



## Content Knowledge, Self-Efficacy, and Mathematics Achievement: A Mediation Analysis Among Senior High School Students in the Philippines

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### Abstract

**Background and Aim:** Mathematics achievement is influenced by both cognitive and affective factors that shape students' learning experiences and academic outcomes. While content knowledge is widely recognized as a key determinant of achievement, students' beliefs in their capabilities may also play a crucial role in translating knowledge into performance. This study examined the mediating role of mathematics self-efficacy in the relationship between content knowledge and mathematics achievement among senior high school students in the Philippines. Grounded in Social Cognitive Theory and supported by constructivist and expectancy-value perspectives, the study explored how cognitive competence and self-beliefs jointly contribute to academic success in mathematics.

**Materials and Methods:** A quantitative, non-experimental, cross-sectional correlational design with mediation analysis was employed. The participants were 313 Grade 11 students from public secondary schools in Tangub City, Philippines. Data were collected using a validated Numeracy Test for content knowledge ( $\alpha = .87$ ), the Regional Unified Quarterly Assessment for mathematics achievement ( $\alpha = .89$ ), and the Mathematics Self-Efficacy Scale ( $\alpha = .93$ ). Descriptive statistics, Pearson product-moment correlation, and bootstrapped regression-based mediation analysis with 5,000 bootstrap samples were performed using JAMOV software.

**Results:** The findings indicated that students demonstrated a nearly proficient level of content knowledge ( $M = 28.99$ ,  $SD = 4.15$ ), a high level of mathematics self-efficacy ( $M = 3.84$ ,  $SD = 0.67$ ), and mathematics achievement classified as moving toward mastery ( $M = 36.50$ ,  $SD = 6.47$ ; MPS = 73%). Significant positive relationships were found between content knowledge and self-efficacy ( $r = .46$ ,  $p < .001$ ), self-efficacy and mathematics achievement ( $r = .85$ ,  $p < .001$ ), and content knowledge and mathematics achievement ( $r = .57$ ,  $p < .001$ ). Mediation analysis revealed that mathematics self-efficacy significantly and partially mediated the relationship between content knowledge and mathematics achievement (indirect effect = 0.543,  $SE = 0.063$ ,  $p < .001$ ), accounting for approximately 61.8% of the total effect.

**Conclusion:** Mathematics self-efficacy serves as a significant psychological mechanism linking content knowledge to mathematics achievement. The findings highlight the importance of integrating confidence-building strategies with content instruction to enhance students' mathematical performance and support more effective learning outcomes.

**Keywords:** Mathematics Achievement, Content Knowledge, Self-efficacy, Mediation Analysis, Bootstrapped Regression, Philippines, Senior High School

### Introduction

Mathematics education remains an important pillar for developing students' analytical thinking, problem-solving, and innovation skills in the 21st century. Student achievement in mathematics has been a significant concern in educational systems worldwide, as it affects students' academic readiness for college and their enrollment in science, technology, engineering, and mathematics (STEM) majors.





Although the mathematics curriculum and instruction have been improved, there are still problems in the mathematics learning of senior high school students, as evidenced by low achievement and poor attitudes toward mathematics.

Achievement in mathematics has been a recurring problem in the Philippine educational setting. These challenges are more pronounced in geographically spread communities with limited resources in the Philippines, where students' learning outcomes are often affected by unequal access to educational resources, instructional support, and socioeconomic opportunities. One socio-educational setting that reflects these challenges is Tangub City in Misamis Occidental, Northern Mindanao, Philippines. Although the local education system has implemented initiatives to improve learning quality, many learners still experience difficulties in mathematics, including numeracy skills, access to quality instruction, and negative perceptions of learning mathematics. Tangub City, as a developing local government unit (LGU) with urban and rural communities, mirrors the general situation of many provincial secondary schools in the Philippines. Given this context, it is important to understand mathematics achievement from the perspective of its contributions to the broader picture of educational equity, learner resilience, and effective mathematics teaching in developing communities.

Content knowledge, defined as students' knowledge of mathematical content, procedures, and principles, is a factor consistently linked to mathematics achievement. Students with strong content knowledge tend to be more successful at solving mathematical problems. But cognitive competence alone is not enough for successful learning in mathematics. Therefore, researchers have increasingly been interested in affective aspects, such as self-efficacy, a person's confidence in their ability to accomplish tasks.

Recent empirical studies have demonstrated the important role of self-efficacy in mathematics learning. The study by Yang et al. (2024) found that mathematics self-efficacy positively predicts students' mathematics achievement across various learning contexts. Likewise, Asanre et al. (2024) stated that study habits and self-efficacy were significant predictors of students' mathematics performance in senior high schools. Moreover, Madrilejos (2025) highlighted that psychological factors such as motivation, persistence, and self-efficacy interact to influence students' engagement and success in mathematics learning. These results indicate a strong link between students' attitudes toward their own mathematical skills and their performance in mathematics.

The need to improve mathematics achievement is aligned with the Sustainable Development Goals (SDGs), namely SDG 4: Quality Education, which promotes inclusive and equitable education for all. Enhancing students' competence and confidence in mathematics may contribute to improved academic achievement and support broader educational objectives, including innovation, economic growth, and sustainability.

While content knowledge and self-efficacy are known to be important factors in mathematics achievement, there is limited research investigating the interaction between content knowledge and self-efficacy within a mediation model among senior high school students. The majority of prior studies are conducted on cognitive/affective variables in isolation, rather than on their integration to affect mathematics achievement. Furthermore, recent research has indicated that knowledge and academic achievement do not always correlate. An investigation by Anyeta & Suglo (2024) showed that pedagogical content knowledge and self-efficacy had no direct significant impact on mathematics performance, suggesting that other psychological processes may be involved in students' achievement. This discovery indicates that students' beliefs and perceptions affect the conversion of knowledge into performance.

Recent mediation-related literature also shows the explanatory role of self-efficacy in academic achievement. Madrilejos (2025) concluded that self-efficacy was a key factor in the relationship between teacher support and the competencies related to mathematics learning. But there is still a dearth of studies examining specifically the role of self-efficacy as a mediator between mathematics content knowledge and mathematics achievement among senior high school students, especially in underrepresented provinces in the Philippines.

This literature gap prevents educational interventions from being designed that consider competency and confidence in learning mathematics together. Failure to consider the mechanisms linking these cognitive and affective factors will result in incomplete and less effective interventions to enhance students' mathematics attainment.

This study aims to address these gaps by examining the mediating role of self-efficacy in the relationship between mathematics content knowledge and mathematics achievement among senior high





school students. In particular, the study aims to evaluate students' mathematics content knowledge and self-efficacy, identify how content knowledge is positively associated with students' mathematics achievement, and investigate the mediating role of self-efficacy in the relationship between students' content knowledge and mathematics achievement. Through mediation analysis, the study aims to gain a deeper insight into the interaction between cognitive and affective aspects in the context of academic achievement in mathematics.

The results of this study are expected to contribute to both theory and practice in mathematics education. Theoretically, the study can enrich current models of mathematics education by integrating cognitive and affective aspects within a mediation context. From a practical perspective, results can inform educators and policymakers in developing evidence-based interventions to enhance students' mathematical competence and confidence. Such interventions also reflect SDG 4 (Quality Education) and SDG 10 (Reduced Inequalities) by promoting equitable learning opportunities and enhancing learning outcomes for all learners.

Finally, the study highlights the need for a shift from traditional methods of mathematics teaching and learning that prioritize knowledge acquisition alone. Rather, it emphasizes that the development of competence and confidence is integral to meaningful and successful mathematical learning.

### Research Objectives

This study aims to examine the mediating role of self-efficacy in the relationship between mathematics content knowledge and mathematics achievement among senior high school students. Specifically, the study seeks to: (1) Determine the level of students' content knowledge across key mathematics areas such as algebra, geometry, and statistics; (2) Determine the level of students' self-efficacy in learning, solving, and performing mathematics-related tasks; (3) Determine the level of students' mathematics achievement in senior high school. (4) Examine the relationship between content knowledge and self-efficacy. (5) Examine the relationship between self-efficacy and mathematics achievement. (6) Examine the relationship between content knowledge and mathematics achievement; and (7) Determine the extent to which self-efficacy mediates the relationship between content knowledge and mathematics achievement among senior high school students.

### Research Questions

This study sought to answer the following questions: (1) What is the level of students' content knowledge across key mathematics areas (algebra, geometry, statistics)? (2) What is the level of students' self-efficacy in learning, solving, and performing numeracy-related tasks? (3) What is the level of students' mathematics achievement in senior high schools? (4) Is there a significant relationship between content knowledge and self-efficacy among senior high school students? (5) Is there a significant relationship between self-efficacy and mathematics achievement among senior high school students? (6) Is there a significant relationship between content knowledge and mathematics achievement among senior high school students? (7) To what extent does self-efficacy mediate the relationship between content knowledge and mathematics achievement among senior high school students?

### Null Hypothesis

H<sub>01</sub>: There is no significant relationship between content knowledge and self-efficacy among senior high school students.

H<sub>02</sub>: There is no significant relationship between self-efficacy and mathematics achievement among senior high school students.

H<sub>03</sub>: There is no significant relationship between content knowledge and mathematics achievement among senior high school students.

H<sub>04</sub>: Mathematics self-efficacy does not significantly mediate the relationship between content knowledge and mathematics achievement among senior high school students.





## Literature Review

### **Theoretical Foundations of Mathematics Achievement: Cognitive and Affective Dimensions**

The understanding of mathematics achievement is now evolving to view it as a multidimensional outcome of cognitive and affective processes. Content knowledge and self-efficacy were both found to be important factors in predicting academic performance, and more recently, researchers Yang et al. (2024) and Liu et al. (2024) found that a combination of the two is better understood within the context of integrative or mediation-based approaches. This attitude reflects a shift in attention towards models that focus on the interaction between students' competence and confidence.

Self-efficacy is a concept based on Social Cognitive Theory: the belief people have in their ability to successfully perform a task, which directly impacts their motivation, persistence, and achievement (Bandura, 1997). Street et al. (2024) and Živković et al. (2023) conducted empirical studies showing that mathematics self-efficacy has strong direct and indirect links with academic performance, including self-regulated learning behaviors.

Constructivist Learning Theory also states that learning is an active process and that learners should develop knowledge in a meaningful way, emphasizing the need for deep conceptual understanding. According to Shone et al. (2023) and Ding et al. (2024), strong content knowledge alone is not enough; it is accompanied by supportive self-beliefs that enable learners to effectively apply mathematical understanding.

Furthermore, Expectancy-Value Theory posits that students' beliefs in their ability to succeed and the perceived value of academic tasks play important roles in achievement outcomes. Eccles and Wigfield (2020) highlighted that self-efficacy has emerged as an important determinant of engagement and performance and can be a central component of a mediation model, in which content knowledge relates to mathematics achievement directly and indirectly through self-efficacy.

### **Mathematics Achievement in Senior High School Education**

The mathematics achievement of senior high school students is a major concern in education systems globally due to its strong associations with higher-order thinking skills, readiness for STEM, and success in postsecondary studies. Galangco (2023) and Tan et al. (2025) found that mathematics achievement is multifactorial; that is, the product of the interplay among cognitive preparedness, motivational beliefs, and the learning environment. The results of the path analysis and structural equation modeling they conducted also showed that both academic and affective dispositions have a significant impact on explaining differences in the mathematics performance of senior high school students.

International reviews supported this as well, that simply being exposed to mathematical content does not lead to academic success. Street et al. (2024) and Zakariya (2022) argued that the ability to apply mathematical knowledge with confidence in answering increasingly demanding questions that require high cognitive processes is a better indicator of sustained achievement, especially at the upper secondary level. The findings highlight the need for an integrated cognitive-affective approach to mathematics achievement.

### **Content Knowledge as Predictor of Mathematics Achievement**

Content knowledge, which refers to students' knowledge of mathematical concepts, procedures, and problem-solving strategies, has always been an important factor in mathematical achievement. The studies by Galangco (2023) and Tan et al. (2025) have been supported by path analysis, which shows that senior high school students' prior mathematical knowledge has a direct effect on higher mathematical problem-solving and abstract reasoning.

Furthermore, Street et al. (2024) and Appiah et al. (2023) concluded that content knowledge played a role in achievement by reducing cognitive overload and allowing learners to be more engaged with challenging mathematical tasks. They also found that students with poor conceptual understanding may fail to apply the knowledge they have acquired to other areas of math, and consequently, their





achievement may be low, even though they have received instruction. These results provide evidence that content knowledge is necessary but not the only requirement for success in math.

### **Mathematics Self-efficacy and Academic Performance**

Mathematics self-efficacy is defined as students' self-beliefs about their ability to accomplish mathematical tasks. Self-efficacy is a central concept in Bandura's Social Cognitive Theory, and it has been a robust affective factor predicting mathematics achievement in secondary education research. The studies by Street et al. (2024) and Yousuf and Rajeswari (2024) found that students with high self-efficacy exhibit greater persistence, effective use of strategies, and high academic resilience in learning mathematics.

On the other hand, Tan et al. (2025) and Zakariya (2022) found that low self-efficacy in mathematics is correlated with avoidance, increased anxiety, and decreased engagement, which negatively impacts achievement outcomes. Their longitudinal and cross-sectional studies also found that self-efficacy itself—rather than previous achievement—accounts for the prediction of mathematics achievement.

### **Interrelation of Content Knowledge and Mathematics Self-Efficacy**

Content knowledge and mathematics self-efficacy (MS) are increasingly recognized as interdependent and dynamic in recent studies, especially among senior high school students. Liu et al. (2024) found that the more competent students are in mathematics, the greater their self-efficacy, because when students succeed in learning mathematics, they gain confidence to solve mathematical problems. Likewise, Street et al. (2024) and Yang et al. (2024) found that mastery of mathematical concepts is associated with stronger perceptions of learners' capability, which in turn is positively associated with sustained learning, persistence, and improvement in mathematics.

This interaction reinforces the idea that competence and confidence are not separate factors in mathematical achievement but rather intertwined, working together to constitute the conceptual shift. Students with a strong conceptual understanding are likely to feel that a complex mathematical problem is manageable and solvable, which will give them greater motivation, confidence, and willingness to persevere in complex learning situations. Galangco (2023) also path-modeled the relationship between mathematics self-efficacy and achievement, showing that mathematics self-efficacy is indirectly associated with achievement by positively influencing students' engagement and attitudes toward learning mathematics. Moreover, Valenzuela-Peñuñuri et al. (2024) noted the role of self-efficacy in the relationship between academic motivation and affective commitment in learning mathematics and science, further highlighting the significance of affective beliefs in academic achievement.

Second, there is a high level of conceptualization of the relationship between content knowledge and mathematics self-efficacy, grounded in Social Cognitive Theory, which posits that mastery experiences are the most important source of self-efficacy beliefs (Bandura, 1997). Learners' confidence in engaging in cognitively challenging tasks increases with their mathematical knowledge and ability to apply mathematical concepts. This may strengthen students' confidence, which in turn may encourage greater academic engagement and continued learning. Recent empirical evidence from Al Umairi (2024) and Cai and Gou (2024) confirmed that students' competence, motivation, and self-beliefs are interdependent, thus giving good theoretical and empirical support for mediation-based models of mathematics achievement.

Moreover, current studies have emphasized that self-efficacy is not only a direct determinant of achievement but also a determinant of how learners perceive and interpret mathematical challenges, regulate effort, and persist in learning mathematics. Street et al. (2024) found that having higher mathematics self-efficacy was associated with students' adaptive learning behaviors, problem-solving strategies, and persistence in the face of difficulties. The results indicate that the relationship between content knowledge and self-efficacy is a reinforcing spiral: as students experience success in learning, they become more confident, which, in turn, is positively associated with greater academic engagement and continued learning.





### Self-Efficacy as a Mediator of Mathematics Achievement

There is a growing body of literature showing that mathematics self-efficacy can act as a mediator between cognitive variables and mathematics achievement. Appiah et al. (2023) and Tan et al. (2025) used structural equation modeling to find that the impact of prior knowledge, instructional quality, and behavioral learning strategies on achievement outcomes is partially or fully mediated by self-efficacy. Recent research on mediation also classifies models into new categories, such as partial and full mediation, when explaining the effect of self-efficacy on academic outcomes. Partial mediation occurs when content knowledge still has a substantial direct effect on mathematics achievement even after introducing the mediator (mathematics self-efficacy). In contrast, full mediation occurs when the direct effect of content knowledge is not statistically significant after introducing the mediator. Theoretically, this distinction matters because it helps clarify the potential role of mathematics self-efficacy as either the sole intervening mechanism or one of many mechanisms linking cognitive competence to achievement in mathematics.

Evidence in the field of mathematics education is more likely to report partial mediation models in which content knowledge is shown to affect mathematics achievement both directly and indirectly through self-efficacy. For instance, Liu et al. (2024) and Yang et al. (2024) reported that students' mastery experiences boost their self-efficacy beliefs and, at the same time, result in improved achievement by developing their conceptual understanding and problem-solving competence. Likewise, Akosah et al. (2024) and Valenzuela-Peñuñuri et al. (2024) identified self-efficacy as a significant mediator in part of the relationships among academic competence, engagement, and academic achievement. They noted that there are still direct cognitive relationships. This suggests that mathematics success is not solely about confidence –a combination of cognitive knowledge and motivational self-beliefs influences it.

Moreover, Akosah et al. (2024) and Zakariya (2022) revealed that self-efficacy is a statistically significant residual link between content knowledge and mathematics achievement, even when content knowledge has a direct impact on achievement. They found that pupils' beliefs about their capacity to make effective use of knowledge can either enhance or constrain the effect of that knowledge. The findings strongly support mediation models of mathematics achievement, both theoretically and empirically.

Partial mediation is more theoretically supported than the proposed mediation in the present study. The literature explicitly mentions partial mediation, suggesting that the effect of content knowledge remains apparent in mathematics achievement. In contrast, mathematics self-efficacy also appears to be an important explanatory factor in the relationship between cognitive competence and performance outcomes. This conceptual clarification helps strengthen the logical linkage among the theoretical bases, empirical findings, and the study's proposed mediation model.

### Mathematics Self-efficacy Scale (MSES)

The Mathematics Self-Efficacy Scale (MSES), developed by Betz and Hackett (1983), is one of the most widely used scales for measuring student self-efficacy in mathematics coursework and in completing mathematics-related tasks. The instrument is based on Bandura's Social Cognitive Theory and assesses learners' beliefs about their ability to solve math problems, complete math tasks, and succeed in math. Since its development, the MSES has been widely used in research on mathematics education, as mathematics self-efficacy has consistently been found to be a significant predictor of mathematics achievement (Bandura, 1997; Betz & Hackett, 1983), persistence, engagement, and participation in STEM-related fields. The Mathematics Self-Efficacy Scale has been psychometrically revised from the original scale to the Revised Mathematics Self-Efficacy Scale (MSES-R) (Kranzler & Pajares, 1997) to enhance the factorial structure and measurement of domain-specific mathematics efficacy beliefs.

The MSES is reliable and valid in numerous studies across various educational settings. Nielsen and Moore (2003) mentioned that internal consistency reliability was high and convergent, and also discriminant validity was established among secondary school students, with a significant association





between mathematics self-efficacy scores and mathematics performance and self-concept scores. Likewise, Gwilliam and Betz (2001) showed that the instrument was cross-group valid for African American and European American student groups. The scale has also recently been subjected to psychometric studies, which further supported its validity. For instance, the MSES has been translated into Mexican Spanish by Morán-Soto et al. (2022), who reported adequate reliability and construct validity, highlighting the scale's suitability for use across different languages and cultures.

Similarly, Toland and Usher (2016) found that mathematics self-efficacy was measured more effectively using revised response-category structures among adolescent learners.

The MSES has also shown acceptable psychometric properties in the context of Asian education. Song and Tay (2019) conducted a Rasch analysis of a mathematics self-efficacy instrument based on the MSES framework for Singaporean students. They obtained good internal consistency, acceptable item fit, and good measurement invariance between gender groups. These results indicate the potential for using mathematics self-efficacy instruments in educational contexts in Southeast Asia. The latest research also consistently supports the substantial impact of mathematics self-efficacy on students' mathematics achievement, academic engagement, and persistence (Liu et al., 2024; Yang et al., 2024). Hence, the MSES is a theoretically based and empirically validated instrument appropriate for studying the relationship among mathematics self-efficacy, content knowledge, and mathematics achievement of senior high school students.

### Research Gap and Rationale

While many studies have explored the effects of content knowledge and mathematics self-efficacy on mathematics achievement individually, few have investigated the mediating role of mathematics self-efficacy between content knowledge and mathematics achievement among senior high school students in the Philippines. Past research primarily investigated the direct links between variables, but did not explore the psychological process by which content knowledge can impact mathematics achievement.

Moreover, there is a lack of local research investigating the partial mediation of mathematics self-efficacy between cognitive competence and the academic achievement of senior high school students. This gap indicates that there is no study on the interaction between cognitive and affective factors in shaping the mathematics achievement of students in Philippine secondary educational institutions.

The present study attempts to address this gap by investigating the possible partial mediation of the relationship between content knowledge and mathematics achievement by mathematics self-efficacy among senior high school students in Tangub City, Philippines. In particular, the study explores the extent of content knowledge, mathematics self-efficacy, and mathematics achievement; the associations among them; and the mediating role of mathematics self-efficacy in the relationship between content knowledge and mathematics achievement.

The results of the present study may have implications for the development of evidence-based instructional models and learner-centered educational interventions that enhance cognitive competence and learner confidence in learning mathematics.

### Conceptual Framework

The study is grounded in Bandura's Social Cognitive Theory (1997), which posits that self-efficacy is associated with academic motivation, persistence, and performance. The model assumes that students' mathematical achievement is related to their cognitive competence and psychological factors, such as self-efficacy. In this study, Content Knowledge is the independent variable and encompasses students' knowledge of mathematical concepts, procedures, and problem-solving skills. A high level of content knowledge may support students' understanding of mathematical concepts and help them use appropriate strategies to approach and solve mathematical problems. Self-Efficacy is identified as the mediating variable associated with Mathematics Achievement, the study's dependent variable, as



students gain greater competence in Mathematics. Self-efficacy refers to students' confidence in performing specific mathematical tasks and solving related problems.

The conceptual paradigm shows the direct and indirect effects of content knowledge on mathematics achievement. In the direct pathway, students with high content knowledge tend to demonstrate higher achievement in mathematics. The indirect pathway proposes that the higher the mathematics content knowledge, the more likely students are to have higher levels of self-efficacy and mathematics achievement. The framework is based on the premise that competence is positively associated with confidence, and confidence is positively associated with academic achievement. This should not be overlooked, and it is important to increase learners' self-belief and conceptual understanding to develop their confidence and academic success, thereby improving achievement in mathematics at the senior high school level.

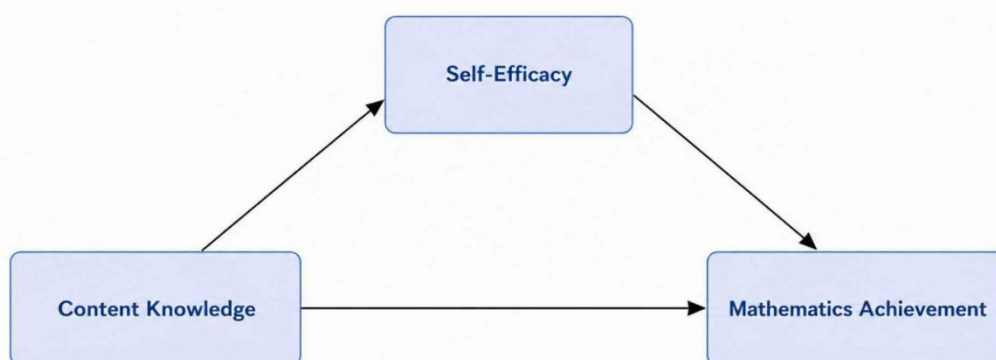


Figure 1: Schematic Diagram of the Study

## Methodology

### Research Design

This study used a quantitative, non-experimental, cross-sectional, correlational research design with mediation analysis. A correlational design was deemed appropriate because the study aimed to explore relationships among content knowledge, mathematics self-efficacy, and mathematics achievement, with no variables manipulated. In this mediation framework, the role of mathematics self-efficacy as a mediator in the relationship between content knowledge and mathematics achievement was examined in senior high school students.

The mediation analysis was conducted using a bootstrapped regression approach with bias-corrected confidence intervals (BC 95% CI) with 5,000 bootstrap samples, as recommended in current literature on indirect effect estimation in mediation analysis. Bootstrapping is recommended for its greater power in estimating indirect effects, especially when the sampling distribution may be non-normal. (Tibbe and Montoya, 2022).

### Participants and Sampling

The respondents of this study were 313 Grade 11 students from selected public secondary schools in Tanguib City, Misamis Occidental, Philippines, during the school year 2025-2026. Stratified random sampling was conducted to ensure that participants were proportionately represented from the schools participating in the study. Student respondents were selected by simple random sampling within each stratum.

Initially, 320 students were identified as potential respondents, but 7 were excluded due to incomplete responses and missing data on the research instruments. Therefore, only 313 grade 11 students who provided complete and appropriate responses were selected for the final sample.



The sampling procedure enhanced the sample's representativeness and minimized sampling bias. The use of stratification enabled the researcher to account for variations across schools and to provide equal opportunity for participation among respondents eligible for the study.

### **Research Instruments**

Three standardized instruments were used in collecting the required data for this study: the Numeracy Test, the Regional Unified Quarterly Assessment (RUQA), and the Mathematics Self-Efficacy Scale (MSES).

#### **Numeracy Test**

The Numeracy Test was used to assess the students' mathematical content knowledge. The instrument was a set of competency-based mathematical problems consistent with the Department of Education (DepEd)- prescribed Grade 11 mathematics curriculum. Mathematics experts conducted content validation of the test, and pilot testing was conducted before administering it. The internal consistency reliability of the Numeracy Test in the present study was good, with a Cronbach's alpha coefficient of .87, indicating reasonable reliability for measuring the mathematical content knowledge of senior high school students.

#### **Regional Unified Quarterly Assessment (RUQA)**

The Regional Unified Quarterly Assessment (RUQA) was used to assess students' mathematics achievement. RUQA is a mathematics standardized assessment instrument designed by the Department of Education to assess students' competency in mathematics throughout secondary school.

The RUQA was found to be reliable in the current study, with a Cronbach's alpha of .89, indicating good internal consistency for measuring mathematics achievement. In addition, the assessment was validated with content reviews and quality assurance by curriculum specialists and mathematics supervisors in the Department of Education.

#### **Mathematics Self-Efficacy Scale (MSES)**

Students' self-confidence in performing mathematics-related tasks was measured using the Mathematics Self-Efficacy Scale (MSES) developed by Betz and Hackett (1983). The instrument was in a Likert-scale format and assessed learners' perceived ability to solve mathematical problems and succeed in mathematical courses.

The MSES showed very high internal consistency among Grade 11 respondents, with a Cronbach's alpha of .93 in the current study. This reliability coefficient indicates that the instrument was reliable when used in the Philippine senior high school context. The validity and reliability of the MSES have also been confirmed in previous studies across various educational contexts, including the Asian context (Street et al., 2024).

#### **Data Collection Procedure**

The researcher obtained approval from the Schools Division Office and the school authorities of the public secondary schools in Tangub City, Philippines, involved in the study before data collection. Permission letters and informed consent forms were sent to respondents and their parents/guardians before the administration of the research instruments.

Data collection took place within three weeks in the fourth quarter of the School Year 2025-2026. Data collection for the three instruments was conducted in two separate sessions at each school, with each session lasting about 60-90 minutes. During the administration, respondents were told the purpose of the study, that participation was voluntary, that their answers were confidential, and that they could stop at any time without penalty. The instruments were personally administered by the researcher to ensure a standardized testing procedure, with support from subject teachers.

During the administration process, respondents were informed about the purpose of the study, the voluntary nature of participation, the confidentiality of responses, and their right to withdraw at any stage without penalty. The researcher personally administered the instruments, with assistance from subject teachers, to ensure standardized testing procedures.

All retrieved questionnaires and test answer sheets were thoroughly examined for completeness before being coded and analyzed. Responses with significant missing information and/or incomplete





entries were not included in the final data set to ensure the accuracy and reliability of the statistical analyses.

### Data Analysis

Data collected were analyzed using Jamovi statistical software version 2.4. Descriptive statistics, including the mean and standard deviation, were used to determine the levels of content knowledge, mathematics self-efficacy, and mathematics achievement. Pearson Product–Moment Correlation was used to analyze the relationships between the study variables.

Mediation analysis was performed using bootstrapped regression analysis to test the partial mediation of mathematics self-efficacy between content knowledge and mathematics achievement. To estimate indirect effects, 5,000 bootstrap samples with bias-corrected 95% confidence intervals were used. Mediation analysis was conducted as described in the current literature, with an indirect effect deemed statistically significant if the 95% CI did not include zero (Tibbe and Montoya, 2022). The level of significance for all statistical analyses was set at .05.

To examine the potential issue of multicollinearity arising from the strong correlation between mathematics self-efficacy and mathematics achievement, Variance Inflation Factor (VIF) and tolerance diagnostics were conducted before the mediation analysis. The results showed acceptable tolerance values above .20 and VIF values below the recommended threshold of 5.0, indicating that multicollinearity was not a serious concern and that the predictor variables demonstrated acceptable discriminant validity for regression-based mediation analysis.

### Ethical Considerations

Ethical guidelines were followed in conducting the study. All relevant educational authorities and school administrators were consulted and approved data collection. The study was voluntary, and respondents were informed of their rights, including the right to withdraw from the study at any time without consequences. Confidentiality and anonymity were observed during the research process. No personally identifiable information was gathered, recorded, or published throughout the study. All answers were used confidentially and only for academic and research purposes. The researcher also ensured that all collected data were securely stored and accessed only by authorized individuals directly involved in the study.

## Results

**Table 1.** Level of Students' Content Knowledge Across Key Mathematics Domains

| Domain                          | No. of Items | M     | SD   | Interpretation    |
|---------------------------------|--------------|-------|------|-------------------|
| Number & Algebra                | 27           | 21.32 | 3.44 | Proficient        |
| Measurement & Geometry          | 5            | 2.96  | 1.01 | Nearly Proficient |
| Data & Probability              | 8            | 4.31  | 1.74 | Nearly Proficient |
| Content Knowledge (Total Score) | 40           | 28.99 | 4.15 | Nearly Proficient |

*Note.* M = mean; SD = standard deviation. Interpretation is based on proficiency levels (MPS): 90–100 = Highly Proficient; 75–89 = Proficient; 50–74 = Nearly Proficient; 25–49 = Low Proficient; 0–24 = Not Proficient.

The students exhibited varying levels of content knowledge in the major areas of mathematics. Specifically, they were proficient in Number and Algebra ( $M = 21.32$ ,  $SD = 3.44$ ), and nearly proficient in Measurement and Geometry ( $M = 2.96$ ,  $SD = 1.01$ ) and Data and Probability ( $M = 4.31$ ,  $SD = 1.74$ ). The overall content knowledge score ( $M = 28.99$ ,  $SD = 4.15$ ), which represented students' knowledge, indicated that the knowledge level was almost complete, meaning that students had mastered the basic level of knowledge but had not yet reached a complete level in all aspects.

**Table 2** Level of Students' Mathematics Self-Efficacy in Learning, Solving, and Performing Numeracy-Related Tasks

[10/20]

Citation:



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| Indicators                           | M    | SD   | Interpretation |
|--------------------------------------|------|------|----------------|
| Confidence in Solving Math Problems  | 4.07 | 0.76 | Confident      |
| Confidence in Learning Math Problems | 3.78 | 0.65 | Confident      |
| Confidence in Performing Math Tasks  | 3.68 | 0.60 | Confident      |
| Self-Efficacy                        | 3.84 | 0.67 | Confident      |

Note. M = mean; SD = standard deviation. Interpretation is based on the following scale: 1.00–1.79 = Not confident at all; 1.80–2.59 = Slightly confident; 2.60–3.39 = Moderately confident; 3.40–4.19 = Confident; 4.20–5.00 = Very confident.

Results indicated that mathematics self-efficacy in learning, solving, and performing numeracy-related tasks was high. Specifically, students were confident in solving math problems ( $M = 4.07$ ,  $SD = 0.76$ ), learning mathematics ( $M = 3.78$ ,  $SD = 0.65$ ), and performing math tasks ( $M = 3.68$ ,  $SD = 0.60$ ). The mean self-efficacy score ( $M = 3.84$ ,  $SD = 0.67$ ) suggests that students were generally confident in their mathematical skills.

**Table 3.** Level of Students' Mathematics Achievement in Senior High School

| Variable                       | No. of Items | N   | M     | SD   | MPS (%) | Interpretation         |
|--------------------------------|--------------|-----|-------|------|---------|------------------------|
| Mathematics Achievement (RUQA) | 50           | 313 | 36.50 | 6.47 | 73.00   | Moving Towards Mastery |

Note. Where N = number of students; M = mean; SD = standard deviation; MPS = mean percentage score. The MPS was calculated using the formula:  $(M/\text{number of items}) \times 100$ . It is interpreted using the achievement level scale: 96-100 = Mastered; 86-95 = Closely Approximating Mastery; 66-85 = Moving towards Mastery; 35-65 = Average Mastery; 15-34 = Low Mastery.

The results revealed that the students' mathematics performance in senior high school was moderate. Students' achievement, in particular, was  $M = 36.50$ ,  $SD = 6.47$  out of 50 items, yielding a mean percentage score (MPS) of 73.00%. This placed students in the moving towards mastery band on the achievement level scale, meaning they had successfully demonstrated the basic skills of the desired progression in mathematics but had not yet fully mastered them.

**Table 4** Relationship Between Content Knowledge and Mathematics Self-Efficacy

| Variables                    | 1      | 2 |
|------------------------------|--------|---|
| 1. Content Knowledge         | —      |   |
| 2. Mathematics Self-Efficacy | .46*** | — |

Note. Values are Pearson's r correlations.  $N=313$ . \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

The assumptions of the Pearson product-moment correlation were tested before hypothesis testing. Each variable was measured continuously. Shapiro-Wilk tests were used to assess the continuous variables for normality and revealed no significant deviation from normality for content knowledge ( $W = 0.994$ ,  $p = .203$ ) and self-efficacy ( $W = 0.993$ ,  $p = .118$ ). Furthermore, the assumptions of linearity, homoscedasticity, and the absence of extreme outliers were visually assessed using scatterplots, which support the stated assumptions.

Pearson correlation analysis showed a statistically significant, moderate positive relationship between content knowledge and mathematics self-efficacy,  $r(311) = .46$ ,  $p < .001$ . Based on this, the null hypothesis was rejected. This finding suggests that students with greater content knowledge also tend to report higher confidence in their mathematical skills.





**Table 5** Relationship Between Self-Efficacy and Mathematics Achievement

| Variables                  | 1      | 2 |
|----------------------------|--------|---|
| 1. Self-Efficacy           | —      |   |
| 2. Mathematics Achievement | .85*** | — |

Note. Values are Pearson's r correlations.  $N=313$ . \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Before testing the hypothesis, the assumptions under the Pearson product-moment correlation were tested. All measured variables were placed on a continuous scale. The Shapiro-Wilk tests showed no significant differences in normality between self-efficacy ( $W = 0.993$ ,  $p = .118$ ) and Mathematics Achievement ( $W = 0.991$ ,  $p = .054$ ). Also, the visual examination of the scatter plots indicated linearity and homoscedasticity, and the absence of extreme outliers, which supports the appropriateness of

The Pearson correlation analysis showed a statistically significant, very strong positive correlation between self-efficacy and mathematics achievement,  $r(311) = .85$ ,  $p < .001$ . Hence, the null hypothesis was rejected.

**Table 6** Relationship Between Content Knowledge and Mathematics Achievement

| Variables                  | 1      | 2 |
|----------------------------|--------|---|
| 1. Content Knowledge       | —      |   |
| 2. Mathematics Achievement | .57*** | — |

Note. Values are Pearson's r correlations.  $N=313$ . \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

Initial assumption testing indicates that the data meet the conditions for parametric analysis. Content knowledge and mathematics achievement were tested for normality using the Shapiro-Wilk test, which revealed no significant deviations from normality ( $W = 0.994$ ,  $p = .203$ ;  $W = 0.991$ ,  $p = .054$ , respectively). The test of linearity was done through visual inspection of scatter plots, which showed a positive linear relationship between content knowledge and mathematics achievement. The relatively homogeneous dispersion of the residuals also confirmed the assumption of homoscedasticity. The product-moment correlation analysis showed a statistically significant, moderate positive correlation between content knowledge and mathematics achievement,  $r(311) = .57$ ,  $p < .001$ . Based on this, the null hypothesis, which claimed that there was no significant relationship between content knowledge and mathematics achievement among senior high school students, was rejected. This result indicates that greater content knowledge is positively related to mathematics achievement.

**Table 7** Multicollinearity Diagnostics for Predictor Variables

| Predictor                 | Tolerance | VIF  |
|---------------------------|-----------|------|
| Content Knowledge         | .83       | 1.25 |
| Mathematics Self-Efficacy | .79       | 1.28 |

Multicollinearity diagnostics were performed before the mediation analysis to assess the distinctiveness of the predictor variables. Variance Inflation Factor (VIF) values ranged from 1.25 to 1.28, and tolerance values ranged from .79 to .83, indicating no serious multicollinearity, as all VIF values were well below the recommended threshold of 5.0. These results indicate that the variables used in the mediation model have discriminant validity.



**Table 8** Mediation Analysis Results on the Effect of Content Knowledge on Mathematics Achievement Through Mathematics Self-Efficacy ( $N = 313$ )

| Path/Effect                                          | <i>B</i> | <i>SE</i> | 95% BC CI |          | <i>p</i> |
|------------------------------------------------------|----------|-----------|-----------|----------|----------|
|                                                      |          |           | Lower     | CI Upper |          |
| Content Knowledge → Self-Efficacy ( <i>a</i> )       | 0.066    | 0.007     | 0.052     | 0.080    | < .001   |
| Self-Efficacy → Mathematics Achievement ( <i>b</i> ) | 8.268    | 0.339     | 7.603     | 8.933    | < .001   |
| Direct Effect ( <i>c'</i> )                          | 0.336    | 0.048     | 0.242     | 0.430    | < .001   |
| Indirect Effect ( <i>ab</i> )                        | 0.543    | 0.063     | 0.425     | 0.671    | < .001   |
| Total Effect ( <i>c</i> )                            | 0.879    | 0.073     | 0.736     | 1.022    | < .001   |
| Proportion of Total Effect Mediated ( <i>ab/c</i> )  | 0.618    | —         | —         | —        | —        |
|                                                      | (61.8%)  |           |           |          |          |

Note: Bootstrap estimates were generated using 5,000 bootstrap samples with bias-corrected 95% CI intervals (BC CI). *B* = unstandardized regression coefficient; *SE* = standard error; CI = confidence interval.

The table presents the mediation analysis results for the relationship between content knowledge and mathematics achievement of senior high school students, with mathematics self-efficacy as the mediator.

The bootstrapped mediation analysis indicated that content knowledge has a significant effect on mathematics self-efficacy ( $B = 0.066$ ,  $SE = 0.007$ ,  $p < .001$ ). Mathematics self-efficacy was also a significant predictor of mathematics achievement ( $B = 8.268$ ,  $SE = 0.339$ ,  $p < .001$ ). Content knowledge continued to have a statistically significant direct effect on mathematics achievement after controlling for mathematics self-efficacy ( $B = 0.336$ ,  $SE = 0.048$ ,  $p < .001$ ).

The indirect effect of content knowledge on mathematics achievement through mathematics self-efficacy was statistically significant,  $ab = 0.543$ ,  $SE = 0.063$ , 95% Confidence Interval [0.421, 0.668],  $p < .001$ , as the confidence interval did not include zero. This result confirms the partial mediation of the relationship between content knowledge and mathematics achievement by mathematics self-efficacy. The overall impact of content knowledge on performance in mathematics was also significant ( $B = 0.879$ ,  $SE = 0.073$ ,  $p < .001$ ).

A bootstrapped bias-corrected confidence interval for the indirect effect did not contain zero, and thus the indirect effect of content knowledge on mathematics achievement, mediated by mathematics self-efficacy, was statistically significant. There was partial mediation, with approximately 61.8% of the total effect of content knowledge on mathematics achievement mediated by mathematics self-efficacy.

## Discussion

This study aimed to investigate the mediating role of mathematics self-efficacy in the relationship between mathematics content knowledge and mathematics achievement among senior high school students. Results indicated that students' mathematics content knowledge was nearly proficient, mathematics self-efficacy was high, and mathematics achievement was classified as moving toward mastery. More importantly, the study confirmed that mathematics self-efficacy significantly mediated the relationship between content knowledge and mathematics achievement, highlighting the interaction between cognitive competence and motivational processes in mathematics learning.

The findings collectively suggest an interplay between cognitive competence and affective beliefs that influences the achievement of senior high school students in mathematics. Content knowledge was found to be directly linked to mathematics achievement, and mathematics self-efficacy was a partial mediator of this link, suggesting that students' ability to apply mathematical concepts in problem solving may mediate the relationship between content knowledge and mathematics achievement. The results can be used to justify integrative cognitive-affective approaches based on Social Cognitive Theory, Constructivist Learning Theory, and Expectancy-Value Theory, which view





successful learning of mathematics as a combination of conceptual understanding and learners' beliefs about their own abilities in mathematics.

Students' content knowledge was generally higher in Number and Algebra than in Measurement and Geometry, and in Data and Probability. This is a typical phenomenon in mathematics education: students are more successful in procedural and calculation aspects than in conceptual and application aspects. (OECD, 2023). The constructivist view would suggest that purposeful mathematical learning occurs when students are engaged in conceptually exploring and problem-solving in meaningful contexts. Lower performance in abstract and analytical areas can thus be interpreted as a lack of opportunities for higher-order thinking and the real-world use of mathematics in classrooms. The existing literature also indicates that conceptual understanding and content knowledge are important factors in mathematics achievement, as they enhance learners' capacity to transfer mathematical concepts to other contexts. (Zhang et al., 2023; Yang et al., 2024). Findings may also be attributed to ongoing instructional and curricular challenges in the Philippine context, particularly in schools grappling with instructional resource gaps and learning recovery efforts following the pandemic.

The students exhibited relatively high self-efficacy in mathematics, indicating confidence in their ability to perform mathematics-related tasks. This aligns with the findings of Bandura's Social Cognitive Theory (1997), which states that self-efficacy beliefs impact learners' motivation, persistence, emotional control, and academic behavior. Students who have a positive perception of their ability to perform in a task are more likely to attempt difficult tasks, persevere when faced with difficulties, and use effective problem-solving skills. (Street et al., 2024). Research consistently shows that self-efficacy in mathematics is a strong predictor of academic engagement, resilience, and performance. In the current context, students' efficacy beliefs might have been shaped by mastery experiences, supportive classroom interactions, and past success in school. Classroom climate, external reinforcement, and social comparison processes, however, may also affect efficacy beliefs unrelated to actual competence. (Yu et al., 2023). This indicates that confidence-building interventions should be accompanied by opportunities for conceptual understanding to support efficacy beliefs with real learning experiences.

The correlation between content knowledge and mathematics self-efficacy was 0.65, indicating a significant relationship: students with high content knowledge tend to have high mathematics self-efficacy. This result is confirmed by Situated Expectancy-Value Theory, which suggests that learners' perception of competence is related to motivation, engagement, and persistence in doing academic tasks (Eccles & Wigfield, 2020). Students who successfully acquire mathematical knowledge are more likely to achieve mastery and, in turn, gain the confidence to participate in future learning activities. Similarly, mastery experiences and academic competence are shown to be important factors in the development of mathematics self-efficacy in previous studies. (Liu et al., 2024). This suggests that the teaching approach aimed at developing conceptual understanding and learning experiences may also boost learners' confidence and engagement in learning mathematics.

There was a statistically significant relationship between content knowledge and mathematics achievement, indicating that conceptual understanding is one of the bases of learning achievement. Students who understand mathematical concepts more deeply are more likely to exhibit the analytical reasoning, procedural fluency, and problem-solving abilities needed to succeed in mathematics. This result aligns with research in modern mathematics education, highlighting the importance of three dimensions in building students' mathematical achievement: conceptual understanding, cognitive engagement, and strategic learning behaviors. (Zhang et al., 2023). The moderate magnitude of the relationship, however, suggests that achievement depends not only on content mastery but also on motivational, emotional, and contextual factors that affect learners' engagement in the classroom.

The strong association between mathematics self-efficacy and mathematics achievement is particularly noteworthy, indicating that confidence plays a significant role in mathematics learning. Students with a positive attitude towards mathematics are more likely to persist, be resilient, think strategically, and continue to study when faced with challenging tasks (Yang et al., 2024). This discovery is a significant validation of the Social Cognitive Theory, which suggests that efficacy beliefs influence academic decisions, effort, and outcomes. The correlation coefficient between self-efficacy and mathematics achievement was somewhat higher than usual ( $r = .85$ ), but multicollinearity diagnostics indicated that these constructs were statistically different. However, the high correlation suggests overlap with constructs related to this study, including motivation, persistence, study habits, engagement, and previous achievement, which could also influence mathematics achievement.





The path coefficient between content knowledge and mathematics achievement was statistically significant. It accounted for about 61.8% of the total effect, indicating that mathematics self-efficacy partially mediated the relationship between content knowledge and mathematics achievement. The finding of partial mediation suggests that mathematics self-efficacy does not fully account for the relationship between content knowledge and mathematics achievement. Content knowledge was, however, consistently linked to achievement, even controlling for self-efficacy. This means that cognitive competence and affective beliefs both contribute to mathematics performance. The findings are consistent with the Social Cognitive Theory and the Expectancy-Value Theory, which suggest that academic performance is related not only to a student's actual competencies but also to beliefs about his or her competence to perform academic tasks.

Previous studies on mediation have also found that self-efficacy accounts for the effects of cognitive competence and educational experiences on mathematics achievement. (Yang et al., 2024; Street et al., 2024). Contextually, the findings suggest that mathematics achievement among senior high school students may be improved not only through strengthening conceptual understanding but also through fostering learners' confidence, motivation, and emotional readiness for mathematics learning. In context, the results indicate that the increase in the achievement of senior high school students in mathematics depends not only on strengthening students' conceptual understanding but also on building students' confidence, motivation, and emotional readiness in learning mathematics.

One practical implication of the findings is that instructional approaches are needed that simultaneously improve students' competence in doing mathematics and their confidence in doing so. For instance, teachers can use scaffolded problems in which students start with guided problems and then move on to independent, more sophisticated mathematical problems. Focusing on students' successful mastery experiences through formative feedback might also improve self-efficacy in mathematics. Peer-assisted learning, collaborative problem-solving sessions, reflective journals, and differentiated instruction can also be used to benefit students with strong content knowledge but low confidence in mathematics. The following instructional practices may help foster a supportive learning environment that promotes positive attitudes, engagement, and persistence in learning mathematics.

The teaching of mathematics should shift from content-centered to learner-centered, with the simultaneous enhancement of conceptual understanding and self-efficacy beliefs. In recent years, mathematics learning has increasingly been taking place in digital, blended, and personalized learning settings, where technology-enriched learning can also shape students' mathematics self-efficacy. Recent studies on adaptive learning platforms, online collaborative activities, artificial intelligence-assisted instruction, and technology-mediated feedback systems have shown that individualized support and repeated mastery experiences can improve learner engagement, confidence, and self-regulated learning behaviors. (Hwang et al., 2023; Wang et al., 2024). Therefore, learner-centered digital pedagogies and blended learning approaches are possible methods for enhancing conceptual understanding and confidence in learning mathematics.

The results of the study also emphasize the need to combine cognitive and affective support mechanisms in teaching mathematics. The results indicate that mathematics self-efficacy is a partial mediator between content knowledge and mathematics achievement; thus, instructional practices should not only emphasize strengthening students' conceptual understanding, but also their confidence in engaging in mathematics tasks. Teachers can use scaffolded problem-solving, where learners move from guided learning to independent problem-solving to develop their competence and confidence. Peer tutoring, collaborative learning tasks, and small-group mathematical discussions may further promote active participation, cooperative learning, and positive learning experiences. Furthermore, feedback (based on the mastery approach) highlighting the students' effort, improvement, and successful completion of mathematical tasks can enhance self-efficacy beliefs and persistence in mathematics learning. Differentiated instruction can also help students with varying levels of mathematical readiness by modifying learning activities and supports based on students' needs and abilities. These instructional interventions could help improve the mathematics learning environment, which would be more supportive and inclusive for senior high school learners to be confident and competent in learning mathematics.

The study has some limitations that need to be considered. The cross-sectional study design does not permit causal inferences about the relationship among content knowledge, mathematics self-efficacy, and mathematics achievement. While the mediation analysis revealed statistically significant indirect effects, the results should be interpreted as evidence of statistical association rather than



causation. Longitudinal and experimental studies of the temporal and causal relationships among the above variables are therefore recommended. Furthermore, the high correlation between mathematics self-efficacy and mathematics achievement underscores the need for future research to investigate related constructs (e.g., mathematics motivation, study habits, perseverance, and prior achievement) to better understand the unique contribution of mathematics self-efficacy to mathematics learning.

The overall findings of the study contribute to the existing literature on mathematics education in the modern world by illustrating that mathematics achievement is not only a product of cognitive ability but also of affective and motivational processes. The results corroborate an integrative view of mathematics learning, in which competence helps build confidence, and confidence, in turn, facilitates achievement. This underscores the need for a holistic, learner-centered approach to ensure simultaneous conceptual understanding and confidence in mathematics teaching and learning.

## Knowledge Contribution

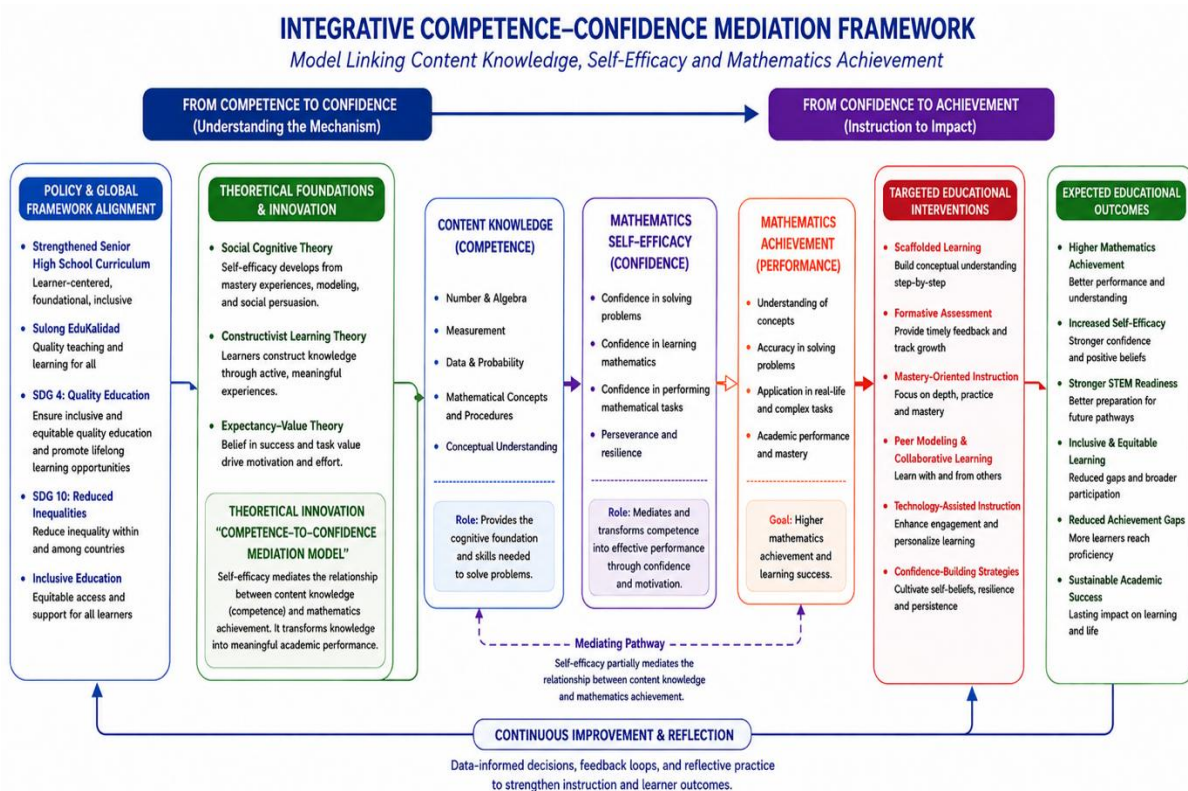


Figure 2: Integrative Competence–Confidence Mediation Framework

The present study contributes to the mathematics education literature by developing and empirically verifying the Integrative Competence – Confidence Mediation Framework (ICCMF), which explains the mediating role of mathematics self-efficacy in the relationship between content knowledge and mathematics achievement among senior high school students. Grounded in Social Cognitive Theory (Bandura, 1997), Constructivist Learning Theory, and Situated Expectancy-Value Theory (Eccles & Wigfield, 2020), this model extends current mathematics achievement models by integrating the cognitive and affective aspects of learning into a single mediation framework, rather than analyzing them separately as predictors of mathematics achievement. Unlike traditional correlational models, the ICCMF expounds the relationship between content knowledge and achievement in terms of learners' efficacy beliefs, offering a more explicit theoretical account of the link between competence and achievement.



The results showed that mathematics self-efficacy was a significant, partial mediator of the relationship between content knowledge and mathematics achievement among Filipino learners. This positions self-efficacy not only as a motivational support factor but also as an active psychological mechanism linking conceptual understanding to performance outcomes. The framework contributes conceptually by demonstrating an operational integration of the cognitive and affective dimensions of mathematics learning, providing a more comprehensive explanation of mathematics achievement processes in mathematics education.

The study also adds empirical evidence to the partial mediating effect of mathematics self-efficacy in the context of a senior high school in the Philippines. While prior studies have examined content knowledge, self-efficacy, and mathematics achievement separately, few have explored their interaction in educational settings in Southeast Asia, particularly within a mediation framework. The present results provide further evidence for the cross-cultural validity of mathematics achievement models and underscore the significance of psychological mechanisms in understanding mathematics achievement among learners in developing educational systems.

For educational and policy purposes, the framework implies a need to enhance conceptual understanding and confidence to improve mathematics achievement. Based on this, the study suggests using learner-centered approaches such as scaffolding problem-solving activities, mastery assessment, formative feedback, collaborative learning, remediation programs, and building learners' confidence through instruction. These are especially significant in schools in the Philippines, where learners are likely to have low confidence in mathematics and receive less instructional support.

The framework also aligns with the mathematics component of the education equity targets of Sustainable Development Goal 4 (Quality Education) and Sustainable Development Goal 10 (Reduced Inequalities), focusing on inclusive and psychologically supportive mathematics teaching. The framework focuses on educational inequality in the Philippines by providing targeted interventions for learners in under-resourced public schools who frequently face inadequate instructional support, high enrollment, poor foundational skills, and low confidence in mathematics. The framework recommends using scaffolded remediation, formative assessment practices, peer-assisted learning activities, and teacher feedback strategies to enhance both conceptual understanding and self-efficacy among struggling learners. Such interventions can help close achievement gaps by providing academically vulnerable students with additional instructional support, motivational reinforcement, and opportunities for meaningful involvement in learning mathematics. The framework combines approaches to building competence and confidence to provide a practical basis for enhancing the mathematical achievement of diverse learners in the Philippines.

In general, the study makes a theoretical, empirical, and contextual contribution to the current mathematics education literature, as it shows that the interaction between conceptual competence and motivational processes influences mathematics achievement. The proposed Competence–Confidence Mediation Framework provides a contextualized and evidence-based description of mathematics learning that could serve as a basis for further structural equation modeling research, longitudinal studies, intervention-based research, and the development of locally developed assessment instruments to examine competence–confidence mechanisms in mathematics learning.

## Recommendations

The following recommendations are proposed based on the findings of the study:

### *For Teachers and School Administrators*

Self-efficacy-enhancing approaches should be integrated into mathematics classrooms, including scaffolding, self-instruction, reflective activities, formative feedback, and mastery-oriented tasks. For instance, a student with a high mathematical content knowledge and low academic self-confidence could be served by a series of scaffolded, mastery-oriented interventions in which teachers slowly fade out the level of direct engagement required with students in problem-solving tasks and give students increasing autonomy in mathematical tasks, while still offering frequent formative feedback and





positive reinforcement. These instructional strategies can boost mathematics self-efficacy by providing students with frequent success experiences, positive peer interactions, and/or decreasing mathematics anxiety. In addition, adaptive learning technology, reflective learning activities, and digital formative assessment tools can help teachers provide individual support and track students' confidence-building processes in both face-to-face and blended settings.

School administrators can also enhance mathematics achievement by creating professional development opportunities that enable teachers to increase their mathematics self-efficacy in instructional practices, technology-integrated teaching, and learner-centered pedagogies, thereby encouraging positive academic engagement.

#### ***For Curriculum Developers and Educational Policymakers***

Curriculum developers should design mathematics learning activities that focus on conceptual knowledge, problem-solving, collaborative learning, and critical thinking, rather than solely on procedural memorization. Instructional programs in mathematics should also incorporate technology-enhanced and personalized learning activities that build students' confidence, engagement, and active involvement in learning mathematics.

Educational policymakers could also design interventions and instructional support measures to address the cognitive and affective aspects of mathematics learning, especially for academically disadvantaged learners and students lacking self-confidence in mathematics.

#### ***Future Research***

The Integrative Competence–Confidence Mediation Framework can be further explored in future studies with longitudinal designs, Structural Equation Modeling, and intervention-based studies, in other educational settings and grade levels. Future researchers may also develop and test content-specific, localized instruments to study the relationships among content knowledge, mathematics self-efficacy, and mathematics outcomes across a variety of mathematics learning contexts.

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