Problem-Solving Skills, Psychological Attributes, and Teaching Competence: A Structural Model on Mathematics Performance of Learners

ABSTRACT

Mathematics is a crucial subject that fosters logical and critical thinking. However, students often struggle with mathematics due to various factors, including problem-solving skills, psychological attributes, and teaching competence. This study aims to develop a structural model that explains how these factors influence mathematics performance among senior high school students. A quantitative research approach was employed using a descriptive-correlational and causal-comparative design. Data were collected through survey questionnaires and achievement tests administered to 517 students from public senior high schools in Davao City. Findings revealed significant relationships between problem-solving skills, psychological attributes, teaching competence, and mathematics performance. Furthermore, the study proposes an optimized structural model that can help educators and policymakers develop targeted interventions to improve students' mathematical proficiency.

Keywords: Mathematics performance, problem-solving skills, psychological attributes, teaching competence, structural equation modeling

INTRODUCTION

Mathematics is a fundamental subject that is crucial across disciplines, fostering logical and critical thinking (Jose, 2015). However, despite its recognized importance, learners' mathematics performance remains a persistent concern globally (Naiker et al., 2020; Pagtulon-an and Tan, 2018; Sharma et al., 2018). Learners often struggle with numerical and algebraic manipulation, problem-solving, and exhibit negative attitudes towards the subject (Yeh et al., 2019). This issue is evident in various countries, including the USA, where only 33% of eighth-graders demonstrated math proficiency in 2017 (Venezky, 2018), and Fiji, where curriculum issues and teacher competence contribute to poor performance (Chand et al., 2021). The Philippines' low ranking in international assessments, such as the TIMSS (Cordova and Tan, 2018), and consistently low scores on national achievement tests highlight systemic challenges. Locally, Davao City National High School has also experienced declining math performance, with learners demonstrating strength in knowledge acquisition but weakness in higher-order thinking, particularly problem-solving.

This decline is attributed to an overemphasis on content rather than process skills. Chapman (2015) emphasizes the importance of combining creative and critical thinking in mathematical understanding, while Mafakheri et al. (2013) and Odumbe et al. (2015) highlight the influence of psychological attributes (like self-efficacy) and teaching competence on performance. While existing literature identifies problem-solving skills, psychological attributes, and teaching competence as key factors, research exploring the interrelationships of these variables within the Filipino context, specifically in Davao City's senior high schools, is limited. This study addresses this gap by exploring a structural equation model of mathematics performance, considering these three variables. The research seeks to contribute to a better understanding of these connections, inform educational practices, and potentially lead to targeted interventions that improve learners' mathematics outcomes.

LITERATURE REVIEW

Problem-Solving Skills and Mathematics Performance

Problem-solving is integral to mathematics learning (Polya, 1957). This is a skill defined as the ability of a person to engage in cognitive processes when understanding and solving problems for which the method of solving is not readily available (Shute et al., 2016). Studies have shown that students with well-developed problem-solving abilities perform better in mathematics (OECD, 2014). However, Filipino students often struggle with problem-solving, affecting their overall mathematics achievement (Guinocor et al., 2020). This is noted with the performance of Filipino learners in national and international surveys on mathematics and science competencies, where they lagged behind their neighboring countries like Singapore, South Korea, Hongkong, Chinese Taipei, and Japan (Care et al., 2015).

Filipino learners excel in knowledge acquisition but fare considerably low in lessons requiring higher-order thinking skills (Dinglasan & Patena, 2013; Ganal & Guiab, 2014). The problem-solving approach emphasizes that essential mathematics concepts and procedures can be best taught through problem-solving tasks or activities that engage learners in thinking about the essential mathematical concepts and skills they need to learn (Albay, 2019). Wiggins (2014) stated that concrete understanding in mathematics means that learners understand which concepts are relevant by being able to draw inferences from them.

Psychological Attributes and Mathematics Performance

Psychological factors such as self-efficacy and anxiety significantly impact mathematics performance (Bandura, 1997). Students with higher self-efficacy tend to exhibit better problem-solving skills (Zakariya, 2022), whereas mathematics anxiety negatively correlates with performance (Sharma, 2017). The essence of self-efficacy influences the choices of tasks of the learners on which they will expend much effort—it determines the learner's perseverance under challenging situations (Zakariya, 2022). Correspondingly, learners who were confident of their performance in mathematics tend to have good results in mathematics achievement (Dela Rosa, 2017). Furthermore, acknowledging mathematics anxiety is of great importance to the development and use of mathematical skills. It is also important as a cause of much stress and distress (Dowker et al., 2016). Woodard (2004) observed in a study that a significantly low negative relationship existed between exam scores and math anxiety scores. This means that learners with high mathematics anxiety tend to perform with lower scores in mathematical performance (Zhang et al., 2019).

Teaching Competence and Mathematics Performance

Teachers' professional competence is conceptualized as teachers' characteristics, which consist of two fundamental dimensions: cognitive and motivational. The cognitive dimension of teacher competence comprises teachers' profession-specific knowledge and beliefs. The motivational extent of teacher competence includes teachers' self-efficacy and enthusiasm for teaching. Researchers have provided empirical evidence that these dimensions of teacher competence affect the teaching and learning of mathematics (Fauth et al., 2019). Teaching competence, encompassing knowledge of subject matter, instructional strategies, and classroom management, is critical in shaping student outcomes (Sriraman & English, 2010). Shin and Shim (2021) revealed that those who consistently perceived their mathematics teachers as highly competent and whose perceptions of their teachers' competence became more positive over time were more likely than other students to choose math-intensive majors.

The learners of highly committed teachers are more likely to learn the material and develop a positive attitude toward school than those of teachers with low levels of commitment. This is because teacher commitment is a crucial factor influencing the teaching-learning process (Asares, 2011). Also, a heavy emphasis on the commitment to teaching is a crucial factor in the achievement of learners (Altun, 2017). Florence (2017) concluded that the quality of teachers significantly determines the quality of graduates and recommends that teachers be assisted in improving competence. Andaya (2014) asserted that teachers significantly contribute to the success and failure of learners in school and their respective lives. Odumbe et al. (2015) stated that mathematics performance hangs on the success of the teaching process.

MATERIALS AND METHODS

Research Design

This study employed a quantitative research approach with a descriptive-correlational and causal-comparative design. Quantitative research methods explain a phenomenon by collecting numerical data and evaluating it using statistics (Apuke, 2017). Meanwhile, the descriptive-correlational studies describe the variables and the relationships that occur naturally between and among them (Barroga et al., 2023). On the other hand, causal-comparative research attempts to identify a causative relationship between an independent variable and a dependent variable (Maheshwari, 2018).

In descriptive research, the researcher does not manipulate the variables in the study. It simply intends to describe the nature of the involved variables (Ayton, 2023). On the other hand, a correlational study determines whether or not two variables are correlated. This means studying whether an increase or decrease in one variable corresponds to an increase or decrease in the other variable (Kabir, 2016). The research sought to examine the relationships between problem-solving skills, psychological attributes, teaching competence, and mathematics performance. The study sampled 517 Grade 11 students from five public senior high schools in Davao City using stratified random sampling.

The study utilized four validated instruments was used: a problem-solving skills questionnaire (Asparin, 2013), a mathematics self-efficacy scale (Nicolaidou & Philippou, 2003), a mathematics anxiety scale (Ikegulu, 2003), and a teaching competence questionnaire (University of Southeastern Philippines, 2012). The achievement test in General Mathematics was aligned with the K to 12 curriculum (DepEd Order No. 8, s. 2015). Furthermore, data were collected via survey administration and test assessments. The analysis employed Pearson correlation, multiple linear regression, and structural equation modeling to determine relationships and model fit indices. In addition, the scoring procedure

Scoring Procedure

The scoring procedure for this study involved assessing both problem-solving skills and psychological attributes. Problem-solving skills were evaluated using descriptors from Asparin (2013) and based on the DepEd Order No. 8, series 2015. Scores were categorized into five levels: Very Good (84.00 - 100%), Good (76.00 - 83.99%), Fair (68.00 - 75.99%), Poor (60.00 - 67.99%), and Very Poor (below 60%). Each level had a corresponding qualifying statement describing the learners' demonstrated abilities.

Psychological attributes, including mathematics self-efficacy and mathematics anxiety, were measured using a 5-point Likert scale ranging from Strongly Disagree to Strongly Agree. For the mathematics anxiety questionnaire, the scale was reversed for items with negative statements. Mathematics self-efficacy was categorized into five levels based on the mean scores: Strongly Agree (4.20 - 5.00), Agree (3.40 - 4.19), Undecided (2.60 - 3.39), Disagree (1.80 - 2.59), and Strongly Disagree (1.00 - 1.79). Each level was accompanied by a qualitative description, such as "very highly confident" or "less confident," to characterize the learners' self-efficacy.

Similarly, mathematics anxiety was categorized using the same 5-point scale and mean score ranges. Qualitative descriptions ranged from "highly anxious" to "less anxious," providing a descriptive assessment of the learners' anxiety levels. This approach allowed for a comprehensive evaluation of both cognitive and affective factors influencing the learners' mathematical performance.

Treatment of the Data

The data were analyzed and interpreted using various statistical tools. The mean and standard deviation determined the level of problem-solving skills, psychological attributes, teaching competence as perceived by the respondents, and mathematics performance. Pearson r determined the significance of the relationship between levels of the variables. Stepwise multiple regression analysis determined the combination of independent variables that best predicts the dependent variable. Structural equation modeling illustrated the model that will explain the learners' performance in mathematics. The following indices were computed to evaluate the goodness of fit of the generated models: Chi-square/degrees of freedom, Goodness of Fit Index, Normed Fit Index, Comparative Fit Index, and Root Mean Square Error of Approximation. The relative chi-square is an index of how fit the data to the tested model by assessing the difference between actual and predicted matrices. The observed value should be less than 2.0 with a p-value greater than 0.05. The RMSEA estimates a lack of fit compared to the entire model and should be less than 0.05.

RESULTS AND DISCUSSION

The level of learners' mathematics performance was assessed through easy, moderate, and difficult items. Students demonstrated varying proficiency levels, with most performing below the expected mastery level (DepEd, 2015). The senior high school student's math performance is below expectations. Across easy (remembering, understanding, applying), moderate (analyzing, evaluating), and difficult (creating) problems, students struggled, achieving mean scores of 71.79, 71.31, and 71.59, respectively. Overall, 73.32% of students did not meet expectations, with a total mean score of 71.56. This reveals weak foundational math skills, impacting recall, application, analysis, and evaluation.

These results confirm declining math performance in Davao City and highlight the need for targeted interventions, likely due to inadequate junior high preparation. Higher-order thinking skills were particularly weak, confirming previous findings (Dinglasan & Patena, 2013). As shown in Table 1, out of 517 respondents, only nine learners, or 1.70%, got an *outstanding performance* on easy items. Thirty (30) learners, or 5.80%, got *very satisfactory*, followed by fifty (50) learners, or 9.70%, who got *satisfactory*, then 51 learners, or 9.90%, got *fairly satisfactory*. The majority, or 377 learners, which is 72.90% of the total respondents, *did not meet expectations* in their mathematics performance.

Table 1: Level of Mathematics Performance of Learners

Score Percentage	**Frequency**	**Percent**	**Qualitative Description**
(Easy Items)			
90 – 100	9	1.70	Outstanding
85 – 89	30	5.80	Very Satisfactory
80 – 84	50	9.70	Satisfactory
75 – 79	51	9.90	Fairly Satisfactory
Below 75	377	72.90	Did Not Meet Expectations
Mean: 71.79 SD: 7.119			Did Not Meet Expectations
(Moderate Items)			
90 – 100	2	0.40	Outstanding
85 – 89	39	7.60	Very Satisfactory
80 – 84	26	5.03	Satisfactory
75 – 79	56	10.80	Fairly Satisfactory
Below 75	394	76.20	Did Not Meet Expectations
Mean: 71.31 SD: 6.845			Did Not Meet Expectations
(Difficult Items)			
90 – 100	20	3.90	Outstanding
85 – 89	47	9.10	Very Satisfactory
80 – 84	0	0.00	Satisfactory
75 – 79	64	12.40	Fairly Satisfactory
Below 75	386	74.60	Did Not Meet Expectations
Mean: 71.59 SD: 9.703			Did Not Meet Expectations
(Over-all Mathematics Performance)			
90 – 100	4	0.77	Outstanding
85 – 89	33	6.38	Very Satisfactory
80 – 84	48	9.28	Satisfactory
75 – 79	53	10.25	Fairly Satisfactory

Below 75	379	73.32	Did Not Meet Expectations
Mean: 71.56 SD: 6.677			Did Not Meet Expectations

The questionnaire has three stems, which refer to three different problem scenarios in the test. Each stem represents George Polya's four (4) problem-solving steps with a Cronbach Alpha Coefficient of 0.80. The senior high school students exhibit weak problem-solving skills, as demonstrated by an overall mean score of 62.63 based on Polya's problem-solving techniques. Students struggle most with devising a plan (mean 58.91), indicating a significant deficiency in selecting appropriate strategies and effectively using given information. Understanding the problem also presents a challenge (mean 65.25), suggesting difficulty in comprehending information and identifying the task at hand. Furthermore, the ability to look back and review solutions for applicability to similar problems is poor (mean 60.57). These findings reveal that students need to strengthen their critical analysis and problem-solving skills across all stages: understanding, planning, execution, and review. This data reinforces existing evidence of inadequate problem-solving skills among these learners.

Presented in Table 2 is the mean proficiency level of learners' problem-solving skills. It was shown that, though carrying out the plan has the highest mean of 65.57, which still denotes *poor skill*. The result indicates that learners have difficulties in their algorithmic ability even after recognizing the correct approach to solving.

Table 2: Level of Problem-solving Skills of Learners

Score Percentage	**Frequency**	**Percent**	**Qualitative Description**
(Understanding the Problem)			
84.00 – 100	106	20.50	Very Good
76.00 – 83.99	92	17.79	Good
68.00 – 75.99	0	0.00	Fair
60.00 – 67.99	115	22.24	Poor
Below 60	204	39.46	Very Poor
Mean: 65.25 SD: 17.24			Poor
(Devising a Plan)			
84.00 – 100	77	14.89	Very Good
76.00 – 83.99	74	14.31	Good
68.00 – 75.99	0	0.00	Fair
60.00 – 67.99	83	16.05	Poor
Below 60	283	54.74	Very Poor
Mean: 58.91 SD: 15.49			Very Poor
(Carrying out a Plan)			
84.00 – 100	126	24.37	Very Good
76.00 – 83.99	83	16.05	Good
Below 60	212	41.01	Very Poor
Mean: 65.57 SD: 17.02 (Looking Back)			Poor
84.00 – 100	78	15.09	Very Good
76.00 – 83.99	0	0.00	Good
68.00 – 75.99	98	18.96	Fair

60.00 – 67.99	142	27.47	Poor
Below 60	199	38.49	Very Poor
Mean: 60.57 SD: 14.52			Poor
(Over-all Problem-solving Skills)			
84.00 – 100	48	9.28	Very Good
76.00 – 83.99	71	13.73	Good
68.00 – 75.99	88	17.02	Fair
60.00 – 67.99	121	23.40	Poor
Below 60	189	36.57	Very Poor
Mean: 62.63 SD: 10.78			Poor

Learners' math self-efficacy (belief in their math problem-solving competence) and math anxiety (fear, low self-esteem, tension towards math) were measured using established scales (Asparin, 2013; Ikegulu, 2003) Results (Table 3) show learners are moderately confident in solving one- and two-step problems, and in helping classmates. Overall, they are moderately confident in planning and executing mathematical problem-solving steps, indicating capability in math tasks. However, this moderate confidence suggests underlying anxieties that could affect performance, highlighting the need to boost their confidence levels. Research indicates widespread math anxiety, with many disliking math or feeling inadequate (Yang, 2014). This anxiety involves tension, apprehension, and fear related to math (as seen in Table 3). Specifically, learners reported anxiety when facing math-related courses, volunteering to solve problems publicly, working on math homework independently, and recalling formulas during tests. Overall, senior high school learners demonstrated moderate math anxiety, indicating a moderate level of fear, low self-esteem, and tension toward mathematics. This moderate anxiety likely influences their moderate confidence in math, creating apprehension that can negatively impact problem-solving performance. This finding aligns with previous research. Lemana (2012) found moderate math anxiety in first-year mathematics education students at the University of Southeastern Philippines. Similarly, Asparin (2013) observed moderate math anxiety levels in Bukidnon National High School learners.

Table 3: Summary of the Level of Psychological Attributes of Learners

Indicators	**Mean**	**Standard Deviation**	**Qualitative Interpretation**
Mathematics Self-Efficacy	2.87	0.53	Moderately Confident
Mathematics Anxiety	3.28	0.68	Moderately Anxious
Psychological Attributes	3.07	0.39	Moderate

As shown in table 4 learners perceived their senior high school mathematics teachers as moderately competent overall, particularly in commitment, knowledge, independent learning strategies, management, and timeliness. While commitment received the highest rating, teachers were seen as moderately competent in orienting students, demonstrating enthusiasm, accommodating individual needs, and maintaining a professional appearance. For knowledge and independent learning, teachers were considered moderately competent in explaining the subject matter, demonstrating up-to-date knowledge, connecting topics, applying concepts, creating critical thinking exercises, recognizing student potential, and encouraging further learning. Even in timeliness, which received the lowest rating, teachers were still seen as moderately competent in record keeping, relating subject matter to current issues, using up-to-date resources, and responding to queries. This moderate perception may be attributed to teachers working outside their primary field of expertise. However, these teachers are committed and doing their best despite student doubts. These findings are consistent with studies by Ferrer (2017), Florence (2017), Andaya (2014), Callaman (2020), and Pantic (2011), which emphasize the impact of teacher competence and personal qualities on student success.

Table 4: Summary of the Level of Teaching Competence

Indicators	Mean	Standard Deviation	Qualitative Interpretation
Commitment	3.24	0.89	Moderately Competent
Knowledge of the Subject Matter	3.16	0.91	Moderately Competent
Teaching for Independent Learning	3.16	0.92	Moderately Competent
Management of Learning	3.09	0.90	Moderately Competent
Timeliness of Education Delivery	3.07	0.87	Moderately Competent
Overall	3.15	0.82	Moderately Competent

The data presented in Table 5 shows the relationship of the exogenous variables: problem-solving skills, psychological attributes, and teaching competence, with the endogenous variable: mathematics performance. Results show that there is a significant relationship that exist between the variables problem solving skills, teaching competence and mathematics performance of learners as evidenced by the probability value. However, no significant relationship exists between self-efficacy and the mathematics performance. The results lead the researcher to reject the null hypothesis that there is no significant relationship between the problem-solving skills, psychological attributes, teaching competence, and the learners' mathematics performance. Therefore, there is a significant relationship that exist between the problem-solving skills, psychological attributes, teaching competence and the learners' mathematics performance.

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Table 5: The Relationship between the Independent Variables and Mathematics Performance

Variables	r	p-value
Problem-Solving Skills	0.407	0.000**
Understanding the Problem	0.233	0.000**
Devising a Plan	0.440	0.000**
Carrying Out the Plan	0.324	0.000**
Looking Back	0.247	0.000**
Psychological Attributes		
Mathematics Self-Efficacy	-0.017	0.694
Mathematics Anxiety	-0.521	0.000**
Teaching Competence	0.665	0.000**
Commitment	0.628	0.000**
Knowledge of Subject Matter	0.626	0.000**
Teaching for Independent Learning	0.607	0.000**
Management of Learning	0.586	0.000**
Timeliness of Education Delivery/Supervision	0.583	0.000**
Legend: * $p < 0.05$ ** $p < 0.01$		

As shown in table 6, the results revealed that devising a plan under problem-solving skills, mathematics anxiety under psychological attributes, and commitment, knowledge of the subject matter, and teaching for independent learning under teaching competence were the said five predictors. This result leads the researcher to reject the null hypothesis. Moreover, the F-ratio strongly indicates that the equation is significant. The r^2 indicates that 51.3% of the variation in mathematics performance could be explained by the five significant predictors. This means that the variables explain the variances in the model.

Therefore, the null hypothesis that "problem-solving skills, psychological attributes, and teaching competence of mathematics teachers as perceived by the learners do not significantly influence mathematics performance" is rejected. The result shows that *commitment* (CTC), *knowledge of the subject matter* (KTC), and *teaching for independent learning* (TTC) for teaching competence, *mathematics anxiety* (MAP) for psychological attributes, and *devising a plan* (DPP) for problem-solving skills were the predictors of mathematics performance (MP). Thus, the regression equation would be:

$$\mathbf{MP} = 61.952 + 1.588(\mathbf{CTC}) - 1.873(\mathbf{MAP}) + 1.536(\mathbf{KTC}) + 0.048(\mathbf{DPP}) + 0.881(\mathbf{TTC})$$

The result is similar to the study of Lemana (2015), on freshmen mathematics, education learners of the University of Southeastern Philippines, where teachers' commitment, knowledge of the subject matter, and teaching for independent learning predicts the achievement test result. The study of Asares (2011) also stated that teacher commitment is a key factor influencing the teaching-learning process. The commitment to teaching is a crucial factor to contribute to the achievement of the learners (Altun, 2017). Teachers with higher knowledge of the subject matter have a more significant impact on the math test scores of their learners. With more emphasis on learners taking responsibility for their learning, the teacher's role becomes that of a leader rather than a controller of learning (Hesmondhalgh, 2011).

Additionally, multiple regression analyses were performed by Olango (2016), in which mathematics anxiety was entered as one of the predictors, and the result shows that mathematics anxiety predicted mathematics performance. Bhat (2014) supported the notion that problem-solving ability is the best predictor of mathematics performance in high school learners. Laterell (2002) emphasized that problem-solving is not simply applying technical skills, because there is a step where learners must decide which procedure to apply. The mathematicians value problem-solving skills, an area of mathematics that should not be ignored or undervalued in the education of secondary mathematics learners.

Table 6: Regression Analysis of Problem-Solving Skills, Psychological Attributes, Teaching Competence and Mathematics Performance

Independent Variables	**Unstandardized Coefficients**		**Standard Coefficients**		
Constant	B	Std. Error	Beta	t	Sig,
Teaching Competence (Commitment)	61.952	1.855		33.397	0.000
Psychological Attributes (Mathematics Anxiety)	1.588	0.412	0.212	3.853	0.000
Teaching Competence (Knowledge of Subject Matter)	-1.873	0.339	-0.205	-5.516	0.000
Problem Solving Skills (Devising a Plan)	1.536	0.434	0.209	3.542	0.000
Teaching Competence (Teaching for Independent Learning)	0.048	0.011	0.155	4.438	0.000
Note: r = 0.716, r^2 = 0.513, F-ratio = 107.524, p-value = 0.000					

Structural Models Testing

This section presents the best-fit model after testing five hypothesized models in the study, which were derived from the correlation of the three exogenous variables with several indicators. Problem-solving skills (PSKILL) is an exogenous variable that is indicated by understanding the problem (UNTP), devising a plan (DEVISE), carrying out the plan (CARRY), and looking back (LOOKB). Psychological attributes (PSYCHAT) is an exogenous variable indicated by mathematics self-efficacy (SEFFIC) and mathematics anxiety (MANX). Teaching competence (TECCOM) is an exogenous variable that is indicated by commitment (COMMI), knowledge of subject matter (KNOWL), teaching for independent learning (INDEP), management of learning (MANLE), and timeliness of education delivery/supervision (TIMEL). The mathematics performance (MAPERF) of the learners is the endogenous variable indicated by easy items (EASY), moderate items (MODER), and difficult items (DIFF).

In this section, the direct, indirect, and total effects, reflected through beta weight, were also presented to explain the strength of the effect drawn from each exogenous variable to the endogenous variable. The model-fit values for each model were likewise elaborated in this section.The mathematics performance (MAPERF) of the senior high school learners is the endogenous variable indicated by easy (EASY), moderate (MODER), and difficult items (DIFF). The percentage of variance explained in the combined influence of *problem-solving skills, psychological attributes*, and *teaching competence* on *mathematics performance* is 58%.

Test of Hypothesized Model 5

Figure 1 produced a combined relationship of problem-solving skills (PSKILL) with the following indicators; understanding the problem (UNTP), devising a plan (DEVISE), carrying out the plan (CARRY), and looking back (LOOKB), and teaching competence (TECCOM) with the following indicators; commitment (COMMI), knowledge of subject matter (KNOWL), teaching for independent learning (INDEP), and management of learning (MANLE).

Compared to previous models, this eliminates psychological attributes (PSYCHAT) and an indicator in teaching competence which is timeliness of education delivery/ supervision (TIMEL) to satisfy to the standard criteria of a fitting model. Model modification is done through elimination of latent variables that do not directly contribute to model fitness (Bryne, 2013).

The model hypothesizes that both problem-solving skills and teaching competence would yield a decent fit model. In this model, 57% of variations in mathematics performance can be explained by the combined influence of problem-solving skills and teaching competence. This result demonstrates the real scenario in the classroom as observed by the researcher that when learners are good problem-solvers they are taught by competent teachers who expose these learners to the different problem-solving strategies and thus, performed better.

Structural Model 5

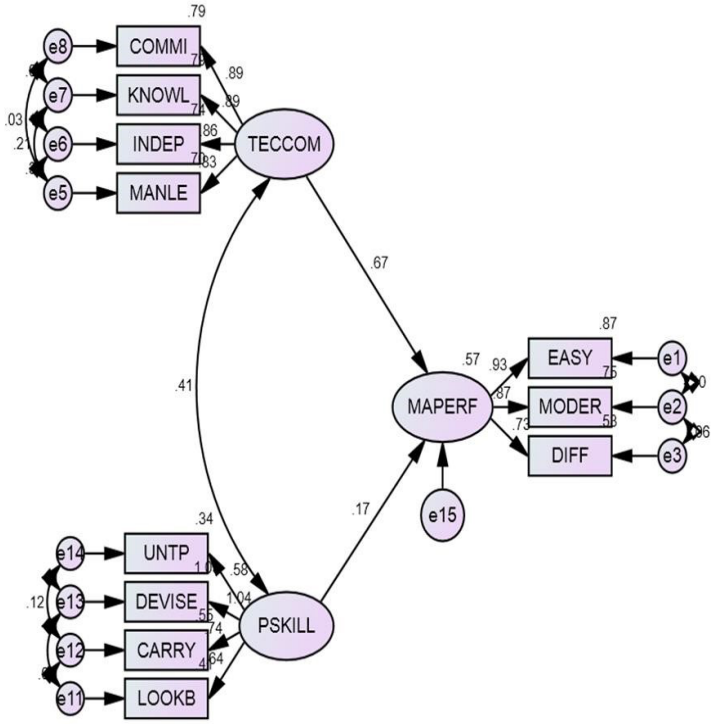

Figure 1: A structural model 5 on mathematics performance of learners.

Legend:

TECCOM	- Teaching Competence	CARRY	- Carrying Out the Plan
COMMI	- Commitment	LOOKB	- Looking Back
INDEP	- Teaching for Independent Learning	MAPERF	- Mathematics Performance
KNOWL	- Knowledge of the Subject Matter	EASY	- Easy Items
MANLE	- Management of Learning	MODER	- Moderate Items
UNTP	- Understanding the Problem	DIFF	- Difficult Items
DEVISE	- Devising a Plan		

Table 7 shows the standardized estimates of the direct, indirect, and total effects of teaching competence and problem-solving skills on mathematics performance. Teaching competence got a higher beta weight compared to problem-solving skills which means that its influence on the success of the senior high school learners' performance in mathematics is greater.

The results affirm the findings of Wrahatnolo and Munoto (2018) revealing that problem-solving skills are one of the 21st-century skills and cognitive skills that affect learners' performance in mathematics, the claim of Tope (2012) stating that competent teachers are the most influential factor in bringing high learners' achievement. The teachers greatly influence the learners' performance through their abilities, potentialities and professional competence.

According to former DepEd Secretary Leonor Briones, learners are now asked to solve problems, to find solutions, and to engage in critical thinking since this is now the global standard for the 21st century learners. To update the quality of instruction based on the needs of our learners, constant reskilling and upskilling is essential for our mathematics educators.

Table 7: *Standardized Direct, Indirect, & Total Effect Estimates of Structural Model 5*

Latent Variables	Direct Effect	Indirect Effect	Total Effect
Problem-Solving Skills	0.169	0	0.169
Teaching Competence	0.668	0	0.668

Table 8 presents the estimated effects of problem-solving skills (PSKILL) and teaching competence (TECCOM) as exogenous variables on mathematics performance (MAPERF) as endogenous variable.

Mathematics performance was influenced by easy, moderate, and difficult items. The teaching competence was influenced by commitment, knowledge of the subject matter, teaching for independent learning, and management of learning. Problem-solving skills were influenced by understanding the problem, devising a plan, carrying out the plan, and looking back. The indicators were significant at ($p<0.05$).

This result validates Polya's theory (Carifio, 2015) that problem-solving accompanies the cognitive activities of mobilization, organization, meta-cognitive evaluation, and quality. These meta-cognitive activities are necessary for actual mathematical problem-solving that generate positive or negative emotions that may help or hinder obtaining a solution to the problem.

As revealed in the table, problem-solving skills such as devising a plan, carrying out the plan, and understanding the problem are the most influential activities in the learners' mathematics performance.

Table 8: Standardized Regression Weights of Structural Model 5

Variables	B	S.E.	Beta	C.R.	p-value
MAPERF <--- TECCOM	3.920		0.668		
MAPERF <--- PSKILL	0.086	0.024	0.169	3.609	***
EASY <--- MAPERF	1.000		0.933		
MODER <--- MAPERF	0.895	0.039	0.868	23.011	***
DIFF <--- MAPERF	1.067	0.065	0.730	16.396	***
MANLE <--- TECCOM	0.662		0.834		
INDEP <--- TECCOM	0.705		0.863		
KNOWL <--- TECCOM	0.713		0.890		
COMMI <--- TECCOM	0.702		0.890		
LOOKB <--- PSKILL	1.000		0.638		
CARRY <--- PSKILL	1.267	0.185	0.745	6.830	***
DEVISE <--- PSKILL	1.708	0.233	1.042	7.343	***
UNTP <--- PSKILL	0.885	0.161	0.582	5.497	***

Table 9 shows the goodness of fit measures for Model 5. The model fit of teaching competence and problem-solving skills combined generated the best-fit model for mathematics performance. In identifying the best fitting model, the value on all indices must meet the required standard criteria. The Chi-Square/Degree of Freedom

(CMIN/DF) got a value of less than 2, a P-value greater than 0.05, a Root Mean Square Error of Approximation (RMSEA) value lesser than 0.05, and Normed Fit Index (NFI), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), and Goodness of Fit Index (GFI) values greater than 0.95.

The Structural Equation Model (SEM) gave way to the generated five structural models through a series of analyses in estimating causal relationships and assumptions concerning learners' mathematics performance. The research study represents the concerted effects of three exogenous variables and one endogenous variable.

Table 9: *Goodness of Fit Measures of Structural Model 5*

INDEX	CRITERION	MODEL FIT VALUE
CMIN/DF	<2	0.965
P-value	>0.05	0.518
NFI	>0.95	0.992
TLI	>0.95	1.001
CFI	>0.95	1.000
GFI	>0.95	0.990
RMSEA	<0.05	0.000

Legend: CMIN/DF-Chi-Square/Degree of Freedom NFI - Normed Fit Index
GFI- Goodness of Fit Index TLI - Tucker-Lewis Index
RMSEA- Root Mean Square Error of Approximation CFI - Comparative Fit Index

Table 10 reveals the comparative analysis of the five generated models. The first structural model included all predictor variables in their full measures. The second structural model eliminated teaching competence. The third eliminated problem-solving skills, and the fourth eliminated psychological attributes. Lastly, the fifth structural model eliminated psychological attributes and timeliness of education delivery/ supervision, an indicator of teaching competence.

Models 1 to 4 did not satisfy some of the acceptable thresholds in finding the best-fit model based on the standard criteria. The indices verify that the standard measures for good fit were all met in Model 5. The direct effect of teaching competence and problem-solving skills on mathematics performance depicts the best-fit model.

The final model therefore, to describe problem solving skills, teaching competence, and learners' mathematics performance is Model 5. The direct effect of teaching competence and problem-solving skills on mathematics performance depicts the best-fit model. The structural model 5 reflects that the problem-solving skills and teaching competence are the key determinants of the learners' mathematics performance.

Table 10: Summary of Standard Fit Indices of the Five Structural Models

Model	CMIN/DF	P - value	NFI	TLI	CFI	GFI	RMSEA
1	2.369	0.000	0.964	0.973	0.979	0.955	0.052
2	2.372	0.000	0.967	0.971	0.980	0.976	0.052
3	2.750	0.000	0.978	0.980	0.986	0.964	0.058
4	2.733	0.000	0.969	0.974	0.980	0.955	0.058
5	0.965	0.518	0.992	1.001	1.000	0.990	0.000
Standard Value	< 2	> 0.05	> 0.95	> 0.95	> 0.95	> 0.95	< 0.05

The final model therefore, to describe problem solving skills, teaching competence, and learners' mathematics performance is Model 5. The direct effect of teaching competence and problem-solving skills on mathematics performance depicts the best-fit model. The structural model 5 reflects that the problem-solving skills and teaching competence are the key determinants of the learners' mathematics performance. This means that learners who follow Polya's four-step process of solving problems and who are exposed to teachers with commitment, knowledge of the subject matter, teaching for independent learning, good management of learning, timeliness of education delivery, and supervision are likely to perform well in mathematics.

The generated result rejected the null hypothesis. Therefore, there is a structural equation model that best fits mathematics performance. The result conforms to Bloom's learning theory, Walberg's theory on educational

productivity, and Carroll's theory on school learning, which illustrates the relationship between learning variables and learners' educational outcomes. Furthermore, mathematics performance is best predicted by teaching competence and problem-solving skills. Relying on the results of this undertaking, specifically as reflected in Model 5, which is the best-fit model, Figure 2 theorized a model for Learning Mathematics (LM). The theory generated on learning mathematics, as reflected in the model, emulates Bloom's learning theory, where learning objectives and assessments are classified into levels of complexity. Also, the mathematics performance of learners was greatly influenced by easy items, followed by moderate, and lastly by difficult items.

It is theorized in the model that the more the students are taught by competent teachers who emphasized the Polya's four-step process of solving mathematics problems, the better would be their mathematics performance. LM model captures the impact of problem-solving skills on mathematics performance of senior high school learners. It can be seen in the model that the greatest influence in problem-solving skills is drawn from devising a plan, followed by carrying out the plan, then looking back, and lastly, understanding the problem.

Profoundly, the bloom's learning theory (1956) also revealed three factors influencing learning achievement. These factors include the cognitive domain, the affective domain, and the teaching quality (Pimta, et al., 2009). Furthermore, it is supported and confirmed by Walberg's theory on educational productivity (1982), and Carroll's theory on school learning (1963) which illustrates the relationship between learning variables and learners' educational outcomes. Contrary to Bandura's theory on self-efficacy (1977) and debilitating anxiety theory, notice that psychological attributes are gray areas in the LM model. This implies that mathematics self-efficacy and mathematics anxiety of senior high school learners in the city of Davao do not predict their mathematics performance.

Moreover, the highest beta weight was drawn from devising a plan because this is the most crucial point when it comes to problem solving Learners cannot see right away the connections, thus, failed to formulate the equation successfully. Efforts in solving will be put into waste if learners will come up with an incorrect formula or equation. The lowest beta weight was drawn from understanding the problem. Though successful problem-solving requires understanding the problem, learners cannot obtain a correct solution without a strong foundation on the different properties in mathematics.

LM model is consistent with Alcantara and Bacsa (2017), stating that the mathematics performance of the learners is positively correlated to their level of problem-solving skills. On the other hand, the model negates the findings of Valencia (2019) signifying the no relationship between problem-solving skills and mathematics performance. A subtle difference from the results of Guven and Cabakcor (2013), which showed a highly significant relationship between mathematics performance and problem-solving skills, and Zacal (2019), which highlighted that problem-solving skills best predict mathematics performance.

Therefore, reskilling/ upskilling teaching competence includes embedding problem-solving skills in teaching. This study is vital since the ultimate goal of Mathematics education is to apply the learned concepts in both familiar and unfamiliar real-life scenarios. The study enables both the teachers and learners to recognize the essence of strengthening problem-solving skills to better their performance in Mathematics. As revealed in the compiled literature, a solid foundation in problem-solving skills paves the way to having an outstanding performance in Mathematics.

Meanwhile, teaching competence as one of the predictors of mathematics performance was negated by Cabalo and Cabalo (2019) claiming that there was no significant correlation between academic performance in mathematics and their teachers' teaching competence. Similar to the findings of Oredina and Ebueza (2020), whereas the competence of mathematics teachers does not necessarily forecast the performance of learners in mathematics. Another study conducted by Irungu and Mugambi (2013) linking teacher competence with student performance in mathematics among senior secondary schools in Nigeria showed that teachers with high levels of competence can break down abstract mathematical knowledge into more straightforward and more refined forms. Competent teachers accomplish their goals and make up for the insufficiencies of the curriculum.

LM model establishes the role of teaching competence in improving mathematics performance. The outcomes of the study would help establish the basis for education administrators and leaders to understand the need to guarantee that teachers proceed to more training and professional growth as a milestone to improve performance in mathematics. These findings may also serve as basis for educational policymakers, internal and external stakeholders, specifically mathematics teachers to always consider and strengthen learners' problem-solving skills and their teaching competence to ensure the attainment of positive and excellent mathematics performance among learners.

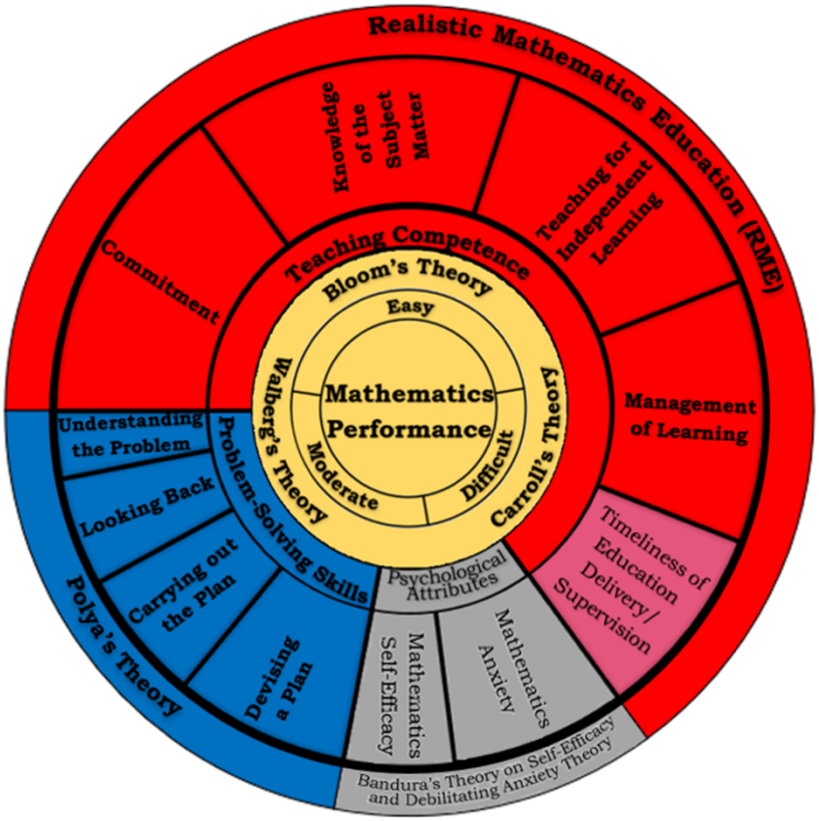

Figure 2: Learning Mathematics Model

CONCLUSION

This study developed a structural model that best fits learners' mathematics performance. The study investigated the learners' problem-solving skills in terms of understanding the problem, devising a plan, carrying out the plan, and looking back; the learner's psychological attributes in terms of mathematics self-efficacy and mathematics anxiety; and teachers' teaching competence as perceived by the students in terms of commitment, knowledge of the subject matter, teaching for independent learning, management of learning, and timeliness of education delivery/supervision. The researcher conducted the study at the five public senior high schools in the division of Davao City, Philippines. The study respondents were the 517 grade 11 senior high school students enrolled during the school year 2017-2018.

A structural model equation model, particularly the maximum likelihood method determined the best-fitting model relative to mathematics performance. Indices such as Chi-Square/Degree of Freedom (CMIN/DF), Normed Fit Index (NFI), Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA) examined the model's goodness of fit.

The study found that Model 5 was the best-fit model for mathematics performance since it satisfied all the prescribed values for CMIN/DF, P-value, NFI, TLI, CFI, GFI, and RMSEA. The model suggests that mathematics performance is best predicted by teaching competence and learners' problem-solving skills. Devising a plan (DPP) as an indicator of problem-solving skills, mathematics anxiety (MAP) as an indicator of psychological attributes, and commitment (CTC), knowledge of subject matter (KTC), and teaching for independent learning (TTC) as indicators of teaching competence predicts mathematics performance. Moreover, 51.3% of the variation in mathematics performance is explained by the five significant predictors of the equation:

$$\mathbf{MP} = 61.952 + 1.588(\mathbf{CTC}) - 1.873(\mathbf{MAP}) + 1.536(\mathbf{KTC}) + 0.048(\mathbf{DPP}) + 0.881(\mathbf{TTC})$$

The Model 5 suggests that teaching competence and learner's problem-solving skills are significant determinants of mathematics performance. The result indicates that the mathematics performance of senior high school

learners in the division of Davao City is anchored on the teaching competence in terms of commitment, knowledge of the subject matter, teaching for independent learning, management of learning, and problem-solving skills in terms of understanding the problem, devising a plan, carrying out the plan, and looking back. On the other hand, The result implies that around 49% of the variability is not explained. A further investigation may be conducted by *future researchers* to determine other unidentified factors that could influence mathematics performance. Similar studies may also be conducted to check the consistency and validity of the result. The *teachers* may reconsider to be familiar with and apply Polya's four-step method in solving word problems since it is a determinant for mathematics performance. The teachers are also encouraged to apply varied and modernized teaching techniques, assessments, and evaluations to pique the learners' interest since teaching competence is also a determinant for mathematics performance.

In conclusion, the mathematics performance of learners demonstrated insufficient mathematics knowledge, skills, and problem-solving abilities, requiring significant support in authentic tasks. The learners performed *poorly* in mathematics problem-solving and lacked the skills to understand mathematics problems and devise a plan for the solution—as the learners cannot carry out the plan to solve a given problem. Additionally, the learners lack the skills to reflect or reflect on what they have done, what worked, and what did not in performing the mathematical tasks. The learner's self-efficacy shows they are *moderately confident*, implying that they are not confident enough to do mathematical tasks. Consequently, the learners were *moderately anxious* regarding mathematics anxiety, which implies that they have real feelings of fear of failure, low self-esteem, and tension towards the mathematics subject. The learners perceive their teachers to be *moderately competent* in teaching competence, implying that learners see their mathematics teachers as modest in their devotion to their work and how they act as role models to them. The result further suggests that they view their teacher's ability as just reasonable. Moreover, significant relationships exist between problem-solving skills, including its indicators, mathematics anxiety as an indicator of psychological attributes, and teaching competence with its indicators of mathematics performance. The result implies that these variables are potent factors in mathematics performance.

RECOMMENDATIONS

The findings and conclusions of the study led to the following recommendations, which are believed to improve teaching and learning. In mathematics performance, educators may implement targeted interventions addressing specific weaknesses, adjust instruction to motivate students and enhance problem-solving skills through Polya's method. Also, teacher training may focus on combining instruction with confidence-building and shifting towards interactive teaching to reduce anxiety. In addition, school administrators may invest in teacher development to handle low-performing students and create a supportive learning environment—recognizing that problem-solving skills, anxiety, and teaching competence significantly impact performance. Further research is needed to explore other influencing factors. Lastly, teachers are encouraged to utilize Polya's method and modernize teaching techniques to boost student engagement, as teaching competence remains a key determinant of success.

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