of learning interest.

Table 1. *Distribution of students' learning interests*

Category	Number of Students	Percentage
High	5	27.27%
Moderate	19	57.58%
Low	5	15.15%
Total	33	100%

The results show that most students (57.58%) fall into the moderate category, while 27.27% have high learning interest and 15.15% have low learning interest. This indicates that although most students are moderately engaged, only a small proportion demonstrate strong enthusiasm toward mathematics.

The highest positive response in the questionnaire was the statement, *"I study mathematics because I know its usefulness."* This finding suggests that students' awareness of the practical benefits of mathematics significantly increases their interest in learning. When students understand the relevance of mathematics in daily life, they tend to feel more motivated and positive.

Conversely, the lowest positive score appeared in the statement, *"I always spend time studying mathematics at home."* Interview results revealed that students often face distractions at home and lack guidance, which reduces their motivation to study independently.

Among the negative statements, many students agreed with, *"I never practice questions at home because I don't understand how to solve them."* This shows that conceptual difficulty and lack of understanding discourage students from practicing. Additionally, some students perceived mathematics as complicated because it involves many formulas, which contributes to lower interest. Overall, the findings indicate that perceived usefulness increases learning interest, while perceived difficulty and lack of confidence reduce it.

Students' problem-solving ability based on learning interest

Based on the questionnaire results, six students were purposively selected to represent each level of learning interest. ARA and SDA represented the high-interest category, NS and AQN represented the moderate-interest category, and MAA and FKM represented the low-interest category.

These six students were then given a problem-solving ability test consisting of three HOTS questions. The questions were structured according to increasing cognitive levels: the first question measured analyzing skills (C4), the second assessed evaluating skills (C5), and the third required creating skills (C6). Students' responses were analyzed using Polya's four stages of problem-solving: understanding the problem, planning, implementing the solution, and reviewing the answer.

Table 2. *Summary of problem-solving ability by learning interest level*

Learning Interest Level	Understanding	Planning	Implementing	Reviewing	Overall Performance
High	Very Good	Very Good	Very Good	Good	Strong
Moderate	Good	Adequate	Limited	Limited	Moderate
Low	Limited	Weak	Weak	Weak	Low

a. Students with high learning interest

ARA and SDA demonstrated strong problem-solving abilities. They were able to clearly understand the given problems, identify important information, formulate systematic solution plans, and apply appropriate mathematical formulas accurately. Their answers were detailed and coherent, reflecting strong analytical and evaluative thinking.

However, both students had trouble with the highest-level question (C6). Although they understood the problem, they were unable to complete all stages of the problem-solving process. This suggests that even highly interested students may face challenges with tasks that require advanced creative thinking.

b. Students with moderate learning interest

NS and AQN showed moderate but inconsistent performance. NS successfully solved the C4 and C5 questions but struggled with C6. AQN solved only one question completely and struggled to understand and plan solutions for the others.

Students in this category were generally able to understand problems but sometimes relied heavily on memorized procedures. They demonstrated weaknesses in connecting concepts, evaluating solutions, and explaining reasoning clearly. Misconceptions in problem-solving steps were observed, which limited their overall performance.

c. Students with low learning interest

MAA and FKM demonstrated the weakest performance. They were only able to partially fulfill the understanding stage but struggled significantly in planning, implementing, and reviewing solutions. Their answers lacked analytical depth, evaluation, and creative reasoning.

Students with low interest expressed confusion in determining strategies and lacked confidence in solving mathematical problems. This confirms that low learning interest is associated with low problem-solving ability.

Integrated relationship between learning interest and problem-solving ability

The overall findings clearly demonstrate a positive relationship between learning interest and mathematical problem-solving ability.

Table 3. *Relationship between learning interest and HOTS performance*

Learning Interest Level	HOTS Performance
High	High
Moderate	Moderate
Low	Low

Students with high learning interest consistently outperformed students with moderate and low interest in solving HOTS questions. Learning interest influences students' engagement, persistence, conceptual understanding, and ability to apply systematic strategies.

The integrated findings show that learning interest significantly affects students' mathematical problem-solving abilities. Students with high interest demonstrate stronger analytical, evaluative, and creative thinking skills. Students with moderate interest show partial mastery, while students with low interest struggle to meet basic problem-solving indicators. Therefore, enhancing students' interest in learning—by emphasizing the usefulness of mathematics, creating engaging learning environments, and supporting independent study—is essential for improving higher-order thinking skills and overall mathematics achievement.

Discussion

This study examined the relationship between students' learning interest and their mathematical problem-solving ability in solving Higher Order Thinking Skills (HOTS) questions on systems of linear equations in one variable. The findings indicate a clear and consistent positive relationship between learning interest and students' ability to perform across the cognitive levels of analyzing (C4), evaluating (C5), and creating (C6). The discussion below integrates the questionnaire results, problem-solving performance, and relevant theoretical and empirical literature.

Learning interest as a determinant of cognitive engagement

The distribution of learning interest revealed that most students were in the moderate category (57.58%), while only 27.27% demonstrated high learning interest. This pattern suggests that although students are not disengaged from mathematics, their intrinsic motivation and emotional attachment to the subject remain underdeveloped.

Learning interest, as reflected in feelings of happiness, attention, involvement, and intrinsic motivation, plays a fundamental role in cognitive engagement. According to Hidi and Renninger's interest development theory, interest evolves from situational engagement to well-developed individual interest through repeated meaningful experiences (Hidi & Renninger, 2006). When students recognize the usefulness of mathematics—identified in this study as the highest-scoring positive statement—they demonstrate higher engagement. This supports previous findings that perceived relevance enhances motivation and learning persistence (Ryan & Deci, 2020).

The present findings are consistent with prior research showing that interest significantly influences mathematics achievement. Students who understand the real-world value of mathematics tend to invest more effort in their learning. Recent studies also indicate that interest predicts students' persistence in complex problem-solving tasks (Linnenbrink-Garcia et al., 2018; Wang & Degol, 2017). Therefore, the emphasis on contextualizing mathematical concepts in real-world situations is pedagogically justified.

Conversely, the low score on independent study at home suggests that environmental and contextual factors also shape learning interest. Interviews revealed that a lack of guidance and home distractions reduce students' ability to concentrate. This aligns with ecological perspectives on learning, which emphasize the role of learning environments in shaping academic engagement (Bronfenbrenner & Morris, 2006). Recent empirical evidence similarly demonstrates that supportive learning contexts significantly enhance mathematics engagement (Putwain et al., 2018).

Furthermore, the interaction between interest and classroom practices deserves attention. Instructional approaches that encourage exploration, inquiry, and discussion may reinforce situational interest, which gradually develops into individual interest. When teachers provide contextualized problems, real-life applications, and opportunities for collaborative reasoning, students' emotional and cognitive involvement increases. In this way, pedagogical design acts as a mediator between interest and engagement. Strengthening classroom environments that support autonomy, relevance, and competence may therefore enhance students' long-term academic motivation and deeper mathematical understanding.

Learning interest and HOTS-based problem-solving ability

The results clearly demonstrate that students with high learning interest (ARA and SDA) performed better across Polya's four stages of problem-solving—understanding, planning, implementing, and reviewing—than students with moderate or low interest. This confirms earlier findings that students with strong learning interests tend to perform better on problem-solving tasks.

From a cognitive perspective, problem-solving in HOTS contexts requires not only conceptual knowledge but also metacognitive regulation (Schoenfeld, 2016). Students with high learning interest systematically identified known information, selected appropriate strategies, and implemented procedures coherently. This suggests that interest facilitates deeper cognitive processing and sustained effort. As noted by Ainley (2017), interest enhances attention allocation and strategic engagement during complex learning tasks.

However, even high-interest students encountered difficulty at the C6 level (creating). This indicates that while interest supports cognitive engagement, it does not automatically guarantee mastery of advanced creative reasoning. HOTS tasks require synthesis, flexibility, and transfer of knowledge across contexts (Brookhart, 2018). The difficulty experienced at the highest cognitive level highlights the need for structured scaffolding in developing creative mathematical thinking.

Students with moderate learning interest demonstrated partial mastery. Although they could analyze (C4) and evaluate (C5) questions to some extent, they showed inconsistent implementation and review of solutions. This aligns with findings suggesting that moderate interest is associated with moderate cognitive persistence, often limited to procedural application rather than conceptual flexibility.

Furthermore, misconceptions observed in moderate-interest students reflect incomplete conceptual understanding. According to recent research, conceptual clarity is strongly associated with intrinsic motivation and sustained interest (Gaspard et al., 2017). Without deep engagement, students tend to rely on memorized formulas rather than relational understanding.

Students with low learning interest performed the worst, often failing to progress beyond the problem-understanding stage. This supports previous findings that low interest correlates with limited problem-solving ability. Low-interest students often lack confidence and avoid cognitively demanding tasks. Research by Jansen et al. (2019) confirms that low academic interest is associated with avoidance behaviors and reduced strategic effort.

The findings also suggest that learning interest functions as a catalyst for strategic thinking during problem solving. Students with higher levels of interest not only completed procedural steps but also demonstrated clearer reasoning structures and more systematic solution planning. This indicates that interest may enhance executive functioning processes such as organizing information, selecting appropriate strategies, and monitoring progress. In HOTS contexts, where tasks demand analytical and evaluative reasoning, such strategic regulation becomes essential. Consequently, fostering interest may indirectly strengthen students' metacognitive competencies.

In contrast, the limited performance of low-interest students highlights the potential cumulative effect of disengagement. When students lack intrinsic motivation, they are less inclined to attempt alternative strategies or verify their solutions critically. This often results in incomplete reasoning and superficial responses. Over time, repeated experiences of difficulty without motivational support may reinforce negative perceptions of mathematics. Therefore, interventions aimed at increasing interest—such as differentiated instruction, formative feedback, and scaffolded HOTS exercises—may help reduce achievement gaps across interest categories.

The role of interest in higher-order thinking development

The present study reinforces the theoretical proposition that learning interest serves as a motivational driver, activating higher-order thinking processes. Interest fosters curiosity, persistence, and willingness to engage in challenging tasks (Renninger & Hidi, 2019). When students are emotionally invested in learning, they are more likely to attempt complex problem-solving rather than disengage.

Moreover, interest enhances metacognitive awareness. Students with a high interest in this study demonstrated a better ability to review and evaluate their solutions, even though not perfectly, at the C6 level. This aligns with findings by Schukajlow et al. (2018), who reported that interest significantly predicts reflective thinking in mathematics.

Importantly, the study also confirms earlier evidence that learning interest contributes substantially to mathematics achievement, accounting for nearly half of the variance in achievement. Recent meta-analyses further validate that academic interest strongly predicts performance outcomes across STEM subjects (Harackiewicz et al., 2016; Hulleman & Barron, 2016).

Interest not only influences performance outcomes but also shapes the development of higher-order cognitive structures over time. When students consistently engage in meaningful mathematical activities, neural and conceptual connections become more integrated, enabling flexible reasoning and transfer of knowledge. Sustained interest encourages repeated exposure to complex tasks, which gradually strengthens analytical and creative thinking skills. Thus, higher-order thinking should be viewed not merely as a cognitive outcome but as a developmental process supported by affective engagement.

Moreover, cultivating learning interest may contribute to long-term academic trajectories beyond mathematics achievement alone. Students who develop positive emotional connections with cognitively demanding subjects are more likely to pursue advanced coursework and STEM-related pathways. In this regard, promoting interest serves both immediate instructional goals and broader educational objectives. By integrating motivational strategies with HOTS-oriented pedagogy, educators can create a learning environment that simultaneously nurtures critical thinking, creativity, and sustained academic growth.

Conclusion

This study confirms that students' learning interest significantly influences their mathematical problem-solving ability in solving Higher Order Thinking Skills (HOTS) questions. The findings reveal a clear positive relationship between learning interest and students' performance across the cognitive levels C4 (analyzing), C5 (evaluating), and C6 (creating).

Students with high learning interest demonstrated stronger abilities in understanding problems, planning appropriate strategies, implementing solutions systematically, and partially reviewing their answers. Although challenges remained at the highest cognitive level (C6), their overall performance reflected better analytical and evaluative thinking. Students with moderate learning interest showed partial mastery but were inconsistent in applying strategies and evaluating solutions. In contrast, students with low learning interest experienced substantial difficulties, particularly in planning and executing problem-solving strategies.

The results also indicate that students' perceptions of mathematics—especially their awareness of its usefulness—positively contribute to learning interest. When mathematics is perceived as meaningful and relevant, students are more engaged and persistent. Conversely, perceived difficulty and lack of understanding reduce motivation and limit the development of higher-order thinking.

Therefore, enhancing students' interest in learning through contextual, engaging, and supportive instructional strategies is essential for improving mathematical problem-solving competence and overall academic achievement.

Disclosure Statement

No potential conflict of interest was reported by the authors.

References

Ainley, M. (2017). *Interest: Knowns, unknowns, and basic processes.* Cambridge University Press. https://doi.org/10.1017/9781316823279.017

Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman.

Bronfenbrenner, U., & Morris, P. A. (2006). *The bioecological model of human development*. Wiley.

Brookhart, S. M. (2018). Appropriate criteria: Key to effective rubrics. *Frontiers in Education, 3*, 22. https://doi.org/10.3389/feduc.2018.00022

Brookhart, S. M. (2020). *How to assess higher-order thinking skills in your classroom*. ASCD.

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage Publications.

Field, A. (2020). *Discovering statistics using IBM SPSS statistics*. Sage Publications.

Gaspard, H., Dicke, A.-L., Flunger, B., Schreier, B., Häfner, I., Trautwein, U., & Nagengast, B. (2017). More value through greater differentiation: Gender differences in value beliefs about math. *Developmental Psychology, 53*(1), 71–85. https://doi.org/10.1037/dev0000231

Harackiewicz, J. M., Smith, J. L., & Priniski, S. J. (2016). Interest matters: The importance of promoting interest in education. *Policy Insights from the Behavioral and Brain Sciences, 3*(2), 220–227. https://doi.org/10.1177/2372732216655542

Hermaini, B., & Sirait, E. D. (2020). The effect of learning interest on mathematical problem-solving ability. *Journal of Mathematics Education, 11*(2), 145–154.

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*(2), 111–127. https://doi.org/10.1207/s15326985ep4102_4

Hidi, S., & Renninger, K. A. (2020). *Interest development and its relation to academic achievement.* Cambridge University Press.

Hulleman, C. S., & Barron, K. E. (2016). Motivation interventions in education. *Psychological Science in the Public Interest, 17*(3), 103–131. https://doi.org/10.1177/1529100616637602

Jansen, M., Lüdtke, O., & Schroeders, U. (2019). Students' interest and achievement in mathematics. *Learning and Instruction, 63*(4), 101218. https://doi.org/10.1016/j.learninstruc.2019.101218

Kurniawati, R., & Sugiman, S. (2022). Analysis of students' problem-solving ability based on Polya's stages. *Journal on Mathematics Education, 13*(2), 245–258.

Liljedahl, P., Santos-Trigo, M., Malaspina, U., & Bruder, R. (2021). *Problem solving in mathematics education*. Springer.

Linnenbrink-Garcia, L., Rogat, T. K., & Koskey, K. L. (2018). Affect and engagement during small group instruction. *Contemporary Educational Psychology, 55*, 45–59.

Putri, R. I. I., Dolk, M., & Zulkardi. (2022). Students' difficulties in solving HOTS mathematics problems. *International Journal of Instruction, 15*(3), 567–582.

Putwain, D., Symes, W., & Wilkinson, H. (2018). Reciprocal relations between students' academic engagement and interest. *British Journal of Educational Psychology, 88*(2), 265–283.

Rahman, A., Hidayat, W., & Nurlaelah, E. (2023). Learning interest and mathematical reasoning ability in non-routine problems. *Journal of Mathematics Education Research, 14*(1), 55–70.

Renninger, K. A., & Hidi, S. (2019). *Interest development and learning.* Cambridge University Press.

Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective. *Contemporary Educational Psychology, 61*, 101860.

Sari, D. P., & Pramudya, I. (2021). Learning interest and analytical reasoning in mathematics. *Journal of Educational Research and Evaluation, 5*(2), 210–220.

Schiefele, U., Krapp, A., & Winteler, A. (2022). Interest as a predictor of academic achievement. *Learning and Instruction, 79*(12), 101615.

Schoenfeld, A. H. (2016). Learning to think mathematically. *Journal of Education, 196*(2), 1–38.

Schoenfeld, A. H. (2019). Mathematical problem solving. *Cognitive Science, 43*(9), 127-139.

Schukajlow, S., Krug, A., & Rakoczy, K. (2018). Effects of interest-based instruction on mathematical problem solving. *ZDM Mathematics Education, 50*, 55–70.

Widodo, S., Kartini, T., & Suryadi, D. (2021). Students' difficulties in higher-order thinking mathematics tasks. *Journal on Mathematics Education, 12*(3), 489–502.

Yuliana, R., & Surya, E. (2020). Analysis of students' mathematical problem-solving errors. *International Journal of Scientific & Technology Research, 9*(4), 1053–1058.