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Math Avoidance and Psychological Difficulties in Relation to Number Sense: A Structural Equation Model

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ABSTRACT

Weak number sense persists into tertiary education and is often associated with math avoidance and psychological difficulties that hinder students' engagement and performance in mathematics. While prior studies have examined constructs such as math anxiety, self-efficacy, and achievement independently, limited research has explored the structural relationships among math avoidance, psychological difficulties, and number sense simultaneously, particularly at the college level. Moreover, the application of Structural Equation Modeling (SEM) to analyze these constructs as latent variables within a unified framework remains limited, resulting in an incomplete understanding of how affective factors interact with numerical proficiency among students with recent mathematical learning experiences. To address this gap, this study examined the structural relationships among math avoidance, psychological difficulties, and number sense among first and second-year college students. A correlational quantitative research design was employed, involving 214 participants selected through purposive sampling and enrolled in mathematics-related courses. Data were collected through validated instruments administered via Google Forms. Descriptive statistics, correlation analysis, and SEM were utilized to analyze the data. Results revealed moderate levels of math avoidance, psychological difficulties, and number sense. Math avoidance was significantly and positively related to psychological difficulties and negatively associated with number sense, while psychological difficulties showed no significant relationship with number sense. The SEM results indicated excellent model fit, supporting the proposed framework. These findings emphasize the importance of addressing math avoidance through targeted interventions that enhance confidence, reduce anxiety, and promote active engagement in learning mathematics.

Keywords: *Math avoidance, psychological difficulties, number sense, structural equation model, tertiary students*

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INTRODUCTION

Number sense is a foundational component of mathematical learning that develops in primary education and supports students' understanding of quantities, numerical relationships, and basic operations (Bisaillon, 2023). Research indicates that weaknesses in number sense often emerge early and, when unaddressed, persist into secondary education, where students are expected to apply numerical reasoning to more abstract mathematical concepts (Chang et al., 2022). At this stage, a limited number sense constrains students' ability to process mathematical relationships and perform fundamental operations efficiently (Maldonado Moscoso et al., 2020; Barroso et al., 2021). Further evidence shows that number sense deficits frequently persist into tertiary education, even among students enrolled in college-level mathematics courses (Kirkland, 2022). As mathematical tasks become increasingly abstract at the tertiary level, students with weak number sense are more likely to experience psychological difficulties such as math anxiety, low self-efficacy, and avoidance behaviors, which further impede engagement and performance (Pentang et al., 2020; Bacsal et al., 2022). These challenges are reflected in widespread negative attitudes toward mathematics and elevated anxiety reported across educational systems (Suleiman and Hammed, 2019; Bedetti and Elisei, 2019). Despite extensive research on number sense and affective responses in mathematics, few studies have examined how math avoidance, psychological difficulties, and number sense interact within a unified framework among tertiary students. Addressing this gap is essential for developing interventions that simultaneously strengthen numerical competence and reduce affective barriers to mathematics learning (Picaza et al., 2022). Further study by Suleiman and Hammed (2019) revealed alarming rates of negative attitudes toward mathematics, with 92.50% of students expressing a strong dislike for the subject and 86.25% reporting irrational fear of math-related tasks. Similarly, findings from Bedetti and Elisei (2019) highlight that over 30% of secondary school students in OECD countries experience stress and anxiety while tackling mathematical assignments, with 59% fearing future struggles in the subject.

Moreover, international studies have consistently shown that weak number sense persists across various educational contexts. In Taiwan, Yang and Sianturi (2019) found that many students performed poorly in number sense, reflecting mathematical misconceptions and insufficient foundational understanding. Similarly, in Indonesia, Wulandari et al. (2021) reported consistently low number sense ability across grade levels, indicating students' ongoing struggles with core numerical concepts. In Malaysia, Singh (2019) study likewise revealed low attainment among secondary students, with less than half of the test items answered correctly, highlighting a general deficiency in numerical comprehension. Collectively, these findings affirm that inadequate number sense is not a localized problem but a widespread educational challenge that calls for deliberate, research-based interventions to strengthen students' mathematical understanding.

Furthermore, weak number sense also persists among Filipino learners. In the Philippines, Santos et al. (2022) reported that junior high school students from public schools demonstrated poor number sense competency, revealing substantial gaps in foundational mathematical understanding. Likewise, Damaso (2019) found that only 10.31% of high school students achieved satisfactory performance, while 35.94% did not meet expectations, emphasizing the ongoing struggles in mastering basic numerical skills. Furthermore, Marga and Papadopoulos (2020) observed that many students relied heavily on rote memorization rather than on flexible mental computation strategies, suggesting limited conceptual understanding. Taken together, these studies affirm that weak number sense is not only a global concern but also a pressing national issue that demands targeted, evidence-based instructional interventions to strengthen students' mathematical foundations.

In addition, mathematics achievement remains a concern, as school-based diagnostic and regional assessments reveal below-average performance in elementary mathematics, particularly in basic computation and numerical reasoning. This challenge is also evident at Davao de Oro State College, Maragusan Branch, where the researcher has observed within the campus that the students struggle with simple mental calculations, often experiencing anxiety and avoiding math-related activities. This local situation is further supported by national data, which show that only 16% of Filipino 15-year-old students reached the baseline level of mathematics proficiency in the 2022 Programme for International Student Assessment (PISA), far below the OECD average of 69%, with the Philippines ranking among the lowest-performing countries globally (OECD, 2023). Together, these local and national findings underscore systemic challenges in number sense development that extend across educational levels and affect students' capacity to engage successfully in higher mathematics learning.

In addition to the academic imperative, there is a pressing relevance and urgency attached to this research endeavor. Studying number sense and the factors that affect it is a crucial step towards ensuring quality education, especially in mathematics. This study would provide an exemplary perspective of learning mathematics by addressing academic problems, eliminating learning barriers, eradicating academic prejudices and misconceptions, evaluating teaching-learning mathematical practices, and providing viable and appropriate strategies, approaches, and techniques in dealing with mathematics. Hence, this study would pave the way for curriculum development by enabling early identification and intervention to prevent prolonged math difficulties. Disseminating research on number sense effectively is crucial to maximizing its impact on education, policy, and practice through academic publications, workshops, seminars, and policy reports.

Previous studies implicitly suggest that psychological factors such as anxiety, pressure, etc., affect academic performance. However, no studies have explicitly examined the interrelationship between math avoidance and psychological difficulties, nor have they examined how this interrelationship correlates with number sense, especially at the college level. Thereupon, this study aims to remind us of the importance of cultivating students' number sense and to identify the factors that affect it. Hence, resolving the factors that hinder the cultivation of the student's mathematical prowess is significant for a more effective teaching-learning process. Students should master the basics and cultivate their mathematical foundation by understanding whyand how computations or algorithms are developed and applied in a particular context; in other words, students must develop adept number sense.

This study aims to determine the best-fit model of DV. Specifically, it seeks answers to the following questions: 1. What is the level of students' math avoidance in terms of self-confidence, values, enjoyment, and Motivation? 2. What is the level of students' psychological difficulties in terms of: General Mathematics Self-efficacy; Grade Anxiety; Future Anxiety; In-class Anxiety; and Assignment Anxiety? 3. What is the level of number sense of the students? 4. Is there a significant relationship between the following: Math-avoidance and number sense; Psychological difficulties and number sense; and Math-avoidance and psychological difficulties? 5. What is the fit model of this study?

MATERIALS AND METHODS

Description of the study area

This study was conducted at one of the public higher institutions in Davao de Oro. The tertiary school where the study was conducted is one of the province's key higher education institutions, serving students from the locality and neighboring municipalities. The institution offers undergraduate programs designed to develop professional competence in teaching, entrepreneurship, and agriculture. These include the Bachelor of Secondary Education (BSED) with majors in Mathematics, English, and Social Studies; the Bachelor of Elementary Education (BEED); the Bachelor of Science in Entrepreneurship (BSE); and the Bachelor of Science in Agriculture (BSA).

This study specifically targeted students enrolled in the BSED, BEED, and BSE departments at Davao De Oro State College, located in the Municipality of Maragusan. The school offered different courses, such as the Bachelor of Science in Entrepreneurship (BSE), Bachelor of Science in Agriculture (BSA), Bachelor of Elementary Education (BEED), and the Bachelor of Secondary Education (BSED), with three majors: Social Studies, Mathematics, and English.

The selection of this public higher institution as the study locale was purposive. Local educators and institutional reports have consistently noted recurring challenges in students' number sense and a tendency toward mathematics avoidance, particularly among education majors who are expected to acquire strong mathematical foundations for their future teaching responsibilities. Compared with other public higher institutions, this chosen institution presents a distinctive context in which many students originate from rural and agricultural backgrounds, often with limited exposure to advanced mathematical applications beyond the classroom. This recurring issue of avoidance and difficulty in number sense provided a compelling rationale for situating the study in the aforementioned location.

Figure 1. Map of Davao De Oro State College, Davao de Oro, Philippines.

Research respondents

The respondents of this study were the 1st- and 2nd-year students of BSE, BEED, and BSED majoring in Social Studies, Mathematics, and English at a tertiary school in Maragusan who have already completed or are currently taking the GED 3 "Mathematics in the Modern World" course. GED 3 courses are offered to all students and include foundational mathematical concepts, providing a relevant background for assessing math avoidance and psychological difficulties related to number sense. The primary reason for selecting these respondents is to ensure a baseline level of mathematical knowledge and exposure, making them ideal for investigating the hypothesized relationships in the structural equation modeling. The inclusion criteria for choosing respondents were as follows: (1) Respondents could be of any gender; (2) Respondents should be enrolled in the Academic Year 2024-2025 at Davao de Oro State College of Maragusan and have completed or are currently taking the GED 3 course; (3) Respondents should be willing to participate in the study. Exclusion criteria include cognitive impairments, psychological instability, significant physical disabilities, and illnesses that could affect participation, ensuring mentally, physically, and psychologically sound participants to guarantee the study's validity and participant safety.

A purposive sampling approach was employed to ensure that respondents had direct experience with math avoidance and psychological difficulties, enabling an in-depth assessment of how these factors influence number sense. Participants were selected based on specific criteria, ensuring that only individuals with previous encounters with math-related anxiety and avoidance behaviors were included in the study. This method was chosen to maximize relevance, as it ensures the sample aligns directly with the study's objectives. Eligible students were identified through self-reported experiences, academic records, and instructor referrals, ensuring that only those who met the criteria were included. By implementing purposive sampling, the study effectively captures meaningful data from individuals who directly experience math-related psychological challenges, reinforcing the validity of the findings and their implications for mathematical learning and intervention strategies. The researcher provided the respondents with the desired time, research duration, and follow-up, allowing for one month of data collection.

To determine an appropriate sample size, we used the 10:1 ratio of cases per estimated parameter (Bentler and Chou, 1987). The estimated parameter for this study is 21, yielding a minimum sample size of 210. Moreover, the Raosoft Sample Size Calculator was used, with a 95% confidence level and a 5% margin of error. Given the total population of Bachelor of Secondary Education (BSE), Bachelor of Elementary Education (BEED), and Bachelor of Education in Secondary Teaching (BSED) first- and second-year students, the expected sample size of 214 was established. This ensures statistical reliability while prioritizing individuals most affected by these factors.

Table 1. Data of the respondents of the study.

Respondents	Number of respondents (Population size)	Number of respondents (Sample size)
BSED 1A	38	16
BSED 2A	33	14
BSED 2B	21	9
BEED 1A	33	14
BEED 1B	31	13
BEED 2A	25	10
BSE 1A	37	15
BSE 1B	30	13
BSE 2A	31	13
BSE 2B	35	15
BSED 1B	30	13
BSED 2C	31	13
BEED 1C	30	13
BEED 2C	35	15
BSE 2C	40	17
Total	480	214

Research design

This study used quantitative research, applying a descriptive-correlational design with Structural Equation Modeling (SEM) to systematically examine the interrelationships among number sense, math avoidance, and psychological difficulties. Quantitative research involves gathering, coding, and analyzing numerical data, enabling objective assessment and statistical evaluation of relationships among variables (Williams et al., 2022; Creswell and Creswell, 2018). By employing a correlational design, this study seeks to identify patterns and measure the strength of associations among math avoidance, psychological difficulties, and number sense, rather than to establish causal relationships (Creswell and Creswell, 2018; Fraenkel et al., 2019). Additionally, Structural Equation Modeling (SEM) was used solely to assess the overall fit of the hypothesized model rather than to establish new relationships among the variables. SEM is a multivariate statistical framework for evaluating how well a proposed theoretical model represents relationships among variables (Kline, 2016; Hair et al., 2019). By analyzing model fit indices, SEM provides statistical validation and determines the adequacy of the theoretical model (Hu and Bentler, 1999; Kline, 2016), ensuring that the proposed pathways among math avoidance, psychological difficulties, and number sense are accurately represented without introducing additional causal interpretations.

Furthermore, this study did not test causal pathways; instead, it focused on verifying whether the constructs are valid and reliably measured, examining interrelationships through correlations between latent variables (Hair et al., 2019; Tabachnick and Fidell, 2019) and providing a solid foundation for future structural analysis. By using SEM as a model validation tool alongside correlational analysis, this study ensures a rigorous evaluation of the model's theoretical accuracy and measurement quality (Kline, 2016; Hair et al., 2019), reinforcing the reliability and significance of its findings.

Research instrument

The study used three standardized survey instruments to measure the research variables. To assess math avoidance, the researcher adapted the shorter version of the Attitude Toward Mathematics Inventory (ATMI) developed by Tapia and Marsh (2004) and later validated through confirmatory factor analysis by Majeed et al., (2013), which reported a high internal consistency with a Cronbach's alpha of 0.96 for the overall scale. To measure psychological difficulties related to mathematics, the study used the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) developed by May (2009), which demonstrated excellent reliability (Cronbach's alpha = 0.96). Lastly, to assess students' number sense, the researcher employed the Brief Assessment of Number Sense developed by Kirkland et al. (2024), which demonstrated good internal consistency (Cronbach's alpha = 0.83). These instruments were selected because they are standardized measures with established validity and reliability suitable for assessing the constructs examined in this study.

For the level of the indicators of math avoidance, such as self-confidence, motivation, enjoyment, and values, the following parameter limits will be used (Tables 2, 3, and 4).

Table 2. Interpretation of means for math avoidance.

Range of means	Descriptive equivalent	Interpretation
4.21 - 5.00	Very High	This means that the level of math avoidance of the students is always observed.
3.41 - 4.20	High	This means that the level of math avoidance of the students is often observed.
2.61 - 3.40	Moderate	This means that the level of math avoidance of the students is sometimes observed.
1.81 - 2.60	Low	This means that the level of math avoidance of the students is seldom observed.
1.00 - 1.80	Very Low	This means that the level of math avoidance of the students is never observed.

For the level of indicators of psychological difficulties, such as self-efficacy, in-class grade anxiety, future, and assignment, the following parameter limits will be used.

Table 3. Interpretation of means for psychological difficulties.

Range of means	Descriptive equivalent	Interpretation
4.21 - 5.00	Very High	This means that the level of psychological difficulties of the students is always observed.
3.41 - 4.20	High	This means that the level of psychological difficulties of students is often observed.
2.61 - 3.40	Moderate	This means that the level of psychological difficulties of the students is sometimes observed.
1.81 - 2.60	Low	This means that the level of psychological difficulties of the students is seldom observed.
1.00 - 1.80	Very Low	This means that the level of psychological difficulties of the students is never observed.

For the level of number sense, the following parameter limits will be used.

Table 4. Interpretation of means for number sense.

Range of means	Descriptive equivalent	Interpretation
20.01` - 25.00	Very High	This means that the level of number sense of the students is outstanding.
15.01 - 20.00	High	This means that the level of number sense of the students is exceedingly satisfactory
10.01 - 15.00	Moderate	This means that the level of number sense of the students is very satisfactory.
5.01 - 10.00	Low	This means that the level of number sense of the students is satisfactory.
1.00-5.00	Very Low	This means that the level of number sense of the students is fairly satisfactory.

Data collection

Before conducting the study, this research underwent an ethical evaluation and approval from the Research Ethics Committee to ensure that all procedures complied with institutional ethical standards for research involving human participants. After obtaining ethical clearance, the researcher sought formal permission from the institution's Branch Director to conduct the study. The adapted survey questionnaires were also subjected to expert validation to ensure their contextual relevance and alignment with the study variables.

The study employed purposive sampling to select respondents who were first- and second-year students enrolled in the Bachelor of Secondary Education (BSED) and Bachelor of Elementary Education (BEED) programs, as these students are directly relevant to the investigation of mathematics-related attitudes and competencies. In accordance with recommended Structural Equation Modeling (SEM) standards, the sample size was determined based on the minimum required for model estimation. Using the 10:1 ratio of cases per estimated parameter suggested by Bentler and Chou (1987), and considering the estimated parameters in the model, the minimum sample size required was 210 respondents. The Raosoft Sample Size Calculator was also used with a 95% confidence level and a 5% margin of error, resulting in a final target sample size of 214 respondents.

Data were collected using Google Forms, where participants received the informed consent form and survey questionnaire through their institutional e-mail accounts and official social media group chats. Participation in the study was entirely voluntary, and respondents were assured that their identities and responses would remain confidential and used solely for research purposes. Participants were also informed of their right to withdraw from the study at any time without any consequences. All responses were automatically recorded in Google Sheets for proper organization and subsequent statistical analysis. After data collection, the data were analyzed with a statistician's assistance using Structural Equation Modeling, and the findings served as the basis for the study's conclusions and recommendations.

Data analysis

In the analysis of data, the mean, standard deviation, Pearson's r, the overall *F*-test, the X^2 test, and SEM analysis were the statistical tools employed to compute the data and test the hypothesis at the 0.05 level of significance. Additionally, a correlational design was used to explore the existence and strength of relationships among measurable variables, including mediating factors (Remulta et al., 2025). Structural Equation Modeling (SEM) was used solely to assess the overall fit of the hypothesized model rather than to establish new relationships among the variables (Picaza et al., 2023). SEM is a multivariate statistical framework for evaluating how well the proposed model captures the relationships among math avoidance, psychological difficulties, and number sense. By analyzing model fit indices, SEM provides robust statistical validation, ensuring that the theoretical pathways in the study are accurately represented without introducing additional causal interpretations.

RESULTS

This section presents the study's statistical findings on the interrelationships among math avoidance, psychological difficulties, and number sense among the respondents. Specifically, it reports the descriptive statistics of the study variables and the results of the correlational and structural equation modeling (SEM) analyses used to evaluate the hypothesized model and the strength of associations among the latent constructs. Before analysis, reverse coding was applied to positively worded items to ensure consistent interpretation of the scales.

Math avoidance

Table 5. Level of math avoidance.

Statements	Mean	SD	Descriptive equivalent
Self-confidence	3.16	0.60	Moderate
Values	2.30	0.93	Low
Enjoyment	2.91	0.70	Moderate
Motivation	2.95	0.58	Moderate
Category mean	2.83	0.56	Moderate

Table 5 presents the descriptive statistics for students' math avoidance across four indicators: low self-confidence, low enjoyment, low motivation, and poor values. Low self-confidence had the highest mean (M = 3.16, SD = 0.60), suggesting that students occasionally doubt their ability to solve problems, hesitate to participate in class, or feel anxious about making mistakes. Low motivation (M = 2.95, SD = 0.58) and low enjoyment (M = 2.91, SD = 0.70) were also moderate, indicating that students sometimes lack the drive or interest to engage in mathematics-related tasks. In contrast, poor values—which include giving up easily, avoiding challenges, or believing that mathematical ability cannot improve—had the lowest mean (M = 2.30, SD = 0.93), suggesting that most students generally recognize the importance of mathematics and believe they can improve. The overall mean for math avoidance (M = 2.83, SD = 0.56) indicates a moderate level, suggesting that avoidance behaviors are observed occasionally rather than consistently.

The variability in scores (SDs ranging from 0.58 to 0.93) indicates that while some students remain confident and motivated, others withdraw under certain conditions. These results align with Self-Determination Theory (Ryan and Deci 2000), which posits that lower perceived competence can lead to hesitation, anxiety, and avoidance behaviors.

Psychological difficulties

Table 6. Overall level of psychological difficulties.

Statements	Mean	SD	Descriptive equivalent
Self-efficacy	3.03	0.79	Moderate
Grade anxiety	3.55	0.96	High
Future anxiety	3.28	0.91	Moderate
In-class anxiety	3.19	0.62	Moderate
Assignment anxiety	3.09	0.54	Moderate
Overall mean	3.23	0.48	Moderate

Table 6 shows students' psychological difficulties related to mathematics, with an overall mean of M = 3.23 (SD = 0.48), indicating moderate anxiety and self-doubt. Among the indicators, grade anxiety—stress or worry about academic performance—was highest (M = 3.55, SD = 0.96), suggesting that students are often concerned about grades, which may hinder engagement. Future anxiety (M = 3.28, SD = 0.91) reflects apprehension about upcoming mathematical demands, including understanding concepts or completing assessments. In-class anxiety (M = 3.19, SD = 0.62) suggests occasional nervousness during instruction, potentially influenced by peer dynamics or classroom climate. Assignment anxiety (M = 3.09, SD = 0.54) highlights stress associated with homework or assessments, while low self-efficacy (M = 3.03, SD = 0.79) reflects moderate challenges in students' beliefs about their capacity to succeed in mathematics.

The standard deviations (0.48–0.96) reveal differences in students' experiences, with some showing resilience and others more susceptible to psychological challenges. Expectancy-Value Theory (Eccles et al., 1983) supports these findings by emphasizing that beliefs about success and task value shape motivation and engagement. Self-Efficacy Theory (Bandura, 1977) further explains that doubts in one's competence can lead to avoidance behaviors, as reflected in the moderate scores for anxiety and self-efficacy.

Number sense

Table 7. Level of number sense.

	Mean	SD	Descriptive equivalent
Number sense	11.52	5.91	Moderate

Table 7 presents the descriptive statistics for students' number sense, with a mean of M = 11.52 (SD = 5.91), indicating a moderate level. This suggests that students generally have a satisfactory understanding of numerical concepts, including estimating values, recognizing numerical relationships, and solving mathematical problems. However, the relatively high standard deviation indicates variability, suggesting that some students struggle with specific aspects of number sense, underscoring the need for targeted instructional support to ensure equitable proficiency.

Structural equation model of the study

The structural equation model (SEM) illustrates the interrelationships among math avoidance, psychological difficulties, and number sense (Figure 2). Key factors such as self-confidence, motivation, and anxiety are depicted to illustrate how psychological challenges contribute to math avoidance, which, in turn, negatively affects numerical fluency. The diagram provides a visual representation of these connections, highlighting how emotional and behavioral factors influence mathematical learning.

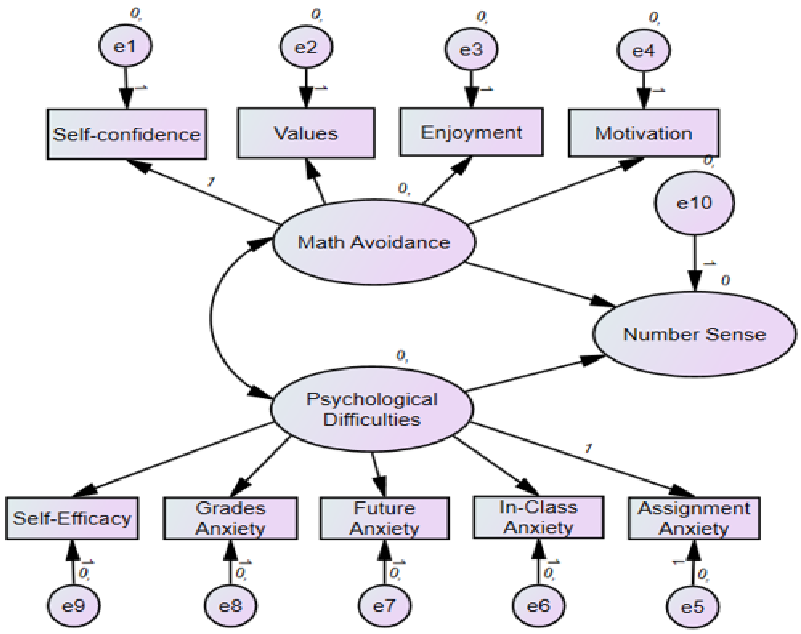

Figure 2. Structural equation model of the study.

Table 8. Structural equation model results.

Model fit	Baseline test					
	AIC	BIC	n	χ^2	df	*p*
Model 1	223.06	253.39	214	0.000	0	1.000

Fit indices	Index	Value
	Comparative Fit Index (CFI)	1.00
	T-size CFI	0.98
	Tucker-Lewis Index (TLI)	1.00
	Bentler-Bonett Non-normed Fit Index (NNFI)	1.00
	Bentler-Bonett Normed Fit Index (NFI)	1.00
	Parsimony Normed Fit Index (PNFI)	0.00
	Bollen's Relative Fit Index (RFI)	1.00
	Bollen's Incremental Fit Index (IFI)	1.00
	Relative Noncentrality Index (RNI)	1.00

Note.: T-size CFI is computed for $\alpha = 0.05$. The T-size equivalents of the conventional CFI cut-off values (poor < 0.90 < fair < 0.95 < close) are **poor** < **NaN** < **fair** < **NaN** < close for model: Model 1.

SEM results indicated excellent model fit, confirming the structural validity of the hypothesized relationships among math avoidance, psychological difficulties, and number sense. The model fit indices met or exceeded recommended thresholds: standardized root mean square residual (SRMR) = 0.000, root mean square error of approximation (RMSEA) = 0.000, comparative fit index (CFI) = 1.000, Tucker–Lewis index (TLI) = 1.000, relative noncentrality index (RNI) = 1.000, goodness-of-fit index (GFI) = 1.000, and adjusted goodness-of-fit index (AGFI) = 1.000 (Table 8).

These values provide strong evidence that the proposed model adequately represents the latent constructs and their interrelationships. Specifically, the SRMR indicates near-perfect correspondence between the observed and model-implied covariances (well below the recommended threshold of 0.08), and the RMSEA suggests excellent fit, meeting the stringent criterion of ≤ 0.06. The CFI, TLI, and RNI values all reached 1.000, surpassing the recommended threshold of ≥ 0.95, while the GFI and AGFI similarly demonstrated optimal fit, exceeding established criteria. Collectively, these indices confirm that the hypothesized structural relationships are well represented in the data.

The standardized regression weights indicate that psychological difficulties significantly increase math avoidance, while math avoidance significantly reduces number sense. However, psychological difficulties do not directly influence number sense, suggesting that their effect operates indirectly through math avoidance.

Direct, indirect, and total effects of the structural model

Table 9. Direct, indirect, and total effects of the structural model.

Path	Direct effect	Indirect effect	Total effect	Interpretation
Psychological difficulties → Number sense	-0.07	-0.25	-0.32	Indirect effect is stronger than the direct effect
Psychological difficulties → Math avoidance	0.52	—	0.52	Direct effect only
Math avoidance → Number sense	-0.48	—	-0.48	Direct effect only

The results show that psychological difficulties influence number sense primarily through math avoidance (Table 9). The indirect effect is stronger than the direct effect, confirming that math avoidance mediates the relationship between psychological difficulties and number sense.

The structural model is just-identified with zero degrees of freedom, resulting in perfect fit indices by default. In such cases, goodness-of-fit measures are not used to evaluate the model. Instead, the interpretation focuses on the structural relationships among the variables, particularly the direction and significance of the path coefficients.

DISCUSSION

In line with earlier studies, this study found that college students demonstrated moderate levels of math avoidance, psychological difficulties, and number sense. These results indicate that while students occasionally exhibit negative attitudes and anxieties toward mathematics, such behaviors are not consistently pervasive. Nevertheless, the moderate level of number sense—despite the use of an instrument calibrated for high school students—reveals a concerning gap between expected and actual proficiency, underscoring the need for focused instructional strategies and interventions to strengthen numerical competence.

Math avoidance

The findings of this study reveal that moderate levels of math avoidance are closely tied to students' low self-confidence, which often manifests as hesitation in problem-solving and disengagement from mathematical reasoning. This supports earlier work by Pentang (2019), who noted that discouraging experiences foster negative perceptions of mathematics, and Akbari et al. (2020), who emphasized that classroom pressures and social comparisons weaken students' belief in their abilities. Luttenberger et al. (2018) further confirmed that low confidence combined with math anxiety directly leads to withdrawal from tasks, while your study adds that students who doubted their problem-solving skills were less likely to participate actively. These findings collectively underscore that diminished confidence is the strongest driver of avoidance behaviors.

Building on this, the consequences of avoidance extend beyond immediate classroom participation. Choe et al. (2019) demonstrated that disengaged students often avoid math-intensive courses, thereby limiting their long-term academic and career opportunities. This withdrawal creates a cycle in which avoidance reduces skill development, reinforcing anxiety and further disengagement. Lashley (2024) highlighted that stress and cognitive fatigue intensify this cycle, while Jenifer et al. (2023) showed that diminished motivation and mental exhaustion reduce active engagement, compounding the problem.

Theoretical perspectives provide a deeper lens for interpreting these patterns. Eccles et al. (1983) Expectancy-Value Theory explains that engagement depends on both perceived competence and the value attributed to mathematics. When students lack confidence and see little relevance in math, avoidance becomes more pronounced. Similarly, Self-Determination Theory (Deci and Ryan, 1985) suggests that external pressures weaken intrinsic motivation, while Seligman (1975) concept of learned helplessness explains how repeated failures foster resignation and disengagement. Given these insights, interventions must target both confidence and motivation. Guided mastery experiences can gradually build competence, while collaborative problem-solving reduces isolation and normalizes struggle. Positive reinforcement and growth mindset messaging help students view math as learnable, while stress-reduction techniques such as mindfulness or structured breaks mitigate cognitive fatigue. Finally, connecting math to real-world applications enhances its perceived value, encouraging students to see mathematics as meaningful and achievable.

In conclusion, your study reinforces that math avoidance is not simply disinterest but a complex interplay of confidence, motivation, stress, and perceived relevance. By strengthening self-confidence, fostering intrinsic motivation, and reducing situational stressors, educators can break the cycle of avoidance. Such holistic interventions not only improve classroom engagement but also expand students' academic and life opportunities.

Psychological difficulties

This study revealed moderate psychological difficulties among students, particularly grade and future anxiety, which strongly influenced their engagement in mathematics. Heightened concern for academic performance reflected fear of failure and performance expectations, consistent with Horowitz and Graf (2019) and Eyler (2022), who identified grade anxiety as a leading source of stress. Ersozlu (2024) and Ehmke and Schulze-Stocker (2024) similarly noted that anxiety disrupts working memory and reduces participation, often leading to avoidance behaviors. Interestingly, this study found that self-efficacy recorded the lowest mean among psychological indicators, suggesting that while students retain a moderate belief in their abilities, persistent anxiety remains a critical barrier to engagement.

Furthermore, this study also demonstrated that psychological difficulties directly impair cognitive functioning and achievement. Skagerlund et al. (2019) showed that math anxiety reduces number processing, while Samuel and Warner (2021) found that anticipatory anxiety consumes working memory, limiting problem-solving. Maldonado Moscoso et al. (2020) further emphasized that psychological difficulties mediate the relationship between numerical competence and math achievement. The findings highlight that moderate psychological difficulties act as a barrier to motivation, engagement, and number sense development, reinforcing the need for interventions that address both emotional and cognitive domains.

Grounded in Bandura's Self-Efficacy Theory and Zeidner's Test Anxiety Theory (1998), this study underscores the importance of strengthening confidence while promoting emotional regulation. Specific interventions include structured feedback to reduce uncertainty, scaffolded problem-solving tasks to build mastery, and metacognitive coaching to help students manage stress. Anxiety-reduction programs such as mindfulness and relaxation training can improve focus and resilience, ensuring that students sustain motivation while coping with evaluative pressures.

In terms of number sense, this study found moderate proficiency among college learners, suggesting gaps in prior instruction and reinforcement. Consistent with Kirkland (2022), weaknesses in number sense persist even at advanced levels, as Damaso (2019) observed among Filipino high school students. Reliance on rote memorization, as noted by Marga and Papadopoulos (2020), further reduces problem-solving flexibility, which explains the observed variability in competence in this study. state this much more concisely and directly to the point,comprehensive also to all types of readers

To address these gaps, this study suggests targeted instructional strategies, such as systematic instruction in place value, grouping, and mental computation, to strengthen number sense. Integrating real-world applications can increase relevance and motivation, while collaborative learning activities encourage peer support and reduce anxiety. Combining number sense training with stress-management techniques creates a dual pathway: improving cognitive skills while mitigating psychological barriers. As Shanley et al. (2017)demonstrated, stronger number sense not only predicts achievement but also buffers against anxiety, reinforcing its protective role in learning.

In conclusion, this study highlights that moderate psychological difficulties and gaps in number sense jointly hinder mathematical engagement. Concise, targeted interventions—structured feedback, scaffolded mastery tasks, metacognitive coaching, systematic number sense instruction, and anxiety-reduction programs—can directly address these barriers. By integrating cognitive and affective strategies, educators can help students build confidence, regulate emotions, and strengthen foundational skills, ultimately reducing avoidance and supporting sustained success in mathematics.

Number sense

This study revealed that students demonstrated only a moderate level of number sense, falling short of expectations for college-level learners. This is particularly concerning because the instrument used was primarily calibrated for middle- to high-school proficiency. Thus, although students achieved a moderate mean score, their performance did not meet the higher standards expected at the tertiary level. This finding underscores that moderate number sense is insufficient to support advanced mathematical reasoning and, more importantly, inadequate to buffer against the psychological difficulties, such as anxiety and avoidance, that were also observed.

The results suggest that weaknesses in number sense stem from instructional gaps and limited reinforcement. Kirkland (2022) reported that deficits in number sense persist even at advanced stages of education, while Damaso (2019) noted that Filipino high school students often struggle with number sense, restricting their ability to transition to abstract reasoning in college mathematics. Reliance on rote memorization, further reduces flexibility and adaptability in problem-solving, thereby accounting for the variability observed in this study. These gaps mean that students enter higher education with fragile numerical foundations, leaving them vulnerable to the compounding effects of math anxiety and low confidence.

Furthermore, the findings highlight that number sense is not only a cognitive skill but also a protective factor against psychological difficulties. Stronger number sense supports problem-solving, arithmetic fluency, and confidence (Bisaillon, 2023; Gruver, 2021), and students with well-developed numerical skills are better equipped to address math-related issues and experience less disengagement (van der Ven et al., 2019). However, the moderate level observed in this study suggests that students lack the resilience needed to counteract stress and avoidant behaviors. Shanley et al. (2017) found that early improvements in number skills strongly predict later achievement, while Mammarella et al. (2021) showed that anxiety interacts with cognitive skills, such as number sense, influencing outcomes. Thus, without stronger number sense, psychological difficulties are more likely to persist and hinder learning.

Finally, this study demonstrated that a moderate level of number sense, coupled with psychological difficulties, creates barriers to engagement and achievement. As Maldonado Moscoso et al. (2020) noted, math avoidance and anxiety can undermine number sense, reinforcing the interconnectedness of emotional and cognitive domains. The moderate mean and high variability observed indicate both a limited foundation and areas needing improvement. Interventions must therefore be comprehensive: strengthening conceptual understanding through systematic instruction in place value, grouping, and mental computation; integrating real-world applications to enhance relevance; and embedding stress-management techniques such as mindfulness and collaborative learning to reduce anxiety. By addressing both cognitive and affective dimensions, educators can help students move beyond “moderate” competence, ensuring that number sense becomes a robust foundation that supports confidence, resilience, and sustained success in mathematics.

Structural Equation Modeling (SEM) findings

SEM analysis demonstrated excellent model fit, confirming the hypothesized relationships among math avoidance, psychological difficulties, and number sense. These results support the notion that math avoidance serves as a mediator between psychological difficulties and number sense, echoing findings from Maldonado Moscoso et al. (2020). While psychological difficulties did not directly predict number sense in this study, their indirect influence through avoidance highlights the importance of addressing affective factors to improve students’ mathematical learning outcomes.

Implications and novel contributions

This study makes a unique contribution by integrating emotional (psychological difficulties), motivational (math avoidance), and cognitive (number sense) constructs within a single structural model. Unlike earlier research that examined these factors separately, the SEM validation here demonstrates their interconnected roles. The findings underscore the need for holistic interventions that address emotional regulation, build confidence, reduce anxiety, and promote active engagement with numerical tasks.

Moreover, the study provides contextual insights within Philippine higher education, suggesting that cultural attitudes toward mathematics, academic pressure, and instructional quality play important roles in shaping students’ avoidance behaviors and numerical competence. Thus, developing strategies that simultaneously target affective, motivational, and cognitive domains is essential to foster mathematical proficiency, enhance engagement, and reduce the barriers posed by anxiety and avoidance behaviors.

CONCLUSION

The present study examined the structural relationships among math avoidance, psychological difficulties, and number sense among college students. The findings reveal that, while students are aware of the importance of mathematics, they still experience moderate levels of math avoidance and psychological strain, along with only moderate numerical proficiency. These outcomes indicate that emotional, motivational, and instructional factors remain pivotal influences in mathematical learning, even at the tertiary level. Furthermore, the results show that low self-confidence, weak motivation, and limited enjoyment are key contributors to math avoidance. Students’ occasional disengagement and self-doubt reflect an internal conflict—valuing mathematics cognitively but struggling to sustain engagement affectively. This suggests that avoidance is not rooted in rejection of the subject but in situational barriers linked to teaching quality, prior experiences, and anxiety toward evaluation. Addressing these barriers requires educators to create learning environments that foster confidence, intrinsic motivation, and positive affect toward mathematics.

Moreover, the moderate psychological difficulties observed—especially the prevalence of grade and future anxiety—underscore how performance pressure and anticipatory worry shape students’ attitudes and behavior. These forms of anxiety can diminish focus, participation, and persistence, even among students with adequate ability. However, the relatively lower level of self-efficacy suggests that while students occasionally doubt their competence, such doubt is not yet debilitating. This finding carries an optimistic implication: targeted interventions emphasizing mastery, feedback, and emotional regulation may enhance self-efficacy and mitigate anxiety before it develops into chronic avoidance. In addition, the study also revealed that students’ number sense remains below expected levels for college learners, indicating persistent weaknesses in fundamental numerical reasoning. This aligns with Wulandari et al. (2021), Kirkland (2022), and Damaso (2019), who observed that poor number sense often stems from inadequacies in earlier instruction and insufficient reinforcement of conceptual understanding. As Marga and Papadopoulos (2020) highlighted, overreliance on rote memorization continues to undermine students’ mathematical flexibility and intuition. Collectively, these insights emphasize the need for early, conceptually grounded, and sustained instruction that promotes reasoning over recall and emphasizes understanding rather than procedural repetition.

The Structural Equation Modeling (SEM) analysis confirmed that the hypothesized model accurately represented the interrelationships among math avoidance, psychological difficulties, and number sense. The results demonstrated that math avoidance functions as a mediating variable, linking emotional factors to cognitive performance. This suggests that while psychological difficulties may not directly impair numerical ability, they can indirectly influence learning through avoidance behaviors. Consequently, effective interventions must address both the emotional and behavioral dimensions of mathematics learning to strengthen cognitive outcomes. Overall, this study contributes to the growing body of literature on the affective and cognitive dimensions of mathematics education by validating a model integrating motivational, psychological, and numerical constructs. It provides empirical evidence that emotional well-being and engagement are not peripheral to mathematical achievement but central to it. The findings hold significant implications for curriclum developers, educators, and policymakers: fostering number sense and mathematical fluency requires not only conceptual instruction but also psychological support systems that nurture confidence and reduce anxiety. Future research should extend these findings through longitudinal and experimental designs to examine how interventions targeting math avoidance and anxiety influence number sense over time. Moreover, exploring cross-cultural and gender-based differences could deepen the understanding of how psychological and contextual factors shape mathematical learning. In sum, this study underscores that strengthening mathematical competence requires a balanced integration of cognition, emotion, and motivation. Interventions that build confidence, regulate anxiety, and promote meaningful engagement are vital to cultivating not only higher number sense but also a more resilient, confident, and motivated generation of mathematics learners.

RECOMMENDATIONS

Based on the findings, several recommendations are proposed. For Instruction, mathematics educators should integrate confidence-building activities, such as incremental challenges, collaborative problem-solving, and mastery-oriented feedback, along with any innovative, viable interventions to reduce avoidance behaviors. For Curriculum Development, early and continuous reinforcement of number sense should be prioritized in secondary education to prevent skill decline in college. For Intervention Programs, schools should implement cognitive-behavioral and motivational interventions that address math anxiety and promote self-efficacy. For Future

Research, subsequent studies may explore longitudinal designs or qualitative analyses to examine how affective and cognitive factors evolve. For Educational Policy, institutional support systems, such as peer mentoring, psychological counseling, and remedial instruction, should be established to help students manage anxiety and strengthen foundational mathematics skills.

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AUTHOR CONTRIBUTIONS

C. C. M. C: Crafted the introduction, methodology, and the result and discussion. R. R. P: Analyzed the data and concluded the result.

DECLARATIONS

Informed consent statement

Studies involving human subjects followed the institutional and national guidelines set by the ethics board. Studies involving minors or children below 18 years old secured consent statement form.

Conflict of interest

The authors declared that there are no competing interests to any authors.

AI Desclosure

The authors declare that no Artificial Intelligence (AI) or AI-assisted technologies were used in the preparatin of this manuscript.

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