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Mediation effect of mathematics vocabulary skills between reading comprehension abilities and mathematics performance

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Abstract

Mathematics requires both comprehension and competence, which, once developed, benefit learners in daily life. This descriptive-correlational and explanatory study filled the gap by determining the mediating effect of vocabulary skills on the relationship between comprehension abilities and mathematics performance of 146 grade 7 students, chosen through multi-stage sampling techniques, in two select schools in Cabuyao City, Philippines, in 2024–2025. The respondents answered valid and reliable instruments with ethical considerations. The study used weighted mean, standard deviation, multiple regression bootstrap technique, mediated regression bootstrap technique, and PLS-SEM. The outcomes showed high levels of mathematics vocabulary skills and reading comprehension abilities, while mathematics performance reached satisfactory levels among the students. Multiple regression bootstrap technique revealed mathematics vocabulary as the most important factor affecting students' mathematics performance, while reading comprehension abilities have no direct significant effect with the presence of mathematics vocabulary. Furthermore, mediated regression bootstrap technique and PLS-SEM displayed a significant total effect of reading comprehension abilities on mathematics performance and the indirect effect flowing through mathematics vocabulary skills was significant. Mathematical vocabulary skills entirely mediate the indirect effect of reading comprehension abilities on mathematics performance exemplifying full mediation. It suggests that mathematics vocabulary skills are essential in enhancing reading comprehension abilities, thereby reinforcing their crucial role in academic achievement. Educators are encouraged to integrate vocabulary-focused strategies, administrators to support professional development in math literacy, and local officials to fund programs that strengthen foundational language skills in mathematics.

Keywords: *mathematics vocabulary skills, reading comprehension abilities, mathematics performance, mediating effect, SEM*

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1. Introduction

Mathematics is a discipline in which learners must comprehend instruction and acquire competence. Once acquired, these competencies become advantageous in their everyday lives. However, the recent mathematics performance of Filipino students has been exceedingly concerning. The Philippines ranked among the bottom 10 out of 81 countries in reading comprehension, mathematics, and science. Furthermore, the country has shown only marginal progress in these areas (Servallos, 2023). According to the DepEd Forum on PISA 2022, the regions of NCR, CAR, and Region 4A had the highest proportions of students who attained the minimum level of proficiency in reading, science, and mathematics. Additionally, it was noted that the mean mathematics proficiency levels in NCR and Region 4A were one level higher than the national average (Hernando-Malipot, 2023). Hence, the Department of Education (DepEd) must undertake significant efforts to improve students' performance, especially in mathematics.

Locally, the overall Mean Percentage Scores (MPS) for the mathematics first-quarter examinations taken by junior high school students in Cabuyao City were significantly below the mastery threshold (61.13%). Seventh graders achieved an MPS of 56.96, while eighth graders scored 60.1. Ninth graders earned 65.72, and tenth graders 61.72. Similarly, the mathematics performance of students at a national high school in Cabuyao City, in the 2023–2024 academic year was unsatisfactory, with diagnostic, first, and second quarterly test scores of 27%, 51%, and 54%, respectively. As a result, mathematics supervisors, educational leaders, and mathematics teachers must take action to enhance students' mathematical proficiency. Furthermore, studies conducted both locally and internationally have consistently found that reading comprehension and vocabulary skills influence mathematics achievement (Peng & Lin, 2019; Lin et al., 2021; Ünal et al., 2021; Song, 2022; Gomez et al., 2020; Orrantia & Canobi, 2019; Fuchs et al., 2016; Fuchs et al., 2018). However, previous studies have not sufficiently explored the mediating role of mathematics vocabulary proficiency in the relationship between reading comprehension abilities and mathematics achievement.

Aligned with the MATATAG agenda, a new curriculum implemented by the Department of Education, which aims to make the curriculum relevant, accelerate service delivery, take care of learners, and support teachers, the study aimed to describe the levels of mathematics vocabulary skills, reading comprehension abilities, and mathematics performance among Grade 7 students at the City Schools Division of Cabuyao, Laguna, in the 2024–2025

school year. Specifically, the study hypothesized and aimed to fill the research gap by testing whether mathematics vocabulary skills and reading comprehension abilities are significant predictors of mathematics performance, and whether mathematics vocabulary skills mediate the relationship between reading comprehension and mathematics performance.

2. Literature Review

2.1. Theoretical Framework

The present study is grounded in Vygotsky's theory of vocabulary development, which emphasizes that students acquire new knowledge, concepts, and abilities through interaction with individuals in their cultural environment. Cultural engagement enables students to acquire symbols that subsequently serve as the foundation for cognitive processes (Vygotsky, 1978). According to Lee and Hickmann (1983), this theory explores how language establishes new functional associations between psychological processes, leading to changes in consciousness. Thus, understanding any specific aspect of development—such as play, motivation, egocentric speech, or inner speech—requires recognizing its position within Vygotsky's broader developmental theory.

Several studies have utilized Vygotsky's sociocultural theory to examine how language and vocabulary skills emerge from social interactions and cultural contexts. For instance, Alkurtehe and Dzakiria (2018) found that sociocultural elements enhanced vocabulary development among Libyan EFL learners by linking language acquisition to meaningful cultural participation. Similarly, Hendricks et al. (2021) demonstrated that linguistic and cultural context significantly impacted vocabulary acquisition in early South African children, supporting Vygotsky's assertion that language is socially mediated. Gibbons (2015) emphasized the importance of scaffolding in secondary-school vocabulary acquisition, showing that learners benefit most from structured interactions within their zone of proximal development. Nourmohammadi (2023) also reported that second language learners acquire vocabulary more effectively when learning is socially constructed and mediated by peers and teachers. These findings affirm that vocabulary development is a socially situated activity, as Vygotsky's theory suggests.

These theories are relevant to the present study, as it proposes that students improve their understanding and mathematical performance by developing and applying their mathematical language skills through active participation in school-based interactions.

Comprehending any aspect of development—particularly mathematics—requires first mastering the foundational elements of language.

2.2. Mathematics Vocabulary and Mathematics Performance

Studies have shown that mathematics vocabulary significantly affects mathematics performance. For example, Peng and Lin (2019) found that mathematics vocabulary influenced performance differently depending on the outcome and type of vocabulary, even after controlling for general vocabulary, IQ, working memory, and processing speed. Math-specific language had a greater impact on word problems than on calculations. Vocabulary related to measurement and geometry was more predictive of word-problem performance than vocabulary related to numerical operations. These specific terms partially explained the relationship between vocabulary, IQ, working memory, and word-problem-solving abilities. In addition, Lin et al. (2021) conducted a meta-analysis of 40 studies with 7,988 participants and 55 independent samples. Their findings indicate that mathematics vocabulary goes beyond simple concept retrieval and serves as a conduit for applying cognitive reasoning in mathematics. Furthermore, Peng et al. (2020) found that complex language and mathematical skills strengthened the language-math connection. Native speakers exhibited a stronger relationship between language and mathematics than second-language learners, although this difference disappeared after controlling for IQ and working memory. Overall, working memory and intelligence explained about 50% of the variance in the language-mathematics relationship.

Ünal et al. (2021) studied middle school students in the U.S. and Turkey and found that mathematics achievement among high-performing students was better predicted by mathematics vocabulary than by general vocabulary knowledge. A lack of domain-specific vocabulary negatively affects performance in language-intensive mathematical tasks, such as solving word problems in a foreign language (Xu et al., 2022). Song (2022) also demonstrated that mathematics vocabulary mediates the relationship between general vocabulary and mathematics performance, although arithmetic fluency remained unaffected. While a local descriptive-correlational study by Bulos (2021) found no significant association between mathematics vocabulary and mathematical ability among 138 Grade 7 students, the current study investigates the effects of both mathematics vocabulary and reading comprehension on mathematics performance among 146 Grade 7 students.

2.3. Reading Comprehension and Mathematics Performance

Gomez et al. (2020) stressed the importance of reading comprehension in mathematics instruction, particularly in solving word problems. Similarly, Fuchs et al. (2016) note that students must comprehend the problem text to derive accurate mathematical expressions. However, Bernadowski (2016) highlights that teachers face challenges in integrating literacy into content instruction.

Studies showed that reading comprehension and mathematics performance are interrelated. For instance, Fuchs et al. (2018) found a strong correlation between high reading comprehension and exceptional mathematics performance. Similarly, Cua (2015) reported a significant relationship between reading comprehension and mathematics performance among Grade 9 students in Negros Occidental, Philippines. Meanwhile, Can (2020) explored whether reading comprehension mediates the relationship between logical reasoning and word problem-solving. The study found significant positive correlations, indicating that reading comprehension partially mediates this relationship. Therefore, students must strengthen their linguistic abilities, particularly reading comprehension, to enhance their logical reasoning and mathematical thinking. However, Luna et al. (2023), in a study of 135 Grade 4 students from Western Mindanao University, found a negligible correlation, particularly in solving word problems.

Akin (2022) examined various factors influencing the relationship between mathematics skills and reading comprehension, including skill components, subject domains, age, language status, and developmental difficulties. The findings revealed a strong, statistically significant relationship between reading comprehension and mathematical ability. Problem-solving had the most significant moderating effect, while spatial skills had the least. Geometry showed minimal influence in this correlation. Moreover, the impact of reading comprehension varied significantly among elementary students, students with learning difficulties, and second-language learners.

In contrast to these earlier studies, the present study used a validated Likert scale to measure reading comprehension, a standardized test to assess mathematics vocabulary skills, and self-reported first-quarter grades to gauge mathematics performance.

2.4. Mathematics Vocabulary as a Mediator Between Reading Comprehension and Mathematics Performance

Mathematics vocabulary plays a crucial role in linking reading comprehension skills with mathematics achievement. Recent research emphasizes how proficiency in mathematical language can mediate this relationship. For example, Lin et al. (2021) demonstrated through a meta-analysis that the connection between math vocabulary and performance is stronger in tasks involving multistep reasoning. Mathematical vocabulary supports conceptual understanding and promotes deeper cognitive engagement. On the other hand, Akin (2022), analyzing data from 49 studies involving over 37,000 participants, confirmed the significant role of reading comprehension in mathematical achievement, identifying problem-solving as the most important mediator.

According to Lariviere et al. (2023), interventions involving explicit vocabulary instruction, the use of representations, and repeated exposure significantly improve vocabulary and subject knowledge in students with arithmetic difficulties. Similarly, reading comprehension and language proficiency directly and indirectly affect mathematics performance, based on PISA assessments (Virgana & Lapasau, 2019). In this context, Hughes et al. (2020) emphasize the importance of domain-specific vocabulary in understanding mathematical concepts while Hughes et al. (2020) advocate for deliberate vocabulary instruction in mathematics curricula to improve student outcomes. Nelson and Powell (2021) found that math-specific vocabulary, beyond general language proficiency, predicts mathematics achievement among high-performing students in both the U.S. and Turkey.

Gomez et al. (2020) emphasize that reading comprehension is essential to mathematical learning, particularly for problem-solving and information retention. The University of Kansas (2024) highlight that applying reading science principles to math instruction helps students better understand and solve complex problems, especially for English language learners. These findings collectively indicate that enhancing mathematics vocabulary can significantly mediate and strengthen the relationship between reading comprehension and mathematical achievement.

3. Methodology

3.1. Research Design

The study employed descriptive-correlational and explanatory research designs to describe the level of mathematics vocabulary skills, reading comprehension abilities, and mathematics performance of the respondents and test if the mathematics vocabulary skills and reading comprehension significantly predict mathematics performance. It also explored if mathematics vocabulary skills mediate the relationship between reading comprehension abilities and mathematics performance.

3.2. Participants of the Study

The participants were grade 7 public high school students in the City Schools Division of Cabuyao enrolled in 2024-2025. The study utilized Power Analysis through the G Power application to determine the study's sample size. Considering the 0.05 probability error, 0.99 power level, and 0.15 effect size, the sample size of this study was 146. The study integrated multi-stage sampling in choosing the respondents by considering the list of 1,606 students of the two schools. Using stratified and simple random sampling techniques to determine the study's samples properly, 64 respondents out of 705 population from one high school and 82 out of 901 from another high school were determined through a stratified sampling formula.

3.3. Instrumentation and Data Gathering Process

The study used an adapted instrument on reading comprehension abilities from Al-Qahtani (2016), while the instrument on vocabulary skills was adapted from Partners for Learning (2014). The mathematics vocabulary test used items from a standardized test whose competencies matched the respondents' levels. Meanwhile, the researchers gathered the mathematics performance through their self-reported grades in the first quarter. The instrument's first part (20 items) gathered data concerning the respondents' mathematics vocabulary skills, while the second part (14 items) solicited data about the respondents' comprehension abilities. The last part obtained data on the respondents' performance in Mathematics through their self-reported grades in the first quarter.

While the instruments were carefully adapted for the study’s context, potential limitations related to the instruments’ full contextual fit were acknowledged, particularly regarding the applicability of content originally developed for different settings or populations.

Hence, modifications were made to the questionnaire to accommodate the characteristics of the respondents in the current study. Six validators, which were composed of 4 mathematics master teachers, one mathematics head teacher, and one head teacher in English, validated the instruments using face and content validation methods (I-CVI $\geq$ 0.83, S-CVI $\geq$ 0.80), while the reliability of the instruments was assessed by internal consistency method using Kuder-Richardson-20 (vocabulary skills test) and Cronbach's Alpha (comprehension skills scale) analyses, respectively. The reliability results showed that the vocabulary skills test (α=0.849) and comprehension skills scale (α=0.904) reached good and excellent reliability, respectively. The respondents' mathematics performance was scored using the following scale: 90-100 Outstanding, 85-89 Very satisfactory, 80-84 Satisfactory, 75-79 Fairly satisfactory, and below 75 did not meet expectations (Lego, n. d.). In addition, the reference scale on vocabulary skills was scored using the following categories: 15.01 - 20.00 Very High Level, 10.01 – 15.00 High Level, 5.01– 10.00 Low Level, and 1.00 - 5.00 Very Low Level. Lastly, the comprehension abilities were scored as follows: The mean range of 3.26 - 4.00, with a descriptive scale of "Strongly agree," signified a "Very high level." The mean range of 2.51 - 3.25, with a descriptive scale of "Agree," signified a "High level." The mean range was 1.76 - 2.50, with a descriptive scale "Disagree/Rare," signified a "Low level." Ultimately, the mean range of 1.00 - 1.75, with a descriptive scale of "Strongly disagree," signified a "Very low level."

3.4. Data Analysis

The survey data was evaluated using both descriptive and inferential data analysis techniques. The researchers used mean and standard deviation to describe the level of mathematics vocabulary skills, reading comprehension abilities, and mathematics performance of the respondents. Additionally, the researchers used the Multiple Linear Regression bootstrap technique to test whether the respondents' mathematics vocabulary and reading comprehension skills affect their mathematics performance. Moreover, the Mediated Regression bootstrap technique and Partial Least Squares - Structural Equation Model (PLS-SEM) were used to show the mediating effect of vocabulary skills on the relationship between comprehension abilities and mathematics performance. Lastly, the study used Jamovi software 2.5.4 trial version (The Jamovi Project, 2024; R Core Team, 2023) and SmartPLS trial version (SmartPLS, n. d.).

3.5. Research Ethics

Before commencing the survey, the researchers formally requested permission from the Schools Division Superintendent of the Cabuyao City to conduct the study and survey inside the division. Upon receiving approval, the researchers sought authorization from the junior high school principals. The researchers disseminated the Google Form link for the survey via Messenger Group Chats, with the aid of school administrators and class advisers, considering the roster of respondents. This was accompanied by a consent letter for the parents and students who responded. The researchers complied with and considered DepEd's Time-on-Task Policy and Republic Act No. 10173 - the 2012 Data Privacy Act. All data collected was strictly confidential to the maximum extent allowed by law. The researchers acquired the responses through Google Forms for two weeks. A spreadsheet was created using the responses from Google Forms. The researchers transferred the data from the spreadsheet to free versions of Jamovi and SmartPLS softwares for the purpose of analysis.

4. Findings and Discussion

Table 1 presents the levels of mathematics vocabulary proficiency among the respondents.

Table 1

The numeracy skills performance of the student-participants in the pretest and posttest

Variable	Mean	Std Dev	Interpretation
Mathematics Vocabulary Skills (MVS)	14.20	4.48	High Level
Reading Comprehension Abilities (RCA)	3.06	0.49	High Level
Mathematics Performance (MP)	83.80	5.65	Satisfactory

***Legend**:* MVS: 15.01 - 20.00 Very High Level, 10.01 – 15.00 High Level, 5.01– 10.00 Low Level, and 1.00 - 5.00 Very Low Level; RCA: 3.26 - 4.00 Very High Level, 2.51 - 3.25 High Level, 1.76 - 2.50 Low Level, and 1.00 - 1.75 Very Low Level; MP: 90-100 Outstanding, 85-89 Very satisfactory, 80-84 Satisfactory, 75-79 Fairly satisfactory, below 75 did not meet expectations

The average score for mathematics vocabulary skills was 14.20 (SD = 4.48), indicating a high proficiency level. This indicates that they are proficient in comprehending and utilizing mathematical terminology effectively, which is crucial for problem-solving and overall achievement in mathematics. The mean score's proximity to the lower limit of the "High Level" category indicates a need for further skill development to reach a very high level of proficiency,

potentially leading to enhanced performance in mathematics-related tasks and evaluations. Additionally, the table exhibits the levels of reading comprehension skills among the respondents. According to the survey results, the students' reading comprehension skills were high, with a mean score of 3.06 (SD = 0.49). This signifies that students possess proficiency in comprehending and interpreting written content, a skill essential for academic achievement across diverse disciplines. Nonetheless, as the mean is proximate to the threshold for the "High Level" category, there is potential to cultivate these abilities further to attain a very high level of comprehension, improving overall academic performance and learning capacity. Finally, the table demonstrates the levels of mathematical performance among the respondents. Accordingly, the mathematics performance exhibited a mean score of 83.80 (SD = 5.65), indicating satisfactory achievement. The data indicates that although the respondents demonstrate robust language and comprehension abilities, their mathematics performance is satisfactory, allowing for potential enhancement. The findings indicate that although the respondents exhibit advanced mathematics vocabulary and reading comprehension capabilities, their mathematics performance is satisfactory. Satisfactory indicates that although students met the basic academic requirements in mathematics, their performance did not necessarily reflect excellence or mastery. It signifies that they demonstrated a foundational understanding of mathematical concepts and procedures sufficient for academic progression but with room for significant improvement. This is particularly noteworthy given their strong language-related skills, which are known to contribute positively to mathematical learning. Notwithstanding robust fundamental skills in language and vocabulary, additional variables may constrain their capacity to attain elevated levels of mathematical performance. It underscores the necessity to examine and mitigate supplementary factors affecting mathematics success, while providing comprehensive intervention programs and differentiated instruction (Aguhayon et al., 2023), to enhance performance results.

This study found high levels of mathematics vocabulary skills among the respondents, which contrasts with the findings of Bulos (2021), whose study recorded only average levels of mathematics vocabulary among the participants. In addition, this study revealed a high level of reading comprehension abilities, which is consistent with the findings of Can (2020), who reported that respondents demonstrated strong reading comprehension skills. However, the study by Luna et al. (2023) found that most Grade 4 respondents exhibited low levels of reading comprehension. Furthermore, this study demonstrated a significant degree of mathematical

proficiency among the participants, aligning with Can (2020), who noted high performance in mathematical word problems. Similarly, Cua (2015) reported that respondents attained a moderately high level of mathematics performance in Algebra and Geometry. In contrast, Luna et al. (2023) observed very low levels of mathematics performance in solving word problems among their respondents.

Table 2 shows the test of prediction of students' mathematics vocabulary skills and reading comprehension on mathematics performance.

Table 2

Test of prediction of mathematics vocabulary skills and reading comprehension on mathematics performance

Predictor	Beta Unstandardized	SE	t	P-value	Decision	Interpretation
Intercept	72.877	2.797	26.050	< 0.001	Reject Ho	Significant
Mathematics Vocabulary	0.488	0.098	5.000	< 0.001	Reject Ho	Significant
Comprehension Abilities	1.308	0.889	1.470	0.143	Failed to reject Ho	Not significant

Note: R^2=0.183, Significant if p<0.05

The Multiple Linear Regression bootstrap technique was run to test if mathematics vocabulary and comprehension abilities significantly influence the mathematics performance of the students. The result disclosed that mathematics vocabulary was the only influential predictor *(β=0.488, p<0.001)*, while reading comprehension abilities had no significant effect (p>0.05) on students' mathematics performance. The r^2 of 0.183 denotes that the predictors contributed a 18.3% variance to students' mathematics performance, with a medium effect size (0.224). In summary, the estimated regression model is given as:

*Mathematics performance = 72.88 + 0.49*Mathematics Vocabulary + 1.308*Comprehension Abilities.*

The result indicates that mathematics vocabulary is the only significant predictor of students' mathematics performance while reading comprehension abilities do not have a meaningful impact. This result is consistent with Vygotsky's sociocultural theory, which emphasizes the role of language (mathematics vocabulary skills) as a fundamental tool for cognitive development and learning (mathematics performance). This result is also aligned

with Peng and Lin (2019) and Ünal et al. (2021), who discovered the significant effect of mathematics vocabulary on mathematics performance, and Lin et al. (2021), who concluded the potential function of mathematics vocabulary as a conduit in the application of cognitive reasoning in mathematics.

Figure 1 reveals the SEM while Table 3 shows the mediated regression results on the mediating effect of mathematics vocabulary skills on the relationship between reading comprehension abilities and mathematics performance.

Table 3

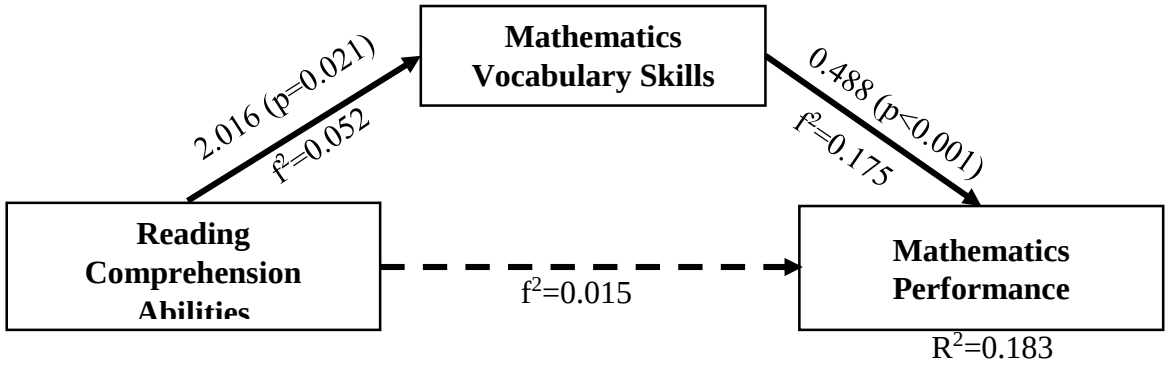
The mediating effect of mathematics vocabulary skills on the relationship between reading comprehension abilities and mathematics performance

Effect	Beta Unstandardized	SE	Z	p	% Mediation
Indirect *RCA→MVS→MP*	0.984	0.50	1.980	0.048	42.9
Direct *RCA→MP*	1.308	0.77	1.700	0.090	57.1
Total *RCA→MP*	2.292	0.89	2.570	0.010	100.0

Note: RCA=Reading Comprehension Abilities, MVS=Mathematics Vocabulary Skills, MP=Mathematics Performance; Significant if p<0.05

Figure 1

SEM on the mediating effect of mathematics vocabulary skills on the relationship between reading comprehension abilities and mathematics performance



The broken line indicates non-significance, while the solid line represents a significant effect. The results of the mediated regression bootstrap technique display that the path or direct

effect from reading comprehension abilities to mathematics vocabulary skills was positive and significant *(β=2.016, p=0.021),* representing that mathematics vocabulary skills escalate as reading comprehension abilities rise. The r^2 of 0.049 indicates that reading comprehension abilities explain 4.9% of the variance in mathematics vocabulary skills. The f^2 of 0.052 indicates that the effect of reading comprehension abilities on mathematics vocabulary skills is slight but noticeable. Moreover, the path or direct effect from mathematics vocabulary skills to mathematics performance was positive and significant *(β=0.488, p<0.001),* signifying that respondents with higher mathematics vocabulary skills are likelier to have higher mathematics performance. It suggests a direct relationship between mathematics vocabulary skills and mathematics performance with the presence of reading comprehension abilities. The f^2 of 0.175 indicates that the effect of mathematics vocabulary skills on mathematics vocabulary skills is moderate. Conversely, reading comprehension abilities had no significant influence on mathematics performance with the presence of eating habits (p>0.05). This suggests that, within the context of the study, reading comprehension alone may not substantially contribute to mathematics performance. It is possible that mathematics tasks assessed relied more on domain-specific vocabulary or numeric reasoning than on general reading ability. Further investigation may be needed to explore potential mediators or contextual factors that influence this relationship. Moreover, the total effect revealed that the direct effect of reading comprehension abilities on mathematics performance and the indirect effect flowing through mathematics vocabulary skills was significant *(β=2.292, p=0.010).* The r^2 0.183 shows that the reading comprehension abilities flowing through mathematics vocabulary skills contribute 18.3% of the variance in mathematics performance.

Furthermore, mediated regression revealed that the indirect effect was significant. Mathematics vocabulary skills statistically significantly mediated the relationship between reading comprehension abilities and mathematics performance *(β=-0.625, p=0.003).* In simple terms, the relationship flows from reading comprehension abilities to mathematics vocabulary skills and mathematics performance. Moreover, the model exposed that mathematics vocabulary skills impacted 42.9% mediation effect between reading comprehension abilities and mathematics performance. The model exposes complete mediation since reading comprehension abilities affect mathematics vocabulary skills, mathematics vocabulary skills affect mathematics performance, and reading comprehension abilities do not affect mathematics performance. According to Krakauer (2014), complete mediation predicts that

the direct influence of the independent variable on the dependent variable will be significant only if the mediator is absent. When the mediator is present, the direct effect becomes non-significant, but the indirect effect is significant. Additionally, it illustrates indirect-only mediation because indirect effects are statistically significant, but there is no direct significant effect of reading comprehension abilities on mathematics performance.

Table 4 shows the model's collinearity statistics based on SEM results. In the model, the VIF gauges the extent of the correlation between one predictor variable and others.

Table 4

Collinearity statistics in outer and inner models

Variable	Collinearity VIF	Criteria	Interpretation
Outer Model			
RCA	1.000	Close to 1	No Multicollinearity
MP	1.000	Close to 1	No Multicollinearity
MVS	1.000	Close to 1	No Multicollinearity
Inner Model			
RCA → MP	1.052	Close to 1	No Multicollinearity
RCA → MVS	1.000	Close to 1	No Multicollinearity
MVS → MP	1.052	Close to 1	No Multicollinearity

***Note**:* Reading Comprehension Abilities=RCA, Mathematics Performance=MP, Mathematics Vocabulary Skills=MVS, Variance Inflation Factor=VIF

According to the outer model results, none of the indicators of the latent constructions show any correlation. Every indication evaluates its constructions independently. Analogously, the inner model reveals that there is no collinearity between the latent variables in the structural model and the predictor variables. The inner model's independent variables are not strongly linked, so steady and trustworthy estimations are ensured. Stated differently, the results point to a well-organized model in which every predictor adds distinctively without repetition.

Table 5 demonstrates the model fit indices on the mediating influence of mathematics vocabulary skills on the relationship between reading comprehension abilities and mathematics performance.

Table 5

Model fit indices on the mediating influence of mathematics vocabulary skills on the relationship between reading comprehension abilities and mathematics performance

Model Fit	Saturated Model	Estimated Model	Criteria	Interpretation
Standardized Root Mean Square Residual (SRMR)	0.000	0.000	Acceptable if <=.10	Perfect Fit
Squared Euclidean Distance (d_ULS)	0.000	0.000	Close to 0: Good Fit	Perfect Fit
Geodesic Distance (d_G)	0.000	0.000	Close to 0: Good Fit	Perfect Fit
Chi-square	0.000	0.000	p-value > 0.05: Acceptable fit.	Perfect Fit
Normed Fit Index (NFI)	1.000	1.000	≥ 0.90: Good fit	Perfect Fit

The findings show that an SRMR value of 0.000 means there is no difference between the observed and predicted correlations; a d_ULS value of 0.000 means there is no difference between the observed and model-implied covariance matrix; a d_G value of 0.000 means there is no difference based on the geodesic distance approach; a chi-square value of 0.000 means there is no difference between the observed and expected covariance matrices; and an NFI value of 1.000 means there is no difference between the chi-square value of the model and the null model. In summary, the values indicate that the model accurately represents the data. In other words, the model fit indicates a perfect model fit, signifying that the model exactly reproduces the observed data.

This study found the statistically significant full mediating effect of mathematics vocabulary skills between comprehension abilities and mathematics performance. This finding diverges from several international studies that report partial mediation or emphasize only the direct effects of language comprehension on mathematics outcomes. The complete mediation observed in this study highlights a distinct contribution, emphasizing the central role of subject-specific vocabulary in academic performance. For instance, studies of Song (2022) discovered the significant mediating effect of mathematics vocabulary in the association between general vocabulary and mathematical performance. Additionally, Akin's study (2022) found a statistically significant relationship between reading comprehension and students' mathematical abilities, and this relationship was affected by factors such as subject requirements in mathematics, age, language proficiency, and developmental concerns.

5. Conclusion and Recommendations

This study found that students exhibited high levels of mathematics vocabulary skills and reading comprehension abilities, while their mathematics performance reached a satisfactory level. Mathematics vocabulary emerged as the strongest predictor of math performance, whereas reading comprehension showed no direct effect when vocabulary was taken into account. The prominence of mathematics vocabulary in predicting performance supports the idea that language mediates students' understanding and problem-solving in academic contexts, particularly in mathematics. However, the lack of a direct effect from reading comprehension may suggest that subject-specific vocabulary plays a more immediate role in mathematical tasks than general linguistic comprehension, indicating a more specialized application of Vygotsky's framework in content-area learning.

The model explained 18.3% of the variance in performance, indicating that other factors also contribute. Still, vocabulary had a stronger predictive weight than comprehension. This study concludes that both mathematics vocabulary and reading comprehension abilities significantly affect students' mathematics performance. However, it further reveals that, in the presence of mathematics vocabulary, reading comprehension abilities no longer directly influence performance. Mathematics vocabulary skills are shown to be critical in linking reading comprehension to mathematics performance, significantly mediating this relationship. Including mathematics vocabulary as a mediator eliminates the direct impact of reading comprehension on mathematics performance, thereby demonstrating complete mediation.

This finding contributes novel insights to the literature by illustrating a complete mediation model, suggesting that interventions targeting mathematics vocabulary may have far-reaching impacts on student achievement. Therefore, developing mathematics vocabulary should be prioritized to support deeper mathematical learning and to enhance the broader effects of reading comprehension.

The recommended action plan to enhance mathematics performance seeks to augment the mathematical lexicon of grade 7 students, facilitating a more profound comprehension of mathematical subjects. This will be accomplished through weekly seminars introducing fundamental terminology and its applications, supplemented by monthly evaluations to track progress. Teachers will include vocabulary enhancement activities with practical examples, optimizing teaching strategies according to evaluation outcomes.

The primary purpose is to enhance student comprehension through focused reading and analytical tasks. Utilizing reading-oriented mathematical problems alongside visual aids, digital resources, and narrative strategies will improve students' proficiency in interpreting word problems. Monthly evaluations will be performed to monitor advancements, resulting in enhanced problem-solving abilities. The action plan incorporates interactive activities, like crossword puzzles, flashcards, and matching exercises, to enhance engagement in learning. Collaboration between mathematics and language instructors will be promoted to formulate interdisciplinary strategies, guaranteeing that students may utilize their reading skills in mathematical contexts.

Collaborative learning via group activities and cooperative problem-solving assignments will enhance confidence in interpreting and resolving word difficulties. The strategy underscores the significance of community engagement and highlights collaboration among educators, parents, and community stakeholders. Parents will be instructed on methods to enhance their children's mathematics vocabulary and comprehension at home. Consistent evaluations will inform instructional improvements, cultivating a robust support network among educators, parents, and the community to guarantee children's academic achievement.

This study was limited to assessing mathematics vocabulary skills, perceived comprehension abilities, and mathematics performance. The researchers acknowledge that the data on mathematics performance were based on self-reported grades, which may be prone to bias or inaccuracies due to subjective perceptions or recall errors. Furthermore, the limited sample scope, which involved only two public high schools within a single school division, may affect the generalizability of the findings to other contexts or populations. The study employed a cross-sectional design, which limits the ability to infer causality among the examined variables. While the study offers valuable insights into the mediating role of vocabulary skills in the relationship between comprehension abilities and mathematics performance, these methodological constraints were considered when interpreting the results and drawing broader conclusions.

Disclosure statement

The authors had no potential conflict of interest.

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Institutional Review Board Statement

This study was conducted in accordance with the ethical guidelines set by the Department of Education. The conduct of this study has been approved and given relative clearance(s) by Department of Education Cabuyao City.

Declaration

The author declares the use of Artificial Intelligence (AI) in writing this paper. In particular, the author used Quillbot in summarizing key points and paraphrasing ideas. The authors take full responsibility in ensuring proper review and editing of contents generated using AI.

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