ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

Mathematics Persistence as Influenced by Mathematics Higher-Order Thinking Skills and School Classroom Engagement in Math

Aljun F. Ruta
University of the Immaculate Conception, Graduate School, Davao City, Philippines
aruta_240000002143@uic.edu.ph

Date Submitted:
September 07, 2026

Date Accepted:
October 05, 2026

Date Published:
November 03, 2026

DOI:
10.5281/zenodo.23924696

ABSTRACT

This study examined the influence of mathematical higher-order thinking skills and school classroom engagement in math on the mathematics persistence of Grade 10 students in selected private schools in Davao City. A quantitative descriptive-correlational research design was employed. Data were gathered using adapted research instruments which were validated by experts and subjected to reliability test. Mean, standard deviation, Pearson product-moment correlation, and multiple regression analysis were used to analyze the data. Based on the findings, the level of mathematical higher-order thinking skills was moderate, school classroom engagement in mathematics was high, and mathematics persistence was moderate. Results further revealed that mathematical higher-order thinking skills and school classroom engagement in mathematics were significantly and positively related to mathematics persistence. Moreover, mathematical higher-order thinking skills and school classroom engagement in mathematics were found to be significant predictors of mathematics persistence among Grade 10 students.

Keywords: *Education, mathematical higher-order thinking skills, school classroom engagement in mathematics, mathematics persistence, descriptive- correlational, Philippines*

INTRODUCTION

Mathematics persistence is often defined as the sustained motivation of the students to continue learning mathematics despite setbacks, showing determination not to give up when challenges or difficulties arise (DiNapoli, 2023). It is the ability of the learners to continue striving towards understanding and reflection of their willingness to put consistent effort toward mastering mathematical concepts and achieving long term academic goals (Tinto, 2017). One critical issue in mathematics education is the lack of mathematics persistence often revealed by the struggle of many students to continue and sustain focus throughout the mathematical process which hinders their ability to understand, apply, and transfer mathematical concepts effectively (Ugpo et al., 2025). Also, by their limited willingness to seek help, poor task discipline, and tendency to be discouraged with lengthy mathematical solutions (Ogbu & Ugwu, 2023).

In United states, mathematics persistence remains a serious problem for students with having lower sense of belongingness, it is when their status and ability is being questioned and it deeply affects their persistence in learning, emphasizing the need for supportive and inclusive learning environments to help students continue despite learning challenges (Lewis et al., 2017). In Nigeria, persistence in mathematics seems to be a problem of the low-achieving students due to the general belief that mathematics is hard and

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

since persistence is always linked to academic achievements (Anyakamunelechi et al., 2025). Meanwhile, In Massachusetts, USA, Miele et al. (2022) emphasized that a lack of math-specific persistence remains a challenge in sustaining engagement of the students in mathematical problem solving. In Indonesia a study by Kamid et al. (2023) found that among elementary students, they have insufficient mathematics persistence and underdeveloped mathematical process skills.

In the Philippines, particularly in Laguna, mathematics persistence of the learners remains a significant challenge as many students still struggling with factors that affect their ability to remain engage in schooling (Hyoduk & Ortega-Dela Cruz, 2024). In the recent study conducted in Maramag, Bukidnon, Cagulada and Ucang (2025) highlighted the significant issue of students struggling with persistence in mathematics, particularly in sustaining concentration and tolerance for lengthy and time-consuming problem-solving task. Similarly, in the context of college students in Samar, Philippines, Verdeflor et al. (2025), revealed that students with difficulty in grasping complex concepts fosters self-doubt and discouragement, which weakens their persistence in mathematics.

Meanwhile, in Davao Region specifically in Davao City, Ugpo et al. (2025) revealed in their study on metacognitive awareness in enhancing persistence in solving mathematics that students with limited mathematics persistence in problem solving disrupts the learning process and reduces opportunities for deeper knowledge construction. In the same locality, Caminse et al. (2025) found that even students majoring in mathematics, despite their value and appreciation in mathematics still exhibit low level of mathematical persistence when faced with challenging mathematical problems. Likewise, Velez et al. (2023) reported that fear and self-doubt of the students in comprehending mathematical concepts and feeling anxious about not understanding the formulas in solving mathematical problems tend to weaken their mathematical persistence, making it harder for them to exert effort despite their determination to succeed.

Mathematics higher-order thinking skills (MHOTS) is often reflected in the ability of the students to apply various mathematical process skills. According to the study conducted by Kamid et al. (2025), students who demonstrate stronger mathematical process skills as an indicator of MHOTS directly enhance their mathematics persistence, allowing them to maintain resilience when dealing with complex and challenging mathematical task. On other hand, Jailani et al. (2017) emphasized that when students regularly exposed with MHOTS based questions, will greatly enhance their confidence and problem-solving abilities which develop stronger sense of mathematical persistence. Over time, mathematical critical thinking as indicator of MHOTS not only strengthen problem-solving abilities of the students but also fosters long-term persistence in academic and real-life challenges (Rivas & Siaz, 2016).

Meanwhile, school classroom engagement particularly through motivation and self-efficacy demonstrate greater mathematics persistence in overcoming mathematical challenges, highlighting the importance of engaging learning environments in fostering mathematics persistence (Madrilejos, 2025). Recent research by Goh (2025) showed that classroom engagement has contribution in mathematics persistence. He stated that students who demonstrated both high consistent classroom engagement and mathematics persistence achieved the best academic performance, highlighting that mathematics persistence retains focus and effort while engagement drives continuous participation.

Several studies have explored persistence in learning mathematics, yet they reveal notable gaps that the present study seeks to address. Some studies have examined persistence in relation to motivation and achievement like what Tinto (2017) conceptualized persistence as related to motivation and a sense of belonging, emphasizing students getting involve in their academic community tends to have decision to continue. Similarly, DiNapoli (2023) distinguishing persistence from grit and perseverance for learning mathematics, emphasizing how mathematics persistence affects the time spent by the students on mathematical problems. Moreover, Miele (2022) explored how math-specific self-perceptions of persistence predict their behavior in math. More recently, Ugpo et al. (2025) showed that MHOTS related to metacognitive awareness predicts persistence in solving mathematics problem among mathematics major

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

revealing 27.9 percent of variance in their study. However, these studies were set in online setting and focused on higher education students with limited attention given to mathematics engagement and mathematics higher-order thinking skills as a contributing factor on mathematics persistence.

Collectively, these studies showed that while persistence has been linked to motivation, self-efficacy, and perseverance, there is only few have examined the combined effects of mathematical higher order thinking and mathematics engagement on mathematics persistence particularly in secondary school settings. In response to these identified gaps, the study focuses to address it by examining how mathematics higher order thinking skills and classroom engagement in mathematics influences their mathematics persistence.

The proposed study holds significant social relevance by identifying how mathematical higher order thinking skills and mathematics engagement influence mathematics persistence that can provide teachers and policymakers with evidence-based strategies to improve mathematics learning outcome. This aligns with the United Nations Sustainable Development Goals (SGDs) particularly SDG 4 on Quality Education by promoting inclusive and equitable access in all individual to effective mathematics instruction and to quality learning experiences. It also contributes to Sustainable Development Goals 8 on Decent Work and Economic Growth since persistence fuels the drive to achieve complex economic goals while HOTS fosters the innovative thinking and problem solving which are crucial skills for future employment.

To ensure that the findings had meaningful impact, the results of this study will be disseminated through school seminars, faculty meeting, and student forums to directly benefit the learning community. These activities will provide opportunities for teachers and school personnel to discuss implications of the findings and identify practical strategies for strengthening student mathematical higher-order thinking skills, classroom engagement, and persistence in learning mathematics. Copies of the result were also provided to the school administrators and teachers to help improve instructional practices. In addition, the study could be presented at local research conference and submitted for publication, making the results accessible to a wider group of educators, researchers, and other interested stakeholders while contributing to the existing body of knowledge in mathematics education.

Statement of the Problem

This study aimed to determine the influence of mathematical higher-order thinking skills and classroom engagement in mathematics to the mathematical persistence among high school students. Specifically, it sought answers to the following questions:

1. What is the level of mathematics higher-order thinking skills of the students in terms of:
   1.1 mathematical critical thinking;
   1.2 mathematical creative thinking;
   1.3 mathematical problem-solving skills; and
   1.4 mathematical metacognitive skills?
2. What is the level of school classroom engagement in math of the students in terms of:
   2.1 cognitive engagement;
   2.2 behavioral engagement;
   2.3 emotional engagement;
   2.4 emotional disengagement;
   2.5 cognitive disengagement; and
   2.6 behavioral disengagement?
3. What is the level of mathematics persistence of the students in terms of;
   3.1 persistence in classroom mathematics exercises;
   3.2 persistence is mathematics take home assignments;
   3.3 persistence in a group mathematics task; and
   3.4 persistence in mathematics examination?

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

4. Is there a significant relationship between:
   4.1 mathematics higher-order thinking skills and mathematics persistence; and
   4.2 school classroom engagement in math and mathematics persistence?
5. Do the mathematics higher-order thinking skills and school classroom engagement in math of the students significantly influence their mathematics persistence?

Literature Review

Mathematics Higher-order Thinking Skills

Mathematics higher-order thinking skills (MHOTS) as defined by Zhou et al. (2024) has the indicators mathematical critical thinking, mathematical creative thinking, mathematical problem-solving skills, and mathematical metacognitive skills. They referred MHOTS as the comprehensive ability of the students to use advanced cognitive processes in mathematics. Similarly, Rahman et al. (2021) emphasized that students who have higher MHOTS are consistently able to analyze, create, and evaluate, while those who have low MHOTS often struggle depending on their learning style.

Research revealed that the level of MHOTS of the students is high when a high-achieving students demonstrating strong problem-solving processes with accurate solutions, while low-achieving students display lower level of MHOTS, characterized by incorrect solving processes and difficulty comprehending complex mathematical problem. The finding implies that the students with high learning achievement can solve MHOTS problem correctly and apply right procedure and arrive with accurate answer, whereas the students with lower learning achievement tend to understand the given information only and struggled to proceed the next step, resulting to incorrect and incomplete solutions (Rahmawatiningrum et al., 2019). In the study by Rahmawati et al. (2025), they revealed that most of the Grade 11 students encountered moderate difficulty in translating mathematical problem to equation affecting lower MHOTS, while students who have high abilities manage to accurately translate the problem successfully. Supporting this, Utami et al. (2025) determined that implementation of problem-based learning on mathematical literacy greatly increases the level of students MHOTS compared to the scenario without the help of problem-based learning.

Some scholarly articles have emphasized that textbooks are so important in fostering MHOTS since they are the primary resource for both the teachers and students, implying that the more MHOTS content in a textbook, the greater the probability of MHOTS to be taught to the students to practice and strengthen their higher-level thinking (Pratama & Retnawati, 2018). Extending beyond resources and knowledge of the teacher, Zana et al. (2022) explains that low reading interest of the students can cause lower MHOTS which hinders analyzing complex math problems.

Mathematical Critical Thinking. Mathematical critical thinking refers to the student ability to carefully evaluate information in order to make decisions on what to believe or act. Mathematical critical thinking involves students thoughtfully analyzing problems, applying established mathematical concepts, and reflecting on their reasoning to arrive at logical and well-justified conclusions (Zhou et al., 2024). In line with this, Suryawan et al. (2023) recognized that mathematical critical thinking as an essential component in mathematics that students should carry with fighting attitude when engaging in mathematical problem-solving.

Several studies examine the level of mathematical critical thinking of junior high school students. Utami and Bharata (2022) found that the level of mathematical critical thinking of Grade 8 students were relatively low, indicating that the students are not yet able to analyze and evaluate the questions clearly. It was slightly supported by Yumiati (2013), that mathematical critical thinking is not innate to the person or develop automatically but cultivated through purposeful learning in mathematics. He added that, it is necessary to develop high-quality instructions that help students encouraged to actively engage in critical thinking.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

Students with higher level of initial mathematical abilities demonstrated higher levels of mathematical critical thinking enabling them to solve mathematical problems with greater precision and accuracy. Conversely, students who began their schooling with limited mathematical knowledge exhibited lower levels of (Kania et al., 2023). Beyond this, critical thinking in mathematics should not be confined to cognitive and social dimensions alone but should also train learners to reflect on their mathematical beliefs, learning processes, and the broader role of mathematics in society (Sachdeva & Eggen, 2021).

Mathematical Creative Thinking. Mathematical creative thinking refers to the ability to process information in a way that generates new and original ideas, flexible strategies, and innovative solutions to mathematical problems (Nugroho et al., 2020). It is often measured through indicators like fluency, flexibility, originality, and elaboration, which reflect how students generate multiple solutions, present unique approaches, and refine their response when solving which developed their creative thinking abilities in mathematics (Yayuk et al., 2020).

The mathematical creative thinking of the students in terms of relation and function in mathematics shows approximate achievement level of 50 percent of the ideal score mark, indicating that the students may acquire proficiency in relation and function but still lack sufficient mathematical creative thinking which limits their ability to showcase the expected mastery level (Ibrahim et al., 2024). However, Fatah et al. (2016) clearly stated in their research that mathematical creative thinking of the students will be enhanced when open-ended learning approach will be observed and implement regardless of the school category. Further, they noted that it is also important to consider the impact on how teachers help the students in problem solving by giving appropriate scaffolding strategies.

Moreover, with regard to instructional strategies for enhancing mathematical creative thinking, Yaniawati et al. (2020) examined the integration of e-learning and resource-based learning to enhance both mathematical creative thinking and self-confidence of the students. Their pretest result showed that the level of mathematical creative thinking of the students found to be low, implying the need to integrate scientific approach in learning. Furthermore, a related study by Puspitasari et al. (2018), found that high-ability students demonstrated high level of fluency, flexibility, and originality in arithmetic problem-solving though slightly struggle with elaboration aspect, while those with moderate and low ability found difficulty understanding mathematical problems with systematic solutions.

Mathematical Problem Solving. Mathematical problem solving is the application of strategies to understand, analyze, and resolve mathematical situations, it is often includes making abstract problems more concrete through visualization techniques, fosters deeper conceptual understanding, motivation, and confidence (Osman et al., 2018). It emphasizes reasoning to draw conclusions from a given information and the ability to generate alternative solution (Ridwan et al., 2021).

Regarding the student proficiency in this skills, Gosilk (2017) revealed low level of mathematical problem. Specifically, some students performed poorly on the number and age-related problem, while others exemplify best performance in work and distance problem. These indicate that their performance with regards to their mathematical problem solving are still in emerging level. Similarly, Osman et al. (2018) reported that students demonstrated a low level of mathematical problem-solving, particularly word problem solving. This was evident in their difficulty in getting the correct answer. These findings highlighted the need to implement various strategies that can be applied to help strengthen the ability of the students in solving. Nevertheless, classroom practices have also been shown to enhance problem-solving as Barana et al. (2022) reported self-assessment and problem-solving skills development in mathematics allowed every student to critically reflect on their work showing that those trained in self-assessment display a degree of accuracy in performing mathematical problem-solving.

Mathematical Metacognitive Skill. Mathematical metacognitive skill is the ability of the learners to plan, monitor, evaluate, and regulate their own thinking processes while utilizing strategies such as task analysis, reflection, self-assessment, which significantly support problem-solving skills of the students (Tachie, 2019). Studies highlights varying levels of mathematical metacognitive skill of the students that

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

influence mathematical problem-solving. In the study by Guner and Erbay (2021), students with high level of metacognitive skills have the capacity of solving mathematics problem correctly using appropriate strategies while those who are poor on metacognitive skills tend to have difficulties in understanding and arriving correct solution. Similarly, Van der Walt and Jagals (2016) reported that strong metacognitive reflection during monitoring and planning improves metacognitive awareness that leads to better problem-solving outcomes.

In terms of metacognitive skills of the students, Erdogan and Sengul (2017), in their investigation of the effect of cooperative learning method and metacognitive strategies, further revealed that the students grounded to cooperative learning with metacognitive strategies achieved high level of metacognitive skills than those in control group. This highlights the importance of providing students with opportunities to apply metacognitive strategies in various mathematical concepts. Despite these positive findings on the effectiveness of instructional strategies in developing metacognitive skills, Abdullah et al. (2017) reported that many Malaysian students demonstrated only medium level of their metacognitive skills reflected to their performance on non-routine mathematical problem solving.

School Classroom Engagement in Math

School classroom engagement in math as defined by Berhanu and Moges (2025) has the indicators cognitive engagement, behavioral engagement, emotional engagement, cognitive disengagement, behavioral disengagement, and emotional disengagement. They refer this as the degree of involvement and attention in learning of the students, which lead to a deeper understanding, persistence, and better outcomes

In terms of its observed level, Sen (2022) reported that students displayed a high level of student engagement in mathematics, suggesting that they had a positive perception of their engagement in the subject. This finding is supported by Abla and Fraumeni (2019), who found that when teachers employed autonomy and supportive practices rather than controlling the learners, students show a high level of engagement. In elementary school context, Qudwatullathifah et al. (2025) reported that the level of classroom engagement in math is high, this indicates that the grade school students really enjoying the school with their friends. They suggested that school classroom engagement of the students is influenced by internal and external factors, they also noted that it is important for the students to received support from parents, classmates, teachers, and also teaching and learning strategies.

Beyond the levels of student engagement and the support they receive, classroom conditions and emotional experiences may also shape their engagement in mathematics. Imms and Byers (2017), demonstrated that higher flexible classroom designs, coupled with proper utilization of technologies, leads to higher improvement on learning environment to the students that directly influences engagement. In addition, emotions and self-efficacy have been highlighted as important components of engagement as Alpaslan and Ulubey (2021) found in their research that students who experienced positive emotions such as pride and enjoyment in mathematics classes tend to have higher engagement cognitively, affectively, and behaviorally. In addition, Durksen et al. (2017) highly emphasized that teacher-student interactions are vital in maintaining engagement. They revealed that the higher the classroom organization and support of the teacher the stronger students' engagement in mathematics being showed. Expanding on this perspective, Jansen et al. (2023) argued that definition of engagement and strategies of the teachers shape how engagement is manifested in the students, describing that cognitive, affective, behavioral dimensions interact differently depending on the classroom purpose.

Cognitive Engagement. Cognitive engagement refers to the mental effort and personal mindset that learners dedicate to understand and reason out with their mathematical ideas and solving problems skills. It involves the use of self-regulatory strategies, persistence in challenging tasks, and the application of metacognitive processes that help learners monitor and adjust their thinking (Skilling & Stylianides, 2022). Grade 11 students demonstrated a high level of cognitive engagement, suggesting that they were willing to participate, motivated by their teachers to exert effort in learning, and allocated time to studying

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

mathematics daily. However, despite these positive indicators, students received limited encouragement from their peers to continuously improve their learning (Bedada et al., 2025). In online learning context, Joshi et al. (2022) reported that during the COVID-19 pandemic, students exhibited high levels of cognitive engagement while learning mathematics online, they notably stated that when virtual instruction is structured effectively, students can remain actively engaged in mathematics.

Behavioral Engagement. Behavioral engagement is the observable engagement of the students in learning, such as, going to class, doing assignments, exerting effort in solving math problems, and persisting when they encounter difficulties (Hidayat et al., 2019). In online learning context, Joshi et al. (2022) indicated that even amidst COVID-19 crisis, students showed high behavioral engagement in digital mathematics learning environments, which made them more active to accomplish learning task and able to collaborate their peers in academic discussion. They discovered that even in virtual environments, systematic methods of teaching can maintain active engagement and task completion, that are important markers of behavioral engagement. Similarly, college students demonstrated behavioral engagement through their consistent efforts to search for solution, explore alternative strategies, and revisit difficult mathematical problems, reflecting their active participation in the learning process (Iji et al., 2018). Building on this perspective, Hidayatullah et al. (2024) highlighted the importance of behavior engagement in facilitating mathematics learning. They explicitly indicated that motivation of students which relate to engagement holds an essential role in enhancing self-efficacy of the students which further influences behavioral engagement among Indonesian primary school students.

Emotional Engagement. Emotional engagement refers to the affective responses exhibited by students in reaction to learning, such as enjoyment, interest, enthusiasm, or fear when performing assigned task (Hong et al., 2020). Emotional engagement captures the emotional connection students develop for mathematics, which in turn influence their persistence, motivation, and engagement in problem-solving activities (Frenzel et al., 2019). Positive emotion such as enjoyment and curiosity are feelings that can lead to greater engagement, whereas frustration or fear are negative emotions that can interfere with mathematics performance of the students (Owusu-Darko et al., 2017).

Several results from empirical research highlight the importance of emotional engagement to mathematical achievement. The study by Joshi et al. (2022) with the use of technology, they found that emotional engagement of the students was high which promote academic performance of the students in mathematics subject. It was revealed that technology really help students feel comfortable, enjoy, and gain interest in participating online learning. Consistent with the finding, Bedada et al. (2025) revealed that the level of emotional engagement of Grade 11 students were high, indicating that they really enjoy and understand learning mathematics. A similar result was reported by Hong et al. (2020), who found that emotional engagement among elementary students is high. Extending this discussion to technology-supported learning environments, Oppmann and Reinhold (2023) found that learners who were exposed to adaptive computer learning environments experienced greater emotional engagement, which further contributed to better learning outcomes. Likewise, Reinhold et al. (2021) revealed that emotional engagement specifically interest and enjoyment was a singular predictor of best learning outcomes.

Emotional disengagement. Emotional disengagement in mathematics is a pattern of response of the students in which there is a withdrawal from positive involvement towards learning mathematics, often experienced as boredom, frustration, anxiety, or lack of interest, which negatively affects persistence in the subject (Schoenherr, et al., 2025). In recent educational research on affective engagement of the students in mathematics reported that low emotional attachment and interest in mathematics influence with the feelings of unimportance and lack of interest toward the subject, which can develop into emotional disengagement and reduced academic persistence (Lewis, 2013). On other hand, Anino and Ubalde (2025) revealed that emotional disengagement tends to arise in level when students perceive mathematics anxiety-provoking, reducing their willingness to participate in learning activities and persist in solving mathematical problem.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

Cognitive disengagement. Cognitive disengagement refers to the tendency of the students to reduce mental effort when tasks become difficult, such as focusing only on easy parts or preferring to be given answers rather than mastering procedures. It is also reflected in negative feelings toward math classwork, which further discourage active thinking and problem-solving (Berhanu & Moges, 2025).

Behavioral disengagement. Behavioral disengagement refers to students lack of effort and participation during math classes, such as not trying hard and engaging in irrelevant activities instead of focusing on learning. It also includes surface-level compliance, where students appear to be working but are not genuinely involved in the task (Berhanu & Moges, 2025). In addition, Jang et al. (2016) described behavioral disengagement as being easily distracted during class, exerting minimal effort and quickly ceasing attempts to complete the task. Learners who are behaviorally disengaged tend to avoid learning activities, perform task with minimal effort and merely finish them.

In the study by Pham et al. (2022), they reported a high level of disengagement behaviors among students as reflected to their withdrawal from learning task and reduced participation in learning activities. Moreover, Wang et al. (2019) revealed notable proportion of learners showing low participation rates in lessons characterized by inattentiveness and avoidance of assigned task.

Mathematics Persistence

Mathematics persistence as defined by Ogbu and Ugwu (2023) has the indicators persistence in classroom mathematics exercise, persistence in mathematics take home assignments, persistence in a group mathematics tasks, persistence in mathematics examination. They describe this as a persistent effort of the students to keep retrying and challenge themselves to overcome every hardship in the process of learning mathematics, encompassing continuous attempts to solve challenging mathematics problem and comprehend abstract concepts even after making failures.

The current study by Asoy and Picaza (2025) revealed a high level of mathematics persistence among higher education students, which indicate that the mathematics persistence of the college students is oftentimes manifested. Consistent with these findings, Ugpo et al. (2025) found that there is also high level of mathematics persistence among mathematics major students in the Philippines, which explains that the students who actively plan, monitor, and regulate their thinking are more capable of successfully shows persistence when faced with challenges. In the study by Riazy et al. (2021), they highlighted important role of prior knowledge in shaping the persistence of students in mathematics learning environment, they notably concluded that persistence of students is highly dependent on their prior mathematical knowledge and language capabilities, this effect highly pronounced when task in language is too difficult or had a low readability indicating that insufficient prior knowledge can hinder students involvement in mathematics activities.

Beyond the influence of prior knowledge and language abilities, persistence has also been associated with the capacity of the students to continue working through mathematical challenges. Sajiman et el., (2024) emphasized that self-persistence plays a crucial role in strengthening the ability of the students to solve mathematical problems. According to their study, self-persistence has a positive influence on mathematical solving ability, which suggest that the students who likely to continue despite the challenges are closer to develop stronger mathematical skills. Moreover, they notably observed that the persistence demonstrated by the students in the teaching and learning process improved their performance in mathematics, indicate that the more persistent the students are the more they improve in solving challenging mathematical task.

Persistence in Classroom Mathematics Exercises. Persistence in classroom mathematics exercises means the productive effort of students in solving complex mathematics problem by making repeated attempts, seeking guidance, remaining steadfast despite difficulties, shown by their willingness to study persistently, exert more effort when mathematics problem gets harder, and finished homework on time (Asoy & Picaza, 2025). Indeed, Madrilejos (2025) emphasized that students who believe to their

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

mathematical capacity tend to be more motivated and persistence to exert learning efforts. Also, they noted that the essential for improving persistence and holistic academic performance of the students in mathematics is to foster quality, effective, and creative learning experiences.

Findings from Ugpo et al. (2025) reported that mathematics major students demonstrate a high level of student persistence in mathematics exercises, which implies that the students always taking notes on the lessons and doesn't give up in solving complex mathematical problem exercises. However, Shen et al. (2016) presented a different perspective, suggesting that the students who demonstrated persistent in solving difficult mathematical were not necessarily equally persistent when confronted with challenging arithmetic problems. This implies that persistence in mathematics exercises may vary depending on the nature and difficulty of the task, as well as their previous experiences of success and failure in mathematics. Complementing this perspective, Bettinger et al. (2018) demonstrated how confidence of the students in their capability to learn, help them to persist in solving difficult algebra questions. Moreover, Mau, (2017) explored factors influencing persistence of students to pursue STEM degrees, it was found out that the older students are less likely to persist compared to young students due to some reason like financial or learning challenges.

Persistence in Mathematics Take Home Assignments. Persistence in mathematics take home assignment is the reflection of the ability of the students to sustain effort, apply problem-solving strategies and engage with mathematical concept independently, it goes beyond simply completing a task (Kosova et al., 2024). Providing supplemental mathematics assignments is necessary so that students with lower exam scores can earn more points, thus offering benefit to the students who found to gain most from the assignments narrowing racial gaps in exam performance (Lu et al., 2024).

Recent research on persistence in mathematics take home assignments of the students showed only a moderate level, emphasizing that the students taking late night sleep in order to understand and able to get the right answer of the mathematical assignments. Indeed, this proves that students have persistence to continue solving difficult mathematical problem even experienced failures (Asoy & Picaza, 2025). In addition to this, Ugpo et al. (2025), also observed high level of persistence in mathematics take home assignments among mathematics major students, this explains that the students received their target grades when decided to not to give up despite the hardship being faced. Extending these findings, Fairman et al. (2025) examined the use of online platform for giving real time immediate feedback among middle school student on their mathematics assignment, targeting feedback specific for student difficulties, this data-driven approach not only improve instructional concentration but also assisted learners sustained effort on assignments thereby promoting persistence in in-dept learning.

Persistence in a Group Mathematics Task. Persistence in group mathematics task refers to the effort to take time to understand difficult topics and staying committed despite the hardship in learning mathematics, group task not only supports individual learning but also enhances collaborative efforts on solving difficult mathematical problems and fosters engagement in learning even when peers has given up (Asoy & Picaza, 2025). Even though group activities in mathematics perceived to be difficult and challenging but still results are worth rewarding, with all students agrees that group work truly has been helpful and enjoyable (Sofroniou & Poutus, 2016).

Previous research indicates that the level of persistence in a group mathematics task among math major students was high which means that students are persistent in collaborating group mates when trying to solve complex mathematical problem (Ugpo et al., 2025). Similarly, Asoy and Picaza, (2025) reported high level of persistence in a group mathematics task of the students, which indicate that the students demonstrated persistence through effort and understanding to collaborate their peers in a group mathematics task even others have given up. Empirical findings from Sofroniou and Poutus (2016) shows that mathematics group task really help students deepen their understanding and honing their analytical thinking skills while working with peers. It is noted when struggling students who once discourage to work

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

independently are now reported having less stress when solving mathematical problems through collaboration with peers.

Persistence in Mathematics Examination. Based on the study by Asoy and Picaza (2025), persistence in mathematics examination can be define as a continuous effort and eagerness of the students to solve difficult mathematical questions by staying focused, not giving up easily, and holding on the advice of the teachers while maintaining their attention during challenging topics. According to them persistence in mathematics examination of the students revealed to be high because students believed that every difficult topic in can be solve given enough attention and efforts and also not giving up easily. More to this, Ugpo et al. (2025) showed that the level of persistence in mathematics examination among college students tend to be very high, this suggests that the students showcasing strong sense of persistence in mathematics examination. On other hand, Rajendran and Gopalasamy (2024) indicated that mathematics skills are essential for various competitive examinations, it underscores the need for persistent effort in math practice to increase their chance to success.

MHOTS and Mathematics Persistence

Developing Mathematical Higher-Order Thinking Skills (MHOTS) is a crucial goal of mathematics education, as these skills foster problem-solving, critical thinking, and creativity (Zhou, 2024). One of the most effective pedagogical approaches for building MHOTS is Problem-Based Learning, which engages students in complex, real-world mathematical problems that require persistence and perseverance. Studies have consistently found correlations between the implementation of PBL and improvements in both MHOTS and student persistence in mathematics learning (Dyah Prastiti, 2020). In the Philippines, Ugpo et al. (2025) highlights the relationship between mathematical higher order thinking and mathematics persistence by demonstrating how metacognitive awareness, a key component of MHOTS significantly predict student persistence in solving mathematical problems. Moreover, Sajiman et al. (2024) reported that there is a significant influence found between persistence and MHOTS characterize by problem solving.

School Classroom Engagement and Mathematics Persistence

Classroom engagement plays a central role in sustaining persistence of the students in mathematics. In the study by Pinugu (2021) highlighted that classroom engagement significantly mediated persistence in challenging programs. Meanwhile, Jung and Lee (2018) found that learning engagement had indirect effects on the relationships between learning persistence implying that when students are actively engaged, they are more likely to sustain their effort and remain persistent in completing learning tasks, highlighting engagement as a mediating factor that strengthens the persistence of learners in academic settings. In other context, Zeng and Xin (2024) examined persistence and engagement in asynchronous and synchronous online learning, showing that both were higher in synchronous settings. Their findings emphasized that autonomous academic motivation significantly influenced both engagement and persistence, with engagement serving as a mediator between the two. This suggests that students who are more motivated are also more engaged, and this heightened engagement translates into greater persistence.

The reviewed studies collectively highlight that mathematical higher-order thinking skills such as mathematical problem-solving, mathematical critical thinking, mathematical creative thinking, and mathematical metacognitive skills play an important role in developing perseverance of the students in mathematics. While no single study found that directly links MHOTS to mathematics persistence, the evidence suggests a strong indirect relationship: students who develop higher-order thinking have greater tendency to persist on facing challenging mathematical tasks, as these skills equip them with strategies to analyze, reflect, and overcome difficulties. Furthermore, approaches like problem-based learning not only enhance the higher-order thinking of the students but also foster perseverance and resilience in solving complex problems. In this sense, mathematics persistence emerges not as an isolated construct but as one

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

that is reinforced by the cultivation of MHOTS, pointing to the need for instructional practices that integrate cognitive challenge with motivational support.

Theoretical Framework

This research was anchored to the *Self-Determination Theory (SDT)* proposed by Deci and Ryan (2000) and *Three-Dimensional Model of Student Engagement* proposed by Fredricks et al. (2004), to explain factors influencing mathematics persistence among students.

SDT is motivational framework that conceptualizes intrinsic and different forms of extrinsic motivation and their roles in learning, social development and individual differences. It explains how the behavior of individuals shaped by the fulfillment of three fundamental psychological needs: autonomy, competence, and relatedness. When these needs are consistently fulfilled, students have a greater tendency to feel healthy, motivated, and able to perform effectively. However, when these needs are not met or are blocked, people may experience emotional difficulties, poor performance, and unhealthy behaviors. Negative actions or experiences, such as aggression or psychological problems, are viewed as results of these basic needs being frustrated either over time or in certain situations.

Within the framework of SDT, persistence in mathematics of the students is influenced by how well their learning environment supports autonomy, competence, and relatedness. When these needs are met, students are more likely to develop high-quality motivation, which drives sustained effort, resilience, and persistence in challenging tasks such as mathematics problem-solving. In the context of this study, SDT provides a theoretical basis for understanding how mathematical higher-order thinking skills of the students which require reasoning, analysis, and problem-solving, can enhance their competence and sense of control, thereby promoting persistence in mathematics.

In addition, Three-Dimensional Model of Student Engagement defines engagement as multidimensional concept consisting of three interconnected aspects: behavioral, emotional, and cognitive. Behavioral engagement describes active involvement of the students in activities that promotes learning, including class attendance, task completion, and participation in discussions. Emotional engagement concerns affective response of the students in learning, such as interest, enjoyment, and enthusiasm. Cognitive engagement refers to the mental effort exerted to understand lessons, such as using problem-solving strategies, thinking deeply about content, and persisting in challenging tasks. Together, these engagement dimensions highlight that persistence of the students in mathematics depends not only on their cognitive abilities but also on their active involvement and emotional connection to learning.

By integrating SDT and the Three-Dimensional Model of Student Engagement, this framework posits that mathematical higher-order thinking skills and student engagement serve as key predictors of mathematics persistence. Higher-order thinking skills enhance competence and problem-solving confidence of the students, while engagement ensures that students remain behaviorally active, emotionally invested, and cognitively committed. Both factors work together to sustain efforts of the students in learning mathematics. Consequently, students who possess strong HOTS and high engagement show a greater tendency to sustained persistence in mathematics, even when faced with challenging problems.

Conceptual Framework

Shown in Figure 1 is the conceptual framework of this study. This framework illustrates the influence between the independent variable mathematical higher-order thinking and school classroom engagement in mathematics, and the dependent variable mathematics persistence among high school students.

Mathematics higher-order thinking skills (MHOTS) serves as the primary independent variable, it is the ability of the students to analyze, evaluate, and create beyond traditional rote memorization. This variable consists of the following components; mathematical critical thinking, mathematical creative thinking, mathematical problem solving, and metacognitive skill. When students are given mathematical

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

tasks that require critical reasoning and problem-solving, they are more likely to develop confidence and resilience, which are key elements of persistence in learning mathematics.

School classroom engagement is grounded to the Three-Dimensional Model of student engagement. It includes cognitive engagement which reflects to the mental effort the students showed and strategic thinking possess in mathematical task; behavioral engagement which refers to the student active participation and effort in the classroom activities; emotional engagement which involves the enthusiasm and interest of the students towards learning. When the students are actively involved, interested, and invest mental effort into classroom tasks, they exhibit commitment and a sense of fulfillment that facilitates long-term persistence in mathematics learning.

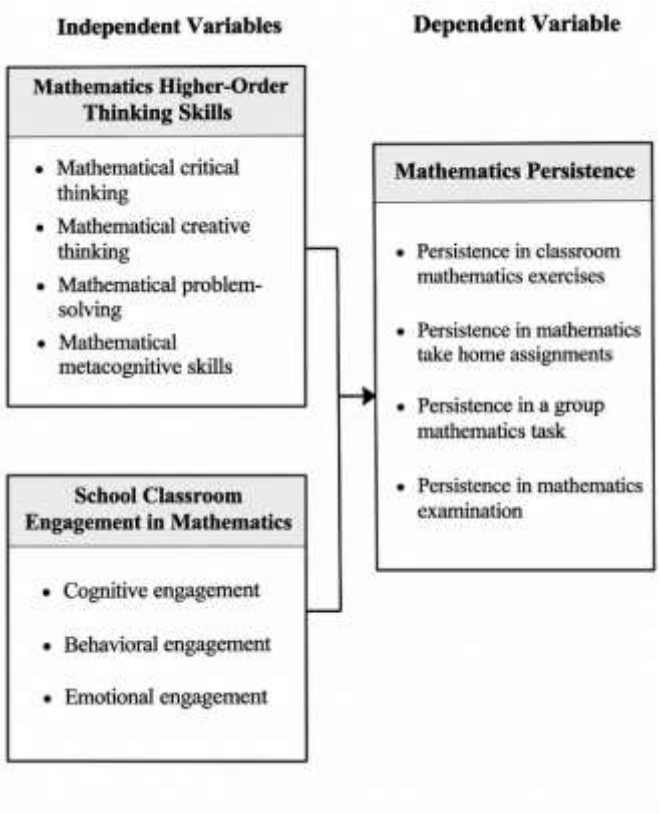


Figure 1. *Conceptual Framework of the Study*

The dependent variable, *mathematics persistence*, represents the consistent effort and willingness of the students to understand complex mathematical problem despite the difficulties faced in mathematics learning. The variable encompasses four key components persistence in classroom mathematics exercises, persistence is mathematics take home assignments, persistence in a group mathematics task, persistence in mathematics examination. These components enable students view persistence as an essential outcome reflects adaptive coping in learning mathematics.

Together, these factors are posited to influence *mathematics persistence*, defined as continued effort, motivation, and determination of the students to pursue mathematical understanding despite challenges. The framework assumes that persistence is not only a product of individual cognitive skills but also a function of the level of engagement in the classroom environment of the students.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

METHODS

Research Design

This study utilized a quantitative research design specifically descriptive-correlational design. Quantitative research design is a systematic approach aims to quantify data and expressing information in numerical form, it is usually seeking answers to the questions to what extent (Ghanad, 2023). It was appropriate to use in this study as it allowed to collect, measure, and analyze numerical data, and understand relationship between variables (Bhuvanasri et al., 2025).

Descriptive-correlational research design is a research design used to describe the existing levels of variables and determines the relationship among the variables without manipulating any conditions, it aims to present summary of the characteristics and behavior of a particular population, though it does not imply cause and effect relationship but provides detailed summary that can be serve as baseline for further analysis (Bhuvanasri et al., 2025). The design was used to examine the current level and patterns of the student mathematics higher-order thinking skills, school classroom engagement, and mathematics persistence and to analyze the strength and direction of the relationships between the independent and dependent variables. This design is particularly appropriate for identifying how higher-order thinking skills and level of engagement of the students predict their persistence in mathematics learning among students in the selected population.

Research Locale

Figure 2 presents the geographical location of the research locale where the study was conducted. The study was carried out in three private school in Davao City, a recognized city for a clean and safe environment. For confidentiality purposes, the participating schools are referred to as school A, school B, and school C throughout this study.

School A is private secondary institution that provides a structured and supportive learning environment for its students. The school offers mathematics instruction that encourages learners to develop their mathematical reasoning, problem-solving and critical thinking skills. Its classrooms and teaching practices, provides opportunities for the students to participate in mathematics learning, making it a suitable setting for examining their mathematical higher-order thinking skills, classroom engagement in math, and persistence in mathematics.

School B is a private Christian institution located in, Davao City. The school is being recognized on their faith-based Christian principles and a strong emphasizes on collaborative learning and student-centered instructional strategies, allowing students to actively practice mathematical reasoning and critical thinking. These characteristics make it suitable for investigating the relationship between student engagement, higher-order thinking skills, and mathematics persistence.

School C is a private educational institution in Davao City that was established to provide quality education while promoting academic excellence, character development, and holistic student growth. The institution provides basic education programs that encourage learners to participate actively in classroom activities, particularly in mathematics and other academic areas.

It also provides opportunities for students to engage in challenging mathematical task that require critical thinking, problem solving, and the application of learned concepts. This made school C an appropriate setting for examining the relationship between mathematics higher-order thinking skills, classroom engagement, and mathematics persistence among grade 10 students.

These three schools were selected as the research locale because they provide a diverse representation of learning experiences of the students in mathematics. Each school offers programs that emphasizes the development of critical thinking, problem-solving, and student engagement, which are central to the variables of this study. Moreover, the supportive learning environments of the school ensure that the participants have the necessary background and exposure to respond meaningfully to the research

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

instruments. This selection allowed the study to explore the relationship between mathematics higher-order thinking skills, school classroom engagement, and mathematics persistence.



Figure 2. *Maps of the Philippines and Davao City*

Research Respondents

The respondents of this study were the Grade 10 students from three selected private institutions in Davao City. The total population of the study consisted of 147 students distributed as school A with 52 students, school B with 71 students, and school C with 24 students. This group of learners was selected knowing that at this level holds a crucial stage in their mathematics education, where mastery of foundational concept and persistence in higher order problem-solving are essential in preparing for senior high school.

The exclusion criteria of respondents included who were not officially enrolled, those who had recently transferred and had insufficient exposure to the school classroom environment, those who are unwilling or unable to participate, and those parents or legal guardians who did not provide consent. Students with cognitive or learning difficulties that could prevent them from fully understand to the research questions were also excluded from the study.

Since the selected school has a sufficient population, complete enumeration as a sampling technique was employed in this study. This meant that all students within the identified population were invited to participate in the study, with a total of 147 students represented by the three selected school. Complete enumeration ensured that every eligible student from each school has the opportunity to participate in the

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

study, allowing the gathered data to fully represent the target population of the study (Tajik et al., 2024). Following the application of established inclusion and exclusion criteria, no students were excluded from the study, and all 147 identified respondents were included.

The respondents were considered vulnerable population because they were minors below 18 years old and were still developing their cognitive, emotional, and social capacities. Therefore, to ensure ethical compliance and protect the rights of the respondents, informed consent from parents or guardians and assent from the students themselves were obtained before the data collection. The students were also informed of their participation that was voluntary and that they have a right to decline or withdraw from the study at any time without penalty. Although the respondents belonged to a vulnerable population due to their age, the study did not involve physical health-related risk, as it utilized only an academic survey instrument and posed with minimal risk to the participants.

Transparency was ensured by clearly explaining to the participants before the data collection about the research objectives, benefits, procedures, purpose, and potential risk of the study. Without facing any penalty or negative consequences, the respondents were informed that they could withdraw their participation whenever they decide. Results were reported with honesty and accuracy, avoiding manipulation and misrepresentation of the data gathered. These measures ensured that the principle of justice, respect, and protection of vulnerable respondents were upheld throughout the research process.

Research Instrument

The survey questionnaire utilized in this study was composed of three adapted research instruments and was validated prior to the data collection. Prior to the actual data collection, the questionnaire underwent validation by the qualified experts and pilot testing to ensure the appropriateness of the instrument to the respondents.

The first instrument was developed by Zhou et al. (2024) which is mathematical higher-order thinking skills, a 5-point Likert scale consisted 45 items with responses consistent, conforming, uncertain, inconsistent, not at all. It was designed to measure four core elements of higher-order thinking in mathematics which are mathematical critical thinking, mathematical creative thinking, mathematical problem-solving skills, and mathematical metacognitive skills. The pilot testing yielded a Cronbach's alpha coefficients of 0.96, which is exceeded the accepted reliability benchmark of 0.70. The researcher used the interpretation of means below to determine the level of mathematical higher-order thinking skills of the respondents.

Range of Means	Description	Interpretation
4.20 – 5.00	Very High	The mathematical higher-order thinking skills of the students are always manifested.
3.40 – 4.19	High	The mathematical higher-order thinking skills of the students are oftentimes manifested.
2.60 – 3.39	Moderate	The mathematical higher-order thinking skills of the students are sometimes manifested.
1.80 – 2.59	Low	The mathematical higher-order thinking skills of the students are rarely manifested.
1.00 – 1.79	Very Low	The mathematical higher-order thinking skills of the students are never manifested.

The second instrument used in this study is the Secondary School Classroom Engagement Instrument in Mathematics developed by Berhanu and Moges (2025). The tool contains 25 items measured using a 5-point Likert scale ranging from 5 – Strongly Agree to 1 – Strongly Disagree. It evaluates three key dimensions of student classroom engagement: cognitive engagement, behavioral engagement, and emotional engagement. Psychometric validation indicated strong reliability, with Cronbach's alpha value

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

of 0.89, well above the minimum standard of 0.70. The researcher applied the range of means and corresponding descriptions below to interpret the extent of school classroom engagement in mathematics.

Range of Means	Description	Interpretation
4.20 – 5.00	Very High	The school classroom engagement in math of the students is always demonstrated.
3.40 – 4.19	High	The school classroom engagement in math of the students is oftentimes demonstrated.
2.60 – 3.39	Moderate	The school classroom engagement in math of the students is sometimes demonstrated.
1.80 – 2.59	Low	The school classroom engagement in math of the students is rarely demonstrated.
1.00 – 1.79	Very Low	The school classroom engagement in math of the students is never demonstrated.

The third instrument was the Mathematics Persistence Scale for Secondary School Students developed by Ogbu and Ugwu (2023). This scale is composed of 28 items measured on a 4-point Likert scale with response ranging from 4 as Strongly Agree to 1 as Strongly Disagree. It measured four aspects of persistence in mathematics learning: persistence in classroom mathematics exercises, persistence in mathematics take-home assignments, persistence in group mathematics tasks, and persistence in mathematics examinations. The scale demonstrated strong internal reliability, with Cronbach's alpha of 0.92, supporting its appropriateness for use in mathematics education research. The researcher adopted the interpretation of means shown in the next page to determine the degree of mathematics persistence among the respondents.

Range of Means	Description	Interpretation
3.41 – 4.00	Very High	The mathematics persistence of the students are always evident.
2.81 – 3.40	High	The mathematics persistence of the students are oftentimes evident.
2.21 – 2.80	Moderate	The mathematics persistence of the students are sometimes evident.
1.61 – 2.20	Low	The mathematics persistence of the students are rarely evident.
1.00 – 1.60	Very Low	The mathematics persistence of the students are never evident.

Data Gathering Procedure

In gathering the data for this study, several steps were observed. The researcher first secured an endorsement letter from the Dean of the Graduate School of the University of the Immaculate Conception for the Endorsement for Ethics Review. Afterward, the researcher submitted the required documents for ethics review to the Research Ethics Committee (REC). After ethical clearance was granted, the researcher requested an endorsement letter to the Dean of the Graduate School to conduct the study. The endorsement letter was then forwarded to the respective school administrators of the participating institution where the research was conducted.

Upon the approval of the request to the school administrator, the researcher coordinated with the school administration to schedule the data gathering. The Informed Consent Form (ICF) for parents or guardians and the assent form for the students were distributed separately prior to the data collection. The researcher first distributed the ICF to the students for them to bring home to their respective parents or legal guardians. The parents or legal guardians were given enough time to read, understand, and sign the ICF if they agreed to allow their child to participate in the study.

After the signed Informed Consent Forms has been collected, the researcher conducted a short orientation to the students in face-to-face setting in their respective classrooms. The orientation explained the purpose of the study, the voluntary nature of their participation, and the procedures involve in the data collection. The researcher also carefully explained the assent form to the students and distributed copies

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

containing both English and Tagalog translations to ensure that they clearly understood the information provided before participating in the study.

The researcher provided the students with adequate time to review the study information, ask questions, and make an informed decision regarding their participation. The students who agreed to participate were asked to sign the assent form. The data gathering was conducted face-to-face at the respective schools at scheduled time agreed upon with the school administration. During the session, the qualified participants were asked to answer the questionnaire under the supervision of the researcher.

Participation in the study was entirely voluntary and respondents were informed of their right to withdraw at any stage of the data collection process without any consequences to their grades, class standing, or relationship with their teachers or school. Throughout the data collection process, all respondents continued their participation, and no one withdrew from the study. The completed questionnaires were collected immediately by the researcher to ensure proper handling and maintain confidentiality of the data.

In adherence to the Data Privacy Act of 2012, the respondents were not required to provide their names on the questionnaire or any information irrelevant to the focus of the study. All collected data were treated with confidentiality, stored securely in the password-protected files and locked storage, with accessed restricted to the researcher. The data were used exclusively for the objective of the study and were not utilized for any personal motives outside the scope of the study. The research data will be retained for three years following the completion of the study. After this time period, electronic files will be permanently deleted, and printed questionnaires and other research documents containing respondent information will be securely shredded to prevent unauthorized access or disclosure.

Statistical Tools

The following statistical tools were utilized to ensure accuracy and proper interpretation of the gathered data.

Mean. This was used to determine the level of mathematical higher-order thinking skills, classroom engagement, and mathematics persistence of the respondents, describing whether the level is low, moderate, high or very high.

Standard Deviation. This tool was applied to measure the dispersion and consistency of the responses of the respondents, allowing to describe whether their responses show similarity or widely spreading out across the means.

***Pearson Product Moment Correlation*.** This statistical tool was utilized to determine and investigate the strength and direction of the linear relationship between independent and dependent variables. It allowed the researcher to determine whether the level in independent variable is associated with the level of another variable.

***Multiple Linear Regression*.** This statistical tool was used to determine and examined the influence of the independent variables to the dependent variable. It enabled the researcher to identify which variables significantly influence mathematics persistence and to what degree of their impact.

Ethical Considerations

The researcher was firmly committed in maintaining strong ethical principles in the conduct of this research. Before the collection of data, the researcher complied with the requirements of the UIC Research Ethics Committee (UIC-REC) and submitted the research for review and approval before the implementation. The researcher strictly followed established ethical guidelines to safeguard the rights, welfare, and protection, of the respondents acknowledging that they were minors and did not have full legal capacity to provide consent independently.

To ensure research quality, the researcher conducted the study under close supervision of the research adviser and with the guidance from the panel members to maintain integrity and quality of the

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

research process. The academic preparation and training of the researcher provide a solid foundation for conducting the study responsibly at every stage. Finally, institutional resources such as the UIC Library and other available facilities were utilized to support the completion of this research in a transparent and accountable manner.

RESULTS AND DISCUSSION

Level of Mathematical Higher Order Thinking Skills of the Respondents

Shown in table 1, the overall level of mathematical higher order thinking of the respondents which is 3.31, it is described as moderate, which means that mathematical higher order thinking of the students is sometimes manifested. The results indicate that while the respondents possess a reasonable level of mathematical higher-order thinking skills, there is still room for improvement in developing their ability to think critically, creatively, and reflectively. It implies that the respondents are able to demonstrate mathematical higher-order thinking skills such as mathematical critical thinking, mathematical creative thinking, mathematical problem solving, and mathematical metacognitive skill but are not consistently manifested. In addition, the results also have an overall standard deviation of .77, indicating relatively low variability of the rating of the respondents which suggest that their responses were generally clustered around the mean.

This finding is relatively higher than that reported by Sridana et al. (2024), who found that higher-order thinking skills of the students in mathematics were in low category, indicating that many learner experiences difficulties in task requiring analysis, evaluation and creation of ideas. In contrast, the present study revealed a moderate level of mathematical higher- order thinking skills, implying that students demonstrate mathematical critical thinking, creative thinking, problem-solving and metacognitive skills although it is nor consistently manifested. On other hand, the finding is comparable to that of Pasani and Suryaningsih (2021), who concluded that higher-order thinking skills (HOTS) of students in the matrix solving were at sufficient category. Their findings indicate that students possess a moderate level of HOTS but still need further development through continued exposure in HOTS oriented learning activities.

Table 1. *Level of Mathematical Higher Order Thinking Skills of the Respondents*

Mean		SD	Description
Mathematical Critical Thinking			
1. Having all their points supported by mathematical facts or arguments.	3.48	.97	High
2. making appropriate arguments. when arguing against someone point of view in math	3.31	1.08	Moderate
3. having good math and logical reasoning skills.	3.20	1.08	Moderate
4. being good at approaching math problems in a systematic and organized way.	3.21	1.15	Moderate
5. taking into account the given conditions of the topic when solving math problems,	3.38	1.07	Moderate
6. always analyzing the question before answering it.	4.18	1.04	High
7. being good at developing systematic plans to solve complex math problems.	3.07	1.14	Moderate
8. learning math is fun and they are confident that they can learn it well.	3.41	1.25	High
9. appreciating that they have the ability to think logically and accurately.	3.66	1.11	High
10. believing they have the ability to solve all types of math problems.	2.84	1.16	Moderate

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

11.	Being proud of themselves on coming up with innovative and practical solutions.	3.05	1.16	Moderate
12.	learning math is fun.	3.42	1.32	High
13.	preferring solving challenging math problems.	2.91	1.37	Moderate
	Category Mean	**3.32**	**.83**	**Moderate**
Mathematical Creative Thinking				
1.	taking the initiative to try to solve all kinds of math problems.	3.41	1.19	High
2.	deducing the reasoning process of complex mathematical problems in a complete and fluent manner.	3.06	1.06	Moderate
3.	solving different types of math problems in different ways.	2.97	1.14	Moderate
4.	being able to transfer their acquired mathematical knowledge and methods to similar problem types.	3.26	1.14	Moderate
5.	asking new math questions in real life situations.	2.90	1.22	Moderate
6.	trying new ways to solve when they encounter a difficult problem	3.24	1.20	Moderate
7.	switching to other solution ideas when one method does not solve a math problem	3.46	1.13	High
8.	adapting the conditions of the problem and redesign the math problem.	3.01	1.18	Moderate
9.	applying math well by example.	3.31	1.18	Moderate
10.	being flexible and using different mathematical ideas.	3.16	1.22	Moderate
	Category Mean	**3.18**	**.84**	**Moderate**
Mathematical Problem-Solving Skills				
1.	Quickly coming up with many solutions when they are facing with a new problem	3.03	1.12	Moderate
2.	Sifting through valid information to analyze and describe familiar mathematical problems.	3.31	1.17	Moderate
3.	Quickly identifying known and unknown variables when faced with a new math problem.	3.03	1.18	Moderate
4.	Expressing the results of thinking activities in words, symbols, diagrams, and others	3.27	1.17	Moderate
5.	Creating logical relationships between conditions and conclusions in a math problem based on mathematical logic.	3.07	1.09	Moderate
6.	Giving reason logically and rigorously based on definitions and laws.	3.11	1.03	Moderate
7.	Meticulously deducing complex mathematical reasoning processes.	2.86	1.03	Moderate
8.	Synthesizing and applying mathematical knowledge, methods, and strategies to solve mathematical problems.	3.30	1.15	Moderate
9.	Choosing appropriate solution strategies for different types of questions.	3.44	1.18	High
10.	Verifying that the answer is correct after the solution is complete	3.56	1.18	High
11.	Scrutinizing and reflect on the problem-solving process.	3.29	1.12	Moderate
	Category Mean	**3.21**	**.81**	**Moderate**
Mathematical Metacognitive Skills				
1.	generalizing from the solution of a specific problem.	3.32	1.10	Moderate
2.	being very aware of the math that goes into solving math problems.	3.76	1.08	High
3.	identifying their math learning goals or tasks.	3.50	1.20	High
4.	having a clear understanding of common mathematical knowledge and ideas.	3.48	1.17	High

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

5.	knowing if they have mastered the math content they have learned.	3.67	3.63	High
6.	often increasing their confidence in learning math by successfully solving a particular math problem.	3.59	1.19	High
7.	feeling a sense of accomplishment after solving complex math problems.	3.74	1.18	High
8.	motivating themselves when they encounter difficulties in solving complex math problems.	3.54	1.16	High
9.	taking effective ways to control their attention in math class when they have trouble in concentrating	3.35	1.17	Moderate
10.	always going back and checking the entire problem-solving process for any errors or omissions. After solving a math problem	3.75	1.19	High
11.	evaluating the learning outcomes in some way after a period of math learning	3.39	1.18	Moderate
	Category Mean	**3.55**	**.92**	**High**
	Overall Mean	**3.31**	**.77**	**Moderate**

Moreover, the present finding supports the observation of Rahmawati et al. (2025), who reported that many students experience moderate difficulty in translating mathematical problem into mathematical equation, which may affect the full manifestation of mathematical higher-order thinking skills. The results also indicate that students need to have more opportunities to engage in learning activities that promote deeper mathematical reasoning as supported by Utami et al. (2025) who found that instructional approaches such as problem-based learning enhance students mathematical higher-order thinking skills.

*Mathematical Critical Thinking***.** It showed that its category obtained a mean of 3.32 described as moderate with mean ratings of the of the individual items ranged from 2.84 to 4.18. Thus, the item *believing they have the ability to solve all types of math problems* had a mean of 2.84 while the item *always analyzing the question before answering it* has a mean rating of 4.18. Also, it is reflected that most of the standard deviations are greater than one implying that the respondents have varied levels of mathematical critical thinking level.

This means that the respondents sometimes manifest mathematical critical thinking skills in learning mathematics. They tend to analyze the mathematical questions first before answering it as reflected in the highest rated item on this category, indicating that the respondents generally recognize the important of understanding the problem before attempting to solve it. However, the lower rating item which is their belief that they can solve all types of mathematical problem suggest that some respondents still have lack of confidence in their mathematical ability, particularly when faced with challenging task.

The finding is comparable to the study by Jesto et al. (2025), who reported that the majority of teacher education students demonstrated an average level of mathematical critical thinking, while only smaller portion attained the high level. Their finding suggest that many students are capable of performing basic analysis but have not yet consistently demonstrated advanced reasoning and reflective judgement. Likewise, the present finding is consistent to the results reported by Aujero and Fuentebilla (2025) where students demonstrated a fairly satisfactory level of mathematical critical thinking. Their findings revealed that students possessed a reasonable understanding of concepts and critical abilities but still have room for improvement. This observation is similar to the present study where students exhibited a moderate level of mathematical critical thinking, suggesting further enhancement is needed to develop stronger and more consistent critical thinking skills.

This finding supports the argument of Zhou et al. (2024) that mathematical critical thinking involves thoughtfully in analyzing problems and applying established mathematical concepts to arrive at a logical and well-justified conclusion. The result is also consistent with the findings of Utami and Bharata (2022), who reported that students have difficulties analyzing and evaluating mathematical questions,

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

indicating that mathematical critical thinking of the students may still require further development. Moreover, Yumiati (2013) emphasized that mathematical critical thinking of the students is not innate ability to develop automatically but is cultivated through learning experiences that actively engage the students in analyzing, evaluating, and reflecting to the mathematical problem. Furthermore, the variation of critical thinking level of the students may be explained by their prior mathematical knowledge (Kania et al., 2023)

*Mathematical Creative Thinking***.** The results showed that the category had a mean of 3.18 interpreted as moderate. The mean ratings of the individual items ranging from 2.90 to 3.46. The item *asking new math questions in real life situations* has a mean of 2.90 while the *switching to other solution ideas when one method does not solve a math problem* has a weighted mean of 3.46. Also, the responses of the respondents vary as supported by the standard deviations of the items which are greater than one. This means that the respondents sometimes manifest mathematical creative thinking in learning mathematics. The respondents demonstrate moderate ability to generate alternative approaches and try different strategies when solving mathematical problems as reflected on the highest-rated level item finding another solution ideas when the method used does not work. However, the lower rating item on asking new math question in real life situations denotes that some students may have lower tendency to extend their mathematical thinking beyond school classroom task and apply creativity to dig deeper on their own mathematical inquiries.

This finding is in consonance to the study by Ibrahim et al. (2024), which revealed that the students make only about half percent of the score mark on mathematical creative thinking, indicating that although learners may demonstrate proficiency in mathematics, they still lack in creativity necessary to fully exhibited higher-order mathematical thinking. The finding is also supported by Puspitasari et al (2018), who found that while students with high mathematical ability to demonstrate fluency, flexibility, and originality in solving arithmetic problems, students with moderate and low abilities found difficult to understand mathematical problems and developing systematic solutions. This explains why the respondents showed only moderate level of mathematical creative thinking, as differences in mathematical ability can highly influence the capacity of the students to generate innovative approach on problem solving. Furthermore, Fatah et al. (2016) emphasized that mathematical creative thinking can be enhanced by providing open-ended learning approaches and appropriate scaffolding by the teachers.

*Mathematical Problem-Solving Skills***.** The mean rating of the different item ranges from 2.86 to 3.56 with a category mean of 3.21 described as moderate. The item *meticulously deducing complex mathematical reasoning processes* reflects a mean rating of 2.86, while the item *verifying that the answer is correct after the solution is complete* shows a weighted mean of 3.56. Notably, the ratings of the students also vary with standard deviations that are greater than one. The high rated item implies that the respondents recognize the importance of reviewing their work to identify possible errors and ensure accuracy to their solution. Such practice reflects a positive problem-solving behavior to not accept immediate answer but instead engage verification process before arriving at a final conclusion. In contrast, respondents encounter difficulties in analyzing intricate mathematical relationship, developing logical arguments required in more challenging task.

This finding is in support of the study by Barana et al. (2022), who reported that problem-solving skills development in mathematics enable students to critically reflect on their work, resulting to greater accuracy in performing mathematical problem-solving task. This is evident when students verify the correctness of answers after completing a solution which engage reflective practices. Moreover, the moderate level of mathematical problem-solving skills obtained in this study is consistent to the findings of Gosilk (2017), who found that students sometimes experience difficulties in solving mathematical problems, particularly those which require deeper analysis and reasoning.

*Mathematical Metacognitive Skills***.** As assessed by respondents, it has a high category mean of 3.55 with mean ratings of 3.32 to 3.76. Adding on, the item *generalizing from the solution of a specific problem*

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

has a mean rating of 3.32. Meanwhile, the item *being very aware of the math that goes into solving math problems* shows a mean of 3.76. This implies that the respondents are generally aware of their thinking processes when solving mathematical problems and are able to monitor and evaluate their understanding during activities. Adding on, it indicates that the students feel a sense of accomplishment after dealing with mathematical problem and confidence in learning mathematics successfully.

This result is in consonance with the findings of Guner and Erbay (2021), who reported that students with high level of mathematical metacognitive skills are more capable to solve mathematical problem correctly and through the use of appropriate strategies. The result is also supported by Van der Walt and Jagals (2016), who emphasized that strong metacognitive reflection enhances metacognitive awareness of the students that contributes to better problem-solving outcome. Furthermore, Erdogan and Sengul (2017) found that students who are able to used metacognitive strategies achieved higher level of metacognitive skills.

Level of School Classroom Engagement in Math

In Table 2, the level of school classroom engagement in math is presented. An overall mean of 3.50 described as high is shown, which means that school classroom engagement in math of the students is oftentimes demonstrated. This indicates that the respondents are generally active, attentive, and involved in their learning experiences in mathematics. They frequently participate in classroom activities, exert effort in accomplishing assignments and math lessons, and demonstrate positive attitude towards learning mathematics. The results further suggest that the students are cognitively engaged in understanding mathematical concepts, students seldom exhibit behaviors, thoughts and emotions, that distract their learning in mathematics. Adding on, the overall standard deviation of .71 indicated relatively low variability in the response of the respondents, suggesting that their ratings were generally consistent and tended to cluster around the mean. The finding affirms the view of Sen (2022), who reported that the students demonstrated a high level of engagement in mathematics, indicating that the learner possesses positive involvement in learning activities. Similarly, Abla and Fraumeni (2019) found that students show higher level of engagement when teachers employ supportive practices rather than controlling instructional approaches. Meanwhile, Capunong and Apohen (2026) reported a satisfactorily level of engagement in mathematics which implies that the students make use of learning strategies and able to understand concepts in mathematics. Furthermore, the findings are consistent with those from Aquino et al. (2024) who reported a high level of engagement among grade 11 students, showing strong involvement in thinking and participation in mathematics.

Table 2. *Level of School Classroom Engagement in Math*

	Mean	SD	Description
Cognitive Engagement			
1. identifying key information from any reading assignment on math lessons if given	3.76	.96	High
2. combining ideas from different courses to help complete math assignments.	3.47	.99	High
3. looking for chances to be part of math events that are related to things they are doing in their math class.	3.07	1.29	Moderate
4. looking for extra information, books or internet, to learn more about things they do in math classes.	3.50	1.18	High
5. asking themselves questions to make sure they understand what they are learning about when learning a new math lesson	3.71	1.15	High
6. summarizing the material, they learn in class or from other course materials.	3.51	1.07	High

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

7.	spending enough time and making enough effort to learn math.	3.48	1.21	High
8.	trying to connect different topics from course material when they are studying math lessons	3.34	1.18	Moderate
9.	preparing for math courses before going to class.	2.92	1.25	Moderate
10.	going back and reading over again if they do not understand what they are reading in math classes and looking it up, or discussing it with someone.	3.80	1.18	High
11.	looking for different ways to solve math problems.	3.51	1.11	High
	Category Mean	**3.46**	**.79**	**High**
Behavioral Engagement				
1.	keep trying even if something is hard math courses.	3.86	1.03	High
2.	putting effort into learning math individually and in groups.	3.71	1.05	High
3.	trying to do their best regarding my responsibilities in group work on math courses.	3.76	1.01	High
4.	working as hard as they can in math class.	3.69	1.08	High
5.	listening very carefully when they are in math classes	3.65	1.06	High
6.	enjoy learning new things about math.	3.58	1.20	High
7.	making sure to study on a regular basis math course.	3.29	1.17	Moderate
8.	taking good notes in class, on readings, and/or on video lectures.	3.63	1.14	High
	Category Mean	**3.65**	**.83**	**High**
Emotional Engagement				
1.	being motivated by their desire to learn math.	3.36	1.21	Moderate
2.	being very interested in learning mathematics.	3.29	1.22	Moderate
3.	making them curious to learn other things while learning math classwork	3.51	1.18	High
4.	feeling excited by the learning activities in their math classes.	3.24	1.19	Moderate
5.	feeling good when they are in math classes	3.01	1.15	Moderate
6.	finding ways to make math course interesting to them.	3.40	1.19	High
	Category Mean	**3.30**	**1.00**	**Moderate**
Emotional Disengagement				
1.	not caring about learning math.*	2.27	1.24	Low
2.	not wanting to be in math classes.*	2.22	1.30	Low
3.	often feeling down when they are in math classes.*	2.54	1.37	Low
4.	feeling bored when they are learning math.*	2.58	1.26	Low
	Category Mean *	**2.40**	**1.11**	**Low**
Cognitive Disengagement				
1.	only studying the easy parts when math work is hard*	3.21	1.25	Moderate
2.	being told the answer than having to master the procedure during math classes *	2.70	1.25	Moderate
3.	feeling disgusted when they are working on math classwork *	2.13	1.27	Low
	Category Mean *	**2.68**	**.96**	**Moderate**
Behavioral Disengagement				
1.	not trying to work very hard at math courses *.	2.24	1.11	Low
2.	doing irrelevant things when they are supposed to be paying attention in math classes *.	2.44	1.12	Low
3.	just acting as if they are working when they are in math class *..	2.24	1.20	Low

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

Category Mean *	**2.31**	**.96**	**Low**
Overall Mean	**3.50**	**.71**	**High**

Note: Items with asterisk were subjected to reverse coding before computing the overall mean.

*Cognitive Engagement***.** The rated mean of the different items ranges from 2.92 to 3.80 with a category mean of 3.46 described as high. The item *preparing for math courses before going to class* reflects a weighted mean rating of 2.92, while the item *going back and reading over again if they do not understand what they are reading in math classes and looking it up, or discussing it with someone* showed a weighted mean of 3.80. Moreover, the standard deviations which are mostly greater than one, indicate variations of responses of the respondents. This means that the respondents oftentimes demonstrated engagement in mathematics by actively monitor their understanding, reviewing learning materials, revisiting lessons, consulting available resources or other people when necessary, and seeking clarification whenever encounter difficulties.

This finding is in support of the study by Bedada et al. (2025), who reported that students exhibited a high level of cognitive engagement in mathematics, indicating that learners were participating willingly, motivated to work hard, and extending time in studying mathematics. Similarly, the high level of cognitive engagement observed in this study suggest that students actively invest mental effort in understanding mathematical concepts and are willingly to employ strategies that could enhance their learning. The finding also supports the concept presented by Skilling and Stylianides (2022) that cognitive engagement involves the use of self-regulatory strategies that enable learners to monitor their and regulate their thinking. Furthermore, the result is being consistent with the findings presented by Joshi et al. (2022), who reported that students maintained high level of cognitive engagement in mathematics when instruction was effectively structured.

*Behavioral Engagement***.** The rated mean of the items under this indicator ranges from 3.29 to 3.86 with a category mean of 3.65 described as high. The item *making sure to study on a regular basis math course* reflects a mean rating of 4.43, while the item *keeps trying even if something is hard math courses* shows a mean rating of 3.86. This finding is in parallel to that of Joshi et al. (2022), who revealed that students showed high level behavioral engagement in mathematics learning, supported by their active participation in learning task and consistent completion of their academic responsibilities. Similarly, the respondents in this study displayed also a high level of behavioral engagement. This implies that they frequently exert effort, actively participate, and persevere in complying all mathematics-related task.

This finding is in support of the study by Iji et al. (2018), who stated that there is a high level of behavioral engagement among students, reflected by their persistent effort to search for solutions, try alternative strategies, and revisit difficult problems. Along this line, the result supports the assertion of Hidayat et al. (2019) that behavioral engagement is manifested through observable action of the students to participate in learning activities, such as exerting effort, completing assignment, and trying their best being persistent through challenges. Furthermore, Hidayatullah et al. (2024) emphasized that motivation plays a significant role in strengthening behavioral engagement of the students. Therefore, the high level of behavioral engagement observed among the respondents suggest that they are very much involved and has willingness to accomplish mathematical task and overcome difficulties encountered.

*Emotional Engagement***.** It has garnered a moderate category mean rating of 3.30 and the mean ratings range from 3.01 to 3.51. Notably, the item *feeling good when they are in math class* has a mean rating of 3.01, while the item *finding ways to make math course interesting to them* shows a rating of 3.40. This implies that the respondents sometimes demonstrate emotional engagement and generally experience a positive feeling towards mathematics learning such as curiosity, interest, motivation, and enjoyment, although these emotions are not consistently manifested in all situation. The moderate category mean indicates that respondents occasionally develop positive emotional connections in mathematics and classroom activities, but there are instances that their enthusiasm and interest may decline. Overall, the

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

finding implies that while respondents exhibit a moderate level of emotional engagement, there is still a need to strengthen their interest, motivation, enjoyment, and positive feeling towards mathematics through engaging and meaningful learning experiences.

This finding is in support of the study by Bedada et al. (2025), who reported that students generally enjoy and understand mathematics learning. The result also being consistent with that of Joshi et al. (2022), who found that emotionally engaged students are tend to perform better academically because they feel more comfortable and interested in participating mathematics learning activities. Likewise, Hong et al. (2020) emphasized that emotional engagement plays an important role in mathematics learning.

*Emotional Disengagement***.** The weighted mean of 2.40 in this category is interpreted as low. The weighted mean of the individual items ranging from 2.22 to 2.58. The item not *wanting to be in math classes* reflects a mean rating of 2.22, while the item *feeling bored when they are learning math* show a mean rating of 2.58. This means that the respondents seldom demonstrate emotional disengagement in mathematics classes. The low category mean indicted that students generally do not experience strong negative emotions towards learning mathematics. The lowest mean rating of this category suggests that the students are willing to attend and participate in mathematics lesson.

This finding is in support of the study by Lewis (2013), who emphasized that low emotional attachment and interest in mathematics can lead to feelings of unimportance and lack of interest towards the subject, which directly develop into emotional disengagement and reduced academic persistence. Likewise, the results support the view of Schoenherr et al. (2025 that emotional disengagement is characterize by boredom, frustration, anxiety, and lack of interest. Since the respondents exhibited low level of emotional disengagement, it inferred that negative emotions are not commonly experienced by them. Furthermore, the finding is consistent with Anino and Ubalde (2025), who reported that emotional disengagement tends to increase when students perceive mathematics as anxiety-provoking, thereby reducing their willingness to engage in mathematical task.

*Cognitive Disengagement***.** It has garnered a moderate category mean rating of 2.68 and the mean ratings range from 2.13 to 3.21. Notably, the item *feels disgusted when they are working on math classwork* has a mean rating of 2.13, while the item *only studying the easy parts when math work is hard* shows a rating of 3.21. This implies that the respondents sometimes demonstrate cognitive disengagement in mathematics learning. The moderate category mean indicate that students occasionally employ less effective learning strategies when confronted with challenging mathematical task. They tend to avoid difficult portions of mathematics lesson and focus only on the easy part. Overall, this implies that while the respondents generally remain engaged in learning mathematics, they may occasionally withdraw cognitively when faced with challenging task by reducing their effort and avoiding more demanding topics of mathematics learning.

This finding is in support of the study by Berhanu and Moges (2025), who described cognitive disengagement as tendency of the students to reduce mental effort when facing with difficult learning task, often focusing only on easier parts of the lesson and preferring to received answers rather than learning the process themselves.

*Behavioral Disengagement Salary***.** As assessed by respondents, it has a low category mean of 2.31 with mean ratings of 2.24 to 2.44. Adding on, the items *not try to work very hard at math courses* and *just acting as if they are working when they are in math class* have the same mean rating of 2.24. Meanwhile, the item *doing irrelevant things when they are supposed to be paying attention in math classes* shows a mean of 2.44. This implies that the respondents seldom demonstrate behavioral disengagement in mathematics classes. The low category mean indicates that the respondents remain attentive, participating, and exerting effort in accomplishing mathematics related task.

Indeed, this result is in consonance of with the findings of Pham et al. (2022) and Wang et al. (2019), who identified behavioral disengagement as withdrawal of the students from learning task, reduced participation in classroom activities, inattentiveness, and avoidance of assigned work. While these studies

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

reported that there is a presence of behavioral disengagement among learners, the present study revealed a low level of behavioral disengagement. This indicates that such behavior is seldom manifested by the respondents. The results suggest that the learners generally remain attentive during mathematics classes, participate in learning activities, and exert effort in accomplishing assigned task rather than withdrawing and avoiding them.

Level of Mathematics Persistence

In table 3, it is shown that the overall mean of mathematics persistence of the respondents is 2.86 It is described as moderate, which meaning that the mathematics persistence of the students is sometimes evident. This means that the respondents occasionally demonstrate perseverance, determination, and sustained effort when facing with difficult mathematical task and challenges. They are generally willing to continue working on mathematical problems, seek assistance when necessary, and give effort to complete mathematics related activities, however, such persistence is not consistently displayed in all situation.

Also, this implies that while the students possess a moderate level or mathematics persistence, they may still encounter difficulties in maintaining their effort and commitment when faced with complex, time-consuming, and demanding mathematical task. Consequently, there is a need to further strengthen student resilience, confidence, and willingness to persist in solving mathematical problems so that they can more consistently overcome challenges and achieved success in mathematics learning. The overall standard deviation is .82 denoting that responses of the respondents are closer to the mean, indicating a reasonable level of consistency in their perception towards mathematics persistence. This finding supports the study by Asoy and Picaza (2025), who reported that there is a high level of mathematics persistence among higher education students, suggesting that learners commonly demonstrate perseverance when confronted with complex mathematical activities. Although, the present study revealed a moderate level of mathematics persistence, both findings highlight the presence of persistence as an important characteristic among the students in mathematics subject.

Table 3. *Level of Mathematics Persistence*

	Mean		SD	Description
	Persistence in Classroom Mathematics Exercise			
1.	not giving up solving difficult mathematical questions/exercises.	3.00	.81	Moderate
2.	keep taking difficult mathematics questions to their teachers/colleagues for assistance.	2.72	.85	Moderate
3.	always taking note of difficult mathematics exercises/questions in their textbooks and keep attempting them until they get the answers.	3.05	.82	Moderate
4.	being not discouraged by the length of the solutions to mathematical problems.	2.76	.79	Moderate
5.	having no limit on the number of times they attempt difficult questions in mathematics until they get correct answers.	2.88	.84	Moderate
6.	putting more effort in solving more difficult mathematics problems.	2.93	.87	Moderate
7.	waking up in the night to attempt some difficult mathematics topics.	2.31	.94	Low
8.	knowing that if they do not get the solutions to difficult mathematics questions immediately, they will definitely get them if they keep attempting.	2.86	.80	Moderate
9.	solving/studying mathematics for a long time without getting tired easily.	2.46	.95	Low

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

10.	start attempting difficult mathematics topics/exercises in their textbooks even before they are taught in classrooms.	2.46	.91	Low
11.	always completing mathematics assignments and submitting on time no matter their difficulty	2.97	.84	Moderate
12.	hardly stop attempting difficult mathematics exercises/questions.	2.65	.83	Moderate
13.	not getting discouraged for giving wrong answers to questions in mathematics lessons; they keep attempting.	2.94	.85	Moderate
	Category Mean	**2.77**	**.51**	**Moderate**
Persistence in Mathematics Take Home Assignment				
1.	obtaining correct answers to difficult mathematics questions after initial failed attempts.	2.99	.80	Moderate
2.	not giving up easily on difficult mathematics questions/exercises	2.92	.86	Moderate
3.	always achieving their targeted grades in mathematics no matter the challenges.	2.86	.86	Moderate
4.	not sleeping on time, in an attempt to get solutions to difficult mathematics questions/exercises.	2.40	.98	Low
5.	not having peace of mind if they do not get solutions to difficult mathematics exercises/questions.	2.78	.97	Moderate
	Category Mean	**2.79**	**.61**	**Moderate**
Persistence in a Group Mathematics Tasks				
1.	keep solving difficult mathematics questions even when my colleagues have given up.	2.74	.89	Moderate
2.	sacrificing their time and efforts to understand difficult topics in mathematics.	2.76	.91	Moderate
3.	keep discussing difficult mathematics exercises/topics with their classmates.	2.69	.91	Moderate
4.	having difficulties in learning mathematics cannot make them change their math career choice.	2.90	.90	Moderate
Category Mean		**2.77**	**.66**	**Moderate**
Persistence in Mathematics Examination				
1.	considering every difficult topic or question in mathematics as solvable if given enough attention and effort.	3.27	.78	Moderate
2.	getting good grade in mathematics is as a result of not giving up on difficult questions.	3.16	.83	Moderate
3.	not giving up easily on difficult topics in mathematics resulted to getting a good grade in mathematics	3.18	.82	Moderate
4.	taking seriously whenever their mathematics teachers advise them to study hard	3.05	.80	Moderate
5.	being always preoccupied with finding solutions to difficult mathematics questions or exercises.	2.80	.86	Moderate
6.	keep paying serious attention when difficult topics are being taught in their class.	3.16	.97	Moderate
	Category Mean	**3.10**	**.63**	**Moderate**
	Over-all Mean	**2.86**	**.82**	**Moderate**

Likewise, findings are in consonance with the study by Xiao and Sun (2021), who reported a high level of mathematics persistence among the respondents. Also, Ugpo et al. (2025) revealed that there is a high level of mathematics persistence among mathematics major in the Philippines. Although the present study only has a moderate level of mathematics persistence, the findings are being comparable by showing that mathematics persistent is evident among students.

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

Persistence in Classroom Mathematics Exercise. The mean ratings of the different items range from 2.31 to 3.05, which reflects a category mean of 2.77 described as moderate. Adding on, the item *waking up in the night to attempt some difficult mathematics topics.* shows a mean rating of 2.31 while the item *always taking note of difficult mathematics exercises/questions in their textbooks and keep attempting them until they get the answers* reflects a mean rating of 3.05.

This finding is an indication that the respondents sometimes demonstrate persistence when dealing with classroom mathematics exercises. The moderate category mean suggest that the students in general are willing to continue working on difficult mathematical question and give effort to understand challenging concepts, but this behavior is not consistently observed. The results indicate that the respondents tend to take notes of difficult mathematics exercises and continue attempting them until they arrive to the correct answer. However, it is also evident that students are less likely extend their effort beyond regular hours.

This finding corroborates the study by Asoy and Picaza (2025), who reported a moderate level of persistence in mathematics exercise among students. Similar to the present study, their findings revealed that students demonstrate persistence through repeated attempts in solving mathematics exercise, spending time to study the lesson, and continuing to word mathematical task amidst the hardship. The moderate level obtained in both studies suggest that persistence in mathematics exercises is evident but not totally consistent.

Furthermore, the present finding is comparable to that of Ugpo et al. (2025), who found a high level of persistence in mathematics exercise among math major students. Although the reported level in their study was way higher that the present study, both findings indicate that students continue in solving, taking notes, and not afford to give up easily when complex problems come. Likewise, the results of this study support the observation of Shen et al. (2016) that persistence in mathematics exercise is influenced by the student experiences with success and failure in mathematics. The moderate persistence showed by the respondents may reflect varied levels of confidence and willingness to maintain the effort exerted. In addition, the results align with that of Bettinger et al. (2018) which emphasized the role of student confidence in sustaining effort when solving hard type of mathematical questions.

*Persistence in Mathematics Take Home Assignment***.** As assessed by respondents, it has a moderate category mean of 2.79 with mean ratings of 2.40 to 2.99. Adding on, the item *not sleeping on time, in an attempt to get solutions to difficult mathematics questions/exercises has* a mean rating of 2.40. Meanwhile, the item *obtaining correct answers to difficult mathematics questions after initial failed attempts* shows a mean of 2.99. This implies that the respondents sometimes demonstrate persistence in completing take-home assignments, particularly when having difficulty on mathematical questions.

This result is in consistent with the findings of Asoy and Picaza (2025), who reported a moderate level of persistence among students. Similar to the present findings, their respondents demonstrated persistence in mathematics take home assignment by continuing to work on mathematical task, spending enough time studying complex lessons, and making repeated attempts to obtain the correct answers. The moderate level observed in both studies suggest that the students exhibit persistence in completing mathematics-related task, although such persistence have not consistently manifested in all situation.

Likewise, findings are comparable to those of Ugpo et al. (2025), who found a high level of persistence among math major students. Although they reported a high level of persistence, both findings indicate that students trying to continue working on difficult mathematical questions and strive to complete assigned task despite obstacles. Furthermore, the present result supports the observation to that of Shen et al. (2016) that student persistence in mathematics is influenced by their experiences with difficult exercises and past successes and failures. The finding is also consistent with Bettinger et al. (2018), who emphasized that confidence in mathematical capability encourage students to persist when solving challenging problem. Moreover, Mau (2017) highlights that persistence may vary because of different challenges and circumstances encountered by the learners. Taken together, these studies support the present finding that grade 10 students exhibit moderate level of persistence in mathematics take-home assignments, as reflected

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

by their willingness to continue working on difficult questions and obtain correct answer despite having unsuccessful attempts.

Persistence in a Group Mathematics Tasks. The mean ratings of the different items range from 2.69 to 2.90, which reflects a category mean of 2.77 described as moderate. Adding on, the item *keeps discussing difficult mathematics exercises/topics with their classmates* shows a mean rating of 2.69 while the item *having difficulties in learning mathematics cannot make them change their math career choice* reflects a mean rating of 2.90.

This finding is an indication that the respondents are moderately persistent when engage in mathematics activities that require interaction with their groupmates. The moderate level suggest that the respondents are generally willing to contribute their time and effort in understanding mathematical concepts and are able to remain committed despite challenges faced during group activities, although these behaviors are not consistently manifested. The results further show that respondents only sometimes discussing mathematics topic with peers and persist in solving complex mathematical task when working in groups. This pattern implies that while the respondents exhibit certain degree of perseverance, they may not always sustain active involvement when group mathematics task become demanding.

This finding corroborates the study by Ugpo et al. (2025), who reported a high level of persistence in group mathematics task among math major students. Their finding showed that students persist in collaborating with their groupmates when dealing with mathematical problems. Although, the present study revealed only moderate level of persistence, both findings suggest that students are willing to work with others and contribute in accomplishing group mathematics task. Similarly, the findings are consistent with those of Asoy and Picaza (2025), who found a high level of persistence in group mathematical task. They revealed that students demonstrated persistence by exerting effort to understand mathematical concept and continue to collaborate with their peers even when others are given up. Furthermore, the present finding is supported by Sofroniou and Poutos (2016), who emphasized the value of group mathematics task which help enhancing student understanding and analytical skills. They highlighted that collaborating with peers reduces the stress associated with solving mathematical problems and encourages students to remain engage in mathematics activities.

*Persistence in Mathematics Examination***.** The mean rating of the different items ranges from 2.80 to 3.27 with a category mean of 3.10 described as moderate. The item *being always preoccupied with finding solutions to difficult mathematics questions or exercises* reflects a mean rating of 2.80, while the *considering every difficult topic or question in mathematics as solvable if given enough attention and effort* shows a mean rating of 3.27. This finding is in parallel to that of Asoy and Picaza (2025), who reported a high level of persistence in mathematics examinations among the students. They revealed that learners tend to remain focused on difficult mathematical questions, continue exerting effort, and avoid giving up easily during examination. As it can be seen in this present study, the respondents sometimes manifested these behaviors when dealing with challenging mathematics examination items.

However, the present finding differs from the result of Ugpo et al. (2025), who reported very high level of persistence in mathematics examination among college students. The difference in findings may be attributed by the nature of respondents being involved, because their study focused on mathematics major students in higher education, whereas the present study focused only on grade 10 students. Nevertheless, the findings of Rajendran and Gopalasamy (2024) support the importance of persistence in mathematics examination, emphasizing that sustained effort and continues engagement contributed to the success in assessment situation.

Significance of the Relationship of Mathematical Higher Order Thinking, Classroom Engagement in Math, and Mathematics Persistence

The correlation of the variables is presented in Table 4. It is shown that Mathematical higher order thinking reflects a positive strong relationship on mathematics persistence with R-value .75 and a p-value of .00 which is lesser than the alpha set at .05, two- tailed supporting a significant relationship between

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

them. This means that students who reported higher level of mathematical higher-order thinking skills also tended to report higher levels of mathematics persistence. It is reflected by the ability of the students to monitor their understanding, checking solutions, evaluates their learning outcomes, facing challenging mathematics examination topics, and recognizing that difficult problems could be solved though sufficient attention and effort. This also shows that the capability of the students to think critically, explore different solution strategies, solve mathematical problems, and regulate their own learning is associated with their willingness to persevere when confronted with mathematical difficulties.

Table 4. *Significance of Relationship of Mathematical Higher Order Thinking, Classroom Engagement in Math, and Mathematics Persistence*

	r	p-value	Remarks
Mathematical Higher Order Thinking and Mathematics Persistence	.75	.00	Significant
Classroom Engagement in math and Mathematics Persistence	.69	.00	Significant

It corroborates with the study by Ugpo et al. (2025) which revealed that metacognitive awareness, a component of mathematical higher-order thinking
skills significantly predict mathematics persistence. Moreover, the results
support their view that higher-order thinking skills, including mathematical problem-solving, critical thinking, creative thinking, and metacognitive skills play an essential role in developing student persistence in mathematics because these skills enable learners to analyze situation, reflect on their thinking, and overcome challenges encountered.

Consequently, the classroom engagement reveals a significant positive strong relationship on mathematics persistence ($r = .69$, $p < .05$). It means that as the level of classroom engagement increases the level of Mathematics persistence significantly increases. It implies that students who demonstrate higher levels of mathematical higher-order thinking skills are more likely to persist when faced with challenging mathematical activities. As students become more capable of analyzing, evaluating, creating, and monitoring their mathematical thinking, they also become more willing to continue working on difficult problems even facing hardships. Likewise, students who exhibit higher level of classroom engagement in mathematics tend to show greater persistence, as they are more actively involved cognitively, behaviorally, emotionally, and metacognitively in mathematics learning. These findings suggest that both mathematical higher-order thinking skills and classroom engagement serve as important factors in strengthening mathematical persistence.

Furthermore, the significant relationship between classroom engagement in math and mathematics persistence is supported by Pinugu (2021), who highlighted that classroom engagement significantly mediates student persistence. Similarly, Jung and Lee (2018) found that learning engagement has indirect effects on learning persistence, suggesting that students who are actively engaged in learning are more likely to sustain effort. In addition, Zeng and Xin (2024) revealed that engagement and persistence are closely linked, with engagement serving as mediator which enhance persistence.

Significance of the Influence of Mathematical Higher Order Thinking, Classroom Engagement in Math on Mathematics Persistence

In Table 5, the results of the multiple regression analysis are presented. When examined independently, mathematical higher order thinking was found to be significant predictor of student mathematics persistence as indicated by a p-value of .00 which is less than .05 level of significance (2-tailed) and a positive standardized beta value ($\beta = .51$). This indicates that students who demonstrate stronger mathematical higher-order thinking tend to exhibit greater persistence in completing mathematics

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

activities and understanding difficult topics in math.

Table 5. *Significance of the Influence of Mathematical Higher Order Thinking, Classroom Engagement in Math on Mathematics Persistence*

Singular Influence of the Predictors	Standardized Coefficients	t	p-value	Remarks
Mathematical Higher Order Thinking	.51	7.01	.00	Significant
Classroom Engagement in Math	.33	4.58	.00	Significant
Combined Influence of the Predictors				
R	.78			
R^2	.61			
F	114.49			
P	.00			
Remarks	Significant			

This finding is supported by Ugpo et al. (2025), who demonstrated that metacognitive awareness a key component of mathematical higher-order thinking skills significantly predicted persistence of the students in solving mathematical problems. Similarly, Sajiman et al. (2024) reported a significant influence of mathematical higher-order thinking skills on persistence, particularly through problem-solving. These present findings support the view that stronger mathematical higher-order thinking skills contribute to the persistence of the students in mathematics learning.

Likewise, the independent variable, classroom engagement in math is reflected with a positive standardized beta value of 0.33 and a p-value of .00 which is less than the .05 level of significance, 2-tailed. It means that classroom engagement in math is a significant predictor of mathematics persistence of students. This indicates that as the level of classroom engagement in math of the students increases, their level of mathematics persistence is likely to increase by 0.33.In addition, the combined influence of the two independent variables, mathematical higher order thinking, and classroom engagement in math, on the mathematics persistence of students is significant ($p < .05$). Meanwhile, the model explains 61% variance of the mathematics persistence based on the combined influence of the two independent variables included in this study as indicated by the coefficient of determination ($R^2 = .61$). This means that the two variables jointly account for 61% of the variability in mathematics persistence of the students, while the remaining 39% may be attributed to other factors aside from mathematical higher order thinking, and classroom engagement in math.

These findings are significant as it demonstrates that both mathematical higher-order thinking and classroom engagement in mathematics are important predictors of student mathematics persistence. The results indicate that mathematical higher-order thinking has a stronger predictive influence on mathematics persistence compared to classroom engagement in mathematics, as reflected by its higher standardized beta coefficient. This suggests that students who possess stronger abilities in mathematical critical thinking, creative thinking, problem-solving, and metacognitive skills are more likely to persevere when faced with challenging mathematical tasks. Likewise, students who are actively engaged cognitively, behaviorally, and emotionally in mathematics learning are more likely to sustain their effort and commitment in completing mathematical activities.

Moreover, the results of the present study are supported by Ugpo et al. (2025), who found that metacognitive awareness was significantly and positively related to persistence in mathematical problem-solving and explained a substantial proportion of its variance. This finding provides relevant support for the predictive contribution of mathematical higher-order thinking skills, particularly metacognitive skills, which enable students to plan, monitor, and regulate their thinking when confronted with complex

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

mathematical problems.

Finally, the results of the study support the theories anchored in this investigation, the Self-Determination Theory (SDT) of Deci and Ryan (2000) and the Three-Dimensional Model of Student Engagement of Fredricks, Blumenfeld, and Paris (2004). The significant influence of mathematical higher-order thinking on mathematics persistence provides empirical support for SDT, particularly the concept of competence. The findings of this study suggest that students who possess stronger mathematical critical thinking, creative thinking, problem-solving, and metacognitive skills are more likely to persist in mathematics because these abilities enhance their confidence in dealing with challenging mathematical tasks. As students become more competent in analyzing and solving problems, they are more likely to sustain effort and remain resilient when confronted with difficulties, which is consistent with the propositions of SDT.

Likewise, the significant influence of classroom engagement in math on mathematics persistence supports the Three-Dimensional Model of Student Engagement. The findings indicate that students who are cognitively engaged through active thinking and learning strategies, behaviorally engaged through participation and effort, and emotionally engaged through interest and positive feelings toward mathematics are more likely the one to demonstrate persistence in mathematical tasks. This validates the assertion of the theory that engagement is a multidimensional construct that contributes to student continued involvement and commitment to learning.

Furthermore, the combined influence of mathematical higher-order thinking and classroom engagement on mathematics persistence strengthens the integration of the two theories. The substantial proportion of variance explained by the model suggests that persistence in mathematics is shaped not only by student cognitive capabilities but also by their level of engagement in the learning process. Consequently, the findings affirm the theoretical proposition that students who possess strong higher-order thinking skills and who remain cognitively, behaviorally, and emotionally engaged are more likely to persevere in mathematics despite encountering difficult concepts, complex problems, and academic challenges.

Findings

The following were the summary of the findings:

1. The status mathematics higher-order thinking skills of grade 10 students were found to be moderate, by having an overall mean of 3.31 and a standard deviation of 0.77. Of all indicators, mathematical metacognitive skills obtained a high-level mean of 3.55 while the indicators mathematical critical thinking, mathematical problem-solving, and mathematical creative thinking obtained moderate level with means of 3.32, 3.18, and 3.21, respectively, signifying that these indicators were only sometimes manifested by grade 10 students.
2. The level of school classroom engagement in math among grade 10 students were high, as indicated by an overall rated mean of 3.50 and a standard deviation of 0.71. Specifically, behavioral engagement and cognitive engagement were rated high with means of 3.65 and 3.46 respectively. Meanwhile, emotional engagement and cognitive disengagement were rated moderate having means of 3.30 and 2.68 respectively. In terms of disengagement, emotional disengagement and behavioral disengagement were rated low with means of 2.40 and 2.31.
3. The level of mathematics persistence among grade 10 students were rated as moderate with an overall rated mean of 2.86 and a standard deviation of 0.82. Among its indicators, persistence in mathematics examination got the highest weighted mean of 3.10 while the indicators persistence in classroom mathematics exercises, persistence in mathematics take-home assignments, and persistence in group mathematics task has only obtained moderate level with means of 2.77, 2.79, and 2.77 respectively.
4. A significant positive relationship was found between mathematical higher-order thinking skills and mathematics persistence with correlation coefficient of $r = 0.75$ and $p < 0.00$. Likewise, a significant positive relationship was found between school classroom engagement in math and mathematics

ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 11 (November 2026)

persistence with a correlation coefficient of r = 0.69 and p < 0.00.

5. The result of the regression analysis revealed that both mathematical higher-order thinking skills and school classroom engagement in mathematics significantly influences mathematics persistence. Mathematical higher-order thinking skills emerged to have a stronger predictor ($\beta = 0.51, p < 0.00$) compared to school classroom engagement in math ($\beta = 0.33, p < 0.00$). Furthermore, the regression model was significant ($R^2 = 0.61, F = 114.49, p < 0.00$).

CONCLUSIONS

The following conclusions were formulated based on the findings of the study:

1. The grade 10 students demonstrated a moderate level of mathematical higher-order thinking skills, this means that their abilities in mathematical critical thinking, creative thinking, problem-solving, and metacognitive skills were not fully developed. However, their higher metacognitive skills level suggest that students are generally aware and able to regulate their thinking processes when solving mathematical problems.
2. The grade 10 students exhibited a high level of school classroom engagement in math, this means that they are actively involved in mathematics learning though cognitive and behavioral participation. Furthermore, the low levels of emotional and behavioral disengagement suggest that most of the students maintain a positive involvement and avoid withdrawal behaviors in mathematics classes.
3. The grade 10 students manifested a moderate level of mathematics persistence, this means that they sometimes demonstrate determination and sustained effort when faced with difficult mathematical task. This suggests that while students show willingness to persevere, there remains room for strengthening their persistence across classroom exercises, take-home assignments, group task and examinations.
4. Mathematical higher-order thinking skills and school classroom engagement in mathematics were both significantly related to mathematics persistence. Therefore, students who possess stronger higher-order thinking skills and greater engagement in mathematics classes are more likely to persist in solving challenging mathematical problems and completing mathematical task.
5. Mathematical higher-order thinking skills and school classroom engagement in mathematics significantly influence mathematics persistence. Hence, improving student higher-order thinking skills and enhancing their engagement in mathematics classes can contribute substantially to strengthening their persistence in mathematics. Among the two predictors, mathematical higher-order thinking skills exerted the greater influence on mathematics persistence.

Recommendations

Based on the findings and conclusions of the study, the following recommendations were suggested:

1. Since the mathematical higher-order thinking skills of the students were found to be moderate, it is important for mathematics teachers to further enhance these skills through learning experiences that require critical thinking, creativity, problem-solving, and metacognitive reflection. The teachers may employ problem-based learning, inquiry-based activities, open ended mathematical task, and reflective exercises that encourage students to explain their reasoning, evaluate solutions, ang provide alternative strategies.
2. Although the level of school classroom engagement in math was found to be high, it has not yet reach to the highest possible. In this regard, teachers may continue to strengthen student engagement by creating an interactive and learner-centered classroom environments. This may be achieved through collaborative learning activities, mathematical investigations, technology-assisted instruction, and real-life applications of mathematical concepts. Moreover, teachers may provide opportunities for students to actively participate is discussion and decision-making process related to learning activities to sustain their cognitive, behavioral, and emotional engagement.
3. The mathematics persistence of the students was found to have a moderate level, indicating that there

still considerable room for improvement. Mathematics teachers may implement strategies that encourage students to persevere when struggled with mathematical task. Such strategies may include providing progressively challenging exercises, encouraging multiple solutions methods, offering constructive feedback, recognizing student effort, and promoting growth mindset. Teachers may also provide opportunities for students to shortly reflect on how persistence contributes to success in mathematics learning.

4. Considering that mathematical higher-order thinking skills and school classroom engagement in math were found to significantly influence mathematics persistence, school administrators and educators are encouraged to support and develop programs and initiatives that simultaneously strengthen these variables. Professional development programs, workshops, and learning communities may be conducted to help teachers be equip with effective instructional strategies that promote higher-order thinking and active engagement. These initiatives may help foster the development of students who are already persistent in learning mathematics and be prepared to solve complex mathematical problems.
5. Future researchers may investigate other factors that possible influence mathematics persistence among students, factors such as mathematics self-efficacy, mathematics anxiety, academic motivation, parental support, learning strategies, and classroom climate. Future studies may also employ qualitative, mixed-methods, and experimental research design to develop a deeper understanding of mathematics persistence. Furthermore, conducting similar studies in different level of educational settings and among different groups may provide broader insights and contribute to designing more effective interventions in improving mathematics persistence.

REFERENCES

Abdullah, A., Abd Rahman, A., & Hamzah, M. (2017). Metacognitive skills of Malaysian students in non-routine mathematical problem solving. *Bolema: Mathematics Education Bulletin*, *31*(57), 295–315. https://doi.org/10.1590/1980-4415v31n57a15

Abla, C., & Fraumeni, B. R. (2019). *Student engagement: Evidence-based strategies to boost academic and social-emotional results*. McREL International.

Alpaslan, M. M., & Ulubey, O. (2021). Examining the relations between emotions, motivation, classroom engagement and achievement in mathematics. *International Journal of Research in Education and Science*, *7*(4), 1042–1057. https://doi.org/10.46328/ijres.1953

Anino, M. P., & Ubalde, M. V. (2025). Socio-emotional learning skills in mathematics: A systematic literature review. *Journal of Innovations in Teaching and Learning*, *5*(1), 44–48. https://doi.org/10.12691/jitl-5-1-7

Anyakamunelechi, O., Nkeiruka, N., Uzman, A., & Chima, N. (2025). Effect of immediate feedback strategy on the mathematics task-persistence and self-efficacy belief of low achieving students: Implication for educational managers in the need for socio-economic development. *Educational Administration: Theory and Practice*, *31*(2), Article 10781. https://doi.org/10.53555/kuey.v31i2.10781

Aquino, R. M., Buen, M. T., & Calantas, E. J. (2024). Understanding STEM learners: Engagement and success in mathematics. *Antorcha: The Official Research Journal of Undergraduate Students*, *10*(1).

Asoy, N. E. M. P., & Picaza, N. R. R. (2025). Persistence, self-efficacy, and achievement in mathematics. *EPRA International Journal of Multidisciplinary Research (IJMR)*, 583–593. https://doi.org/10.36713/epra20603

Aujero, L., & Fuentebilla, R. (2025). Structured approach in critical thinking skills and mathematics anxiety of grade 12 STEM students of Isulan National High School. *International Journal of Research and Innovation in Social Science*, *9*, 260–269. https://doi.org/10.47772/IJRISS.2025.90400021

Barana, A., Boetti, G., & Marchisio, M. (2022). Self-assessment in the development of mathematical problem-solving skills. *Education Sciences*, *12*(2), Article 81. https://doi.org/10.3390/educsci12020081

Bedada, T., Machaba, F., & Kuona, G. (2025). Grade 11 learners' views on their engagement with mathematics through mathematical modelling. *Eurasia Journal of Mathematics, Science and Technology Education*, *21*, Article 16514. https://doi.org/10.29333/ejmste/16514

Berhanu A., S., & Moges, B. (2025). Development and validation of a secondary school classroom engagement instrument in math and science in the Ethiopian context. *Frontiers in Psychology*, *16*, Article 1491615. https://doi.org/10.3389/fpsyg.2025.1491615

Bettinger, E., Ludvigsen, S., Rege, M., Solli, I. F., & Yeager, D. (2018). Increasing perseverance in math: Evidence from a field experiment in Norway. *Journal of Economic Behavior & Organization*, *146*, 1–15. https://doi.org/10.1016/j.jebo.2017.11.032

Bhuvanasri, P., Agarwal, D., & Sai Sreelekha, U. (2025). Research designs in quantitative, qualitative and mixed methods. *International Journal of Research and Analytical Reviews (IJRAR)*.

Cagulada, J. B. P., & Ucang, J. T. (2025). The relationship between mathematical disposition and academic performance among junior high school students. *Ignatian International Journal for Multidisciplinary Research*, *3*(5), 344–356. https://doi.org/10.5281/zenodo.15389178

Caminse, A., Cadal, J., & Yurango, C. (2025). A quantitative study on 21st-century learning skills and mathematical identity of math majors. *Asian Journal of Education and Social Studies*, *51*(6), 1481–1487. https://doi.org/10.9734/ajess/2025/v51i62090

Capunong, M., & Apohen, S. (2026). Engagement, attitude and mathematics performance of marine engineering students. *International Journal of Research and Innovation in Social Science*, *10*(8). https://doi.org/10.47772/IJRISS.2026.100800575

DiNapoli, J. (2023). Distinguishing between grit, persistence, and perseverance for learning mathematics with understanding. *Education Sciences*, *13*(4), Article 402. https://doi.org/10.3390/educsci13040402

Durksen, T. L., Way, J., Bobis, J., & Anderson, J. (2017). Motivation and engagement in mathematics: A qualitative framework for teacher-student interactions. *Mathematics Education Research Journal*, *29*, 163–181. https://doi.org/10.1007/s13394-017-0199-1

Dyah Prastiti, T. (2020). Problem-based learning on the learning perseverance of Indonesian senior high school students in solving mathematical problems. *Bolema: Mathematics Education Bulletin*, *34*, 1206–1220. https://doi.org/10.1590/1980-4415v34n68a17

Erdogan, F., & Sengul, S. (2017). The effect of cooperative learning method enhanced with metacognitive strategies on students' metacognitive skills in math course. *Eğitim ve Bilim*, *42*(192). https://doi.org/10.15390/EB.2017.6492

Fairman, J., Feng, M., & Roschelle, J. (2025). Teachers' use of learning analytics data from students' online math practice assignments to better focus instruction. *Digital Experiences in Mathematics Education*, 1–27. https://doi.org/10.1007/s40751-025-00170-3

Fatah, A., Suryadi, D., Sabandar, J., & Turmudi, T. (2016). Open-ended approach: An effort in cultivating students' mathematical creative thinking ability and self-esteem in mathematics. *Journal on Mathematics Education*, *7*(1), 9–18. https://doi.org/10.22342/jme.7.1.2813.9-18

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, *74*(1), 59–109. https://doi.org/10.3102/00346543074001059

Frenzel, J.-M., Lampen, C. E., & Brodie, K. (2019). Learners' awareness of their emotions and their engagement with mathematics tasks in a mathematics club. *Journal of Education*, *77*, 45–66. https://doi.org/10.17159/2520-9868/i77a03

Ghanad, A. (2023). An overview of quantitative research methods. *International Journal of Multidisciplinary Research and Analysis*, *6*(8). https://doi.org/10.47191/ijmra/v6-i8-52

Goh, T. (2025). Learning management system log analytics: The role of persistence and consistency of engagement behaviour on academic success. *Journal of Computers in Education*. https://doi.org/10.1007/s40692-025-00358-x

Gosilk, B. (2017). Modular approach in teaching problem solving: A metacognitive process. *International Journal of Science and Research (IJSR)*, *6*(8), 670–677. https://doi.org/10.21275/ART20175782

Güner, P., & Erbay, H. (2021). Metacognitive skills and problem-solving. *International Journal of Research in Education and Science (IJRES)*, *7*(3), 715–734. https://doi.org/10.46328/ijres.1594

Hidayat, D., Kim, T., Listiani, T., & Setianingsih, A. R. (2019). Adolescence student behavioral engagement in mathematics class. *Jurnal Pendidikan Indonesia*, *8*(2), 244–254. https://doi.org/10.23887/jpi-undiksha.v8i2.16927

Hidayatullah, A., Abidin, R., & Muqit, A. (2024). Motivation and behavioral engagement: The mediating role of mathematics self-efficacy in primary education. *Journal on Efficiency and Responsibility in Education and Science*, *17*(3), 237–246. https://doi.org/10.7160/eriesj.2024.170306

Hong, W., Zhen, R., Liu, R., Wang, M., Ding, Y., & Wang, J. (2020). The longitudinal linkages among Chinese children's behavioural, cognitive, and emotional engagement within a mathematics context. *Educational Psychology*, *40*(5), 1–15. https://doi.org/10.1080/01443410.2020.1719981

Hyoduk, K., & Ortega-Dela Cruz, R. A. (2024). Contributing and hindering factors of learner's persistence in a free basic education. *Multidisciplinary Journal for Education, Social and Technological Sciences*, *11*(1), 20–40. https://doi.org/10.4995/muse.2024.20173

Ibrahim, I., Khalil, I., & Prahmana, R. (2024). Mathematics learning orientation: Mathematical creative thinking ability or creative disposition? *Journal on Mathematics Education*, *15*(1), 253–276. https://doi.org/10.22342/jme.v15i1.pp253-276

Iji, C., Abah, J., & Anyor, J. (2018). Educational cloud services and the mathematics confidence, affective engagement, and behavioral engagement of mathematics education students in public universities in Benue State, Nigeria. *Journal of Education and Practice*, *9*(30).

Imms, W., & Byers, T. (2017). Impact of classroom design on teacher pedagogy and student engagement and performance in mathematics. *Learning Environments Research*, *20*, 139–152. https://doi.org/10.1007/s10984-016-9210-0

Jailani, J., Sugiman, S., & Apino, E. (2017). Implementing the problem-based learning in order to improve the students' HOTS and characters. *Jurnal Riset Pendidikan Matematika*, *4*(2), 247–259. https://doi.org/10.21831/jrpm.v4i2.17674

Jang, H., Kim, E., & Reeve, J. (2016). Why students become more engaged or more disengaged during the semester: A self-determination theory dual-process model. *Learning and Instruction*, *43*, 27–38. https://doi.org/10.1016/j.learninstruc.2016.01.002

Jansen, A., Curtis, K., Mohammad Mirzaei, A., & Wagner, L. (2023). Secondary mathematics teachers' descriptions of student engagement. *Educational Studies in Mathematics*, *113*, 425–442. https://doi.org/10.1007/s10649-023-10228-x

Jesto, M. B., Balandra, C. B., & Miranda, A. T. (2025). Critical thinking skills and mathematics performance of teacher education students. *Asian Journal of Education and Social Studies*, *51*(10), 477–487. https://doi.org/10.9734/ajess/2025/v51i102508

Joshi, D. R., Adhikari, K. P., Khanal, B., Khadka, J., & Belbase, S. (2022). Behavioral, cognitive, emotional and social engagement in mathematics learning during COVID-19 pandemic. *PLOS ONE*, *17*(11), Article e0278052. https://doi.org/10.1371/journal.pone.0278052

Jung, Y., & Lee, J. (2018). Learning engagement and persistence in massive open online courses (MOOCs). *Computers & Education*, *122*, 9–22. https://doi.org/10.1016/j.compedu.2018.02.013

Kamid, K., Kurniawan, D., Perdana, R., Widodi, B., Triani, E., Yathasya, D., & Fadillah, P. (2023). The persistence character and math processing skills of elementary school students in thematic learning. *Jurnal Ilmiah Sekolah Dasar*, *7*(3), 363–373. https://doi.org/10.23887/jisd.v7i2.55094

Kania, N., Fitriani, C., & Bonyah, E. (2023). Analysis of students' critical thinking skills based on prior knowledge mathematics. *International Journal of Contemporary Studies in Education*, *2*(1), 49–58. https://doi.org/10.56855/ijcse.v2i1.248

Kosova, R., Sina, Z., Kapçiu, R., & Kosova, A.-M. (2024). Extending math and coding education beyond the classroom: Projects, assignments, and independent research. *International Journal of Advanced Natural Sciences and Engineering Researches*, *8*, 268–273.

Lewis, G. (2013). Emotion and disaffection with school mathematics. *Research in Mathematics Education*, *15*(1), 74–90. https://doi.org/10.1080/14794802.2012.756636

Lewis, K. L., Stout, J. G., Finkelstein, N. D., Pollock, S. J., Miyake, A., Cohen, G. L., & Ito, T. A. (2017). Fitting in to move forward: Belonging, gender, and persistence in the physical sciences, technology, engineering, and mathematics (pSTEM). *Psychology of Women Quarterly*, *41*(4), 420–436. https://doi.org/10.1177/0361684317720186

Lu, Y., Supriya, K., Shaked, S., Simmons, E. H., & Kusenko, A. (2025). Incentivizing supplemental math assignments and using AI-generated hints is associated with improved exam performance. *Physical Review Physics Education Research*, *21*(1), Article 010160. https://doi.org/10.1103/v93w-ytyc

Madrilejos, K. (2025). Structural equation model of students' interest, motivation, self-efficacy, persistence, and perceived teaching quality in mathematics. *Journal of Interdisciplinary Perspectives, 3*. https://doi.org/10.69569/jip.2024.0698

Mau, W.-C. (2016). Characteristics of US students that pursued a STEM major and factors that predicted their persistence in degree completion. *Universal Journal of Educational Research*, *4*(6), 1495–1500. https://doi.org/10.13189/ujer.2016.040630

Miele, D. B., Browman, A. S., Shen, C., Vasilyeva, M., & Tyumeneva, Y. A. (2022). Domain-general and math-specific self-perceptions of perseverance as predictors of behavioral math persistence. *Journal of Experimental Education*, *90*(3), 593–614. https://doi.org/10.1080/00220973.2020.1799312

Nugroho, A. A., Nizaruddin, N., Dwijayanti, I., & Tristianti, A. (2020). Exploring students' creative thinking in the use of representations in solving mathematical problems based on cognitive style. *Journal of Research and Advances in Mathematics Education (JRAMathEdu)*, *5*(2), 202–217. https://doi.org/10.23917/jramathedu.v5i2.9983

Ogbu, S., & Ugwu, F. C. (2023). Development and validation of mathematics persistence scale for secondary school students. *International Electronic Journal of Mathematics Education*, *18*(4), Article em0756. https://doi.org/10.29333/iejme/13742

Oppmann, M., & Reinhold, F. (2023). Motivational and emotional engagement mediates the effect of features of educational technology in mathematics classrooms. *Frontiers in Education*.

Osman, S., Yang, C., Abu, M., Ismail, N., Jambari, H., & Kumar, J. A. (2018). Enhancing students' mathematical problem-solving skills through bar model visualisation technique. *International Electronic Journal of Mathematics Education*, *13*(3), 273–279. https://doi.org/10.12973/iejme/3919

Owusu-Darko, I., Ansah-Hughes, W., & Akpalu, R. (2017). Students' emotional dispositional empathy on mathematical engagement and their performance. *European Journal of Alternative Education Studies*, *2*(2). https://doi.org/10.46827/ejae.v0i0.555

Pasani, C., & Suryaningsih, Y. (2021). Analysis of students' higher order thinking skills (HOTS) ability in matrix subjects. *Journal of Physics: Conference Series*, *1760*, Article 012039. https://doi.org/10.1088/1742-6596/1760/1/012039

Pham, T., Vu, D., & Dinh, V. (2022). The impact of academic aspect quality on student disengagement in higher education. *Education Sciences*, *12*(8), Article 507. https://doi.org/10.3390/educsci12080507

Pinugu, J. J. (2021). *Examining academic persistence of students in challenging programs: A personal investment theory perspective* [Doctoral dissertation, De La Salle University]. DLSU Animo Repository. https://animorepository.dlsu.edu.ph/etd_counseling/2

Pratama, G. S., & Retnawati, H. (2018). Urgency of higher order thinking skills (HOTS) content analysis in mathematics textbook. *Journal of Physics: Conference Series*, *1097*(1), Article 012147. https://doi.org/10.1088/1742-6596/1097/1/012147

Puspitasari, L., In'am, A., & Syaifuddin, M. (2018). Analysis of students' creative thinking in solving arithmetic problems. *International Electronic Journal of Mathematics Education*, *14*(1), 33–43. https://doi.org/10.12973/iejme/3962

Qudwatullathifah, R., Maharani, A., & Miftahurrohmah, C. (2025). Students engagement in learning mathematics with the academic performance of elementary school. *Klasikal: Journal of Education, Language Teaching and Science*, *7*(2), 708–715. https://doi.org/10.52208/klasikal.v7i2.1304

Rahman, A., Rusnayati, H., & Muslim, M. (2021). Analysis of the characteristics of higher order thinking skills (HOTS) test on momentum and impulse for senior high school student using item response theory. *Jurnal Penelitian Fisika dan Aplikasinya (JPFA)*, *11*(2), 127–137. https://doi.org/10.26740/jpfa.v11n2.p127-137

Rahmawati, A., Sa'dijah, C., & Sudirman, S. (2025). Exploring high school students' mathematical representation abilities: Translation from verbal to symbolic using higher-order thinking skills. *TEM Journal*, *14*(3), 2442–2453. https://doi.org/10.18421/TEM143-48

Rahmawatiningrum, A., Kusmayadi, T. A., & Fitriana, L. (2019). Student's ability in solving higher order thinking skills (HOTS) mathematics problem based on learning achievement. *Journal of Physics: Conference Series*, *1318*, Article 012090. https://doi.org/10.1088/1742-6596/1318/1/012090

Rajendran, R., & Gopalasamy, R. (2024). Math skills as a key determinant of success in competitive exams. *International Journal of Emerging Knowledge Studies*, *3*(7), 387–390. https://doi.org/10.70333/ijeks-03-07-032

Reinhold, F., Hoch, S., Schiepe-Tiska, A., Strohmaier, A., & Reiss, K. (2021). Motivational and emotional orientation, engagement, and achievement in mathematics: A case study with one sixth-grade classroom working with an electronic textbook on fractions. *Frontiers in Education*, *6*, Article 588472. https://doi.org/10.3389/feduc.2021.588472

Riazy, S., Simbeck, K., Traeger, M., & Woestenfeld, R. (2021). The effect of prior knowledge on persistence, participation and success in a mathematical MOOC. In H. C. Lane, S. Zvacek, & J. Uhomoibhi (Eds.), *Computer Supported Education* (Vol. 1473, pp. 450–472). Springer. https://doi.org/10.1007/978-3-030-86439-2_21

Ridwan, M. R., Retnawati, H., Hadi, S., & Jailani. (2021). The effectiveness of innovative learning on mathematical problem-solving ability: A meta-analysis. *International Journal of Research in Education and Science (IJRES)*, *7*(3), 910–932. https://doi.org/10.46328/ijres.2287

Rivas, S. F., & Saiz, C. (2016). The effects of teaching critical thinking persist over time. *Journal of Education and Human Development*, *5*(1), 1–17. https://doi.org/10.15640/jehd.v5n1a24

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Sachdeva, S., & Eggen, P.-O. (2021). Learners' critical thinking about learning mathematics. *International Electronic Journal of Mathematics Education*, *16*(3), Article em0644. https://doi.org/10.29333/iejme/11003

Sajiman, S., Sumaryati, H., Suryana, A., & Rahmawati, E. (2024). Correlational study of mathematical problem-solving ability of vocational high students based on self-persistence. *International Journal of Research and Innovation in Social Science*, *VIII*, 2382–2387. https://doi.org/10.47772/IJRISS.2024.805172

Schoenherr, J., Schukajlow, S., & Pekrun, R. (2025). Emotions in mathematics learning: A systematic review and meta-analysis. *ZDM–Mathematics Education*, *57*(4), 603–620. https://doi.org/10.1007/s11858-025-01651-w

Sen, E. O. (2022). Middle school students' engagement in mathematics and learning approaches: Structural equation modelling. *Pedagogical Research*, *7*(2), Article em0124. https://doi.org/10.29333/pr/11908

Shen, C., Miele, D. B., & Vasilyeva, M. (2016). The relation between college students' academic mindsets and their persistence during math problem solving. *Psychology in Russia: State of the Art*, *9*(3), 38–56. https://doi.org/10.11621/pir.2016.0303

Skilling, K., & Stylianides, G. (2022). Using vignettes to investigate mathematics teachers' beliefs for promoting cognitive engagement in secondary mathematics classroom practice. *ZDM – Mathematics Education*, *55*, 1–14. https://doi.org/10.1007/s11858-022-01431-w

Sofroniou, A., & Poutos, K. (2016). Investigating the effectiveness of group work in mathematics. *Education Sciences*, *6*(3), Article 30. https://doi.org/10.3390/educsci6030030

Sridana, N., Qirom, M. S., & Turmuzi, M. (2024). Higher-order thinking skills profile of students in mathematics: Gender perspective. *Jurnal Ilmiah Profesi Pendidikan*, *9*(2), 1120–1128.

Suryawan, I. P. P., Sudiarta, I. G. P., & Suharta, I. G. P. (2023). Students' critical thinking skills in solving mathematical problems: Systematic literature review. *Indonesian Journal of Educational Research and Review*, *6*(1), 120–133. https://doi.org/10.23887/ijerr.v6i1.56462

Tachie, S. A. (2019). Meta-cognitive skills and strategies application: How this helps learners in mathematics problem-solving. *Eurasia Journal of Mathematics, Science and Technology Education*, *15*(5), Article em1702. https://doi.org/10.29333/ejmste/105364

Tajik, O., Golzar, J., & Noor, S. (2024). Purposive sampling. *International Journal of Educational and Life Sciences*, *2*(1), 1–9. https://doi.org/10.22034/ijels.2025.490681.1029

Tinto, V. (2017). Reflections on student persistence. *Student Success*, *8*(2), 1–8. https://doi.org/10.5204/ssj.v8i2.376

Ugpo, L. A., Tubo, M., & Yurango, C. (2025). Role of metacognitive awareness in enhancing persistence in solving mathematical problems among math majors. *Asian Journal of Education and Social Studies*, *51*(6), 1304–1311. https://doi.org/10.9734/ajess/2025/v51i62075

Utami, P., & Bharata, H. (2020). Analysis of mathematical critical thinking skill of junior high school students on the two-variable linear equation system. *Journal of Physics: Conference Series*, *1467*(1), Article 012004. https://doi.org/10.1088/1742-6596/1467/1/012004

Utami, S., Rahmawati, A., & Lusiana, R. (2025). Implementation of problem-based learning based on mathematical literacy to improve student's higher-order thinking skills. *Jurnal Pendidikan Matematika (JUPITEK)*, *8*(1), 1–16. https://doi.org/10.30598/jupitekvol8iss1pp1-16

Van der Walt, M., & Jagals, D. (2016). Enabling metacognitive skills for mathematics problem solving: A collective case study of metacognitive reflection and awareness. *African Journal of Research in Mathematics, Science and Technology Education*, *20*(2), 173–182. https://doi.org/10.1080/18117295.2016.1192239

Velez, A. J. B., Dayaganon, D. G. F., Robigid, J. C., Demorito, J. D., Villegas, J. P., & Gomez, D. O. (2023). Difficulties and coping strategies in understanding mathematical concepts in a private higher education in Tagum City, Davao Del Norte, Philippines. *Davao Research Journal (DRJ)*, *14*(1), 45–54. https://doi.org/10.59120/drj.v14i1.10

Verdeflor, R. N., Tenedero, E. Q., Pacadaljen, L. M., et al. (2025). Changing mindsets of previously non-mathematics and science enthusiasts: Factors leading to shift of behaviors towards math and science. *Environment and Social Psychology*, *10*(3), Article 3315. https://doi.org/10.59429/esp.v10i3.3315

Wang, M.-T., Degol, J., & Henry, D. (2019). An integrative development-in-sociocultural-context model for children's engagement in learning. *American Psychologist*, *74*(9), 1086–1102. https://doi.org/10.1037/amp0000522

Xiao, F., & Sun, L. (2021). Students' motivation and affection profiles and their relation to mathematics achievement, persistence, and behaviors. *Frontiers in Psychology*, *11*, Article 533593. https://doi.org/10.3389/fpsyg.2020.533593

Yaniawati, P., Kariadinata, R., Sari, N. M., Pramiarsih, E. E., & Mariani, M. (2020). Integration of e-learning for mathematics on resource-based learning: Increasing mathematical creative thinking and self confidence. *International Journal of Emerging Technologies in Learning (iJET)*, *15*(6), 60–78. https://doi.org/10.3991/ijet.v15i06.11915

Yayuk, E., Purwanto, As'ari, A. R., & Subanji. (2020). Primary school students' creative thinking skills in mathematics problem solving. *European Journal of Educational Research*, *9*(3), 1281–1295. https://doi.org/10.12973/eu-jer.9.3.1281

Yumiati, Y. (2013). Critical thinking in mathematics: What, why, and how can be developed in mathematics learning. *Journal of Educational Research*, *4*(2), 45–52.

Zana, F., Sa'dijah, C., & Susiswo, S. (2022). LOTS to HOTS: How do mathematics teachers improve students' higher-order thinking skills in the class. *International Journal of Trends in Mathematics Education Research*, *5*(3), 251–260. https://doi.org/10.33122/ijtmer.v5i3.143

Zeng, H., & Xin, Y. (2024). Comparing learning persistence and engagement in asynchronous and synchronous online learning, the role of autonomous academic motivation and time management. *Interactive Learning Environments*, 1–20. https://doi.org/10.1080/10494820.2024.2344033

Zhou, Y., Ning, Y., Chen, J., Zhang, W., & Wijaya, T. T. (2024). Development and validation of Mathematical Higher-Order Thinking Scale for high school students. *Psychology in the Schools*, *61*(8), 3160–3192. https://doi.org/10.1002/pits.23213