Research in Social Sciences
Volume 8, Issue 3, pp. 71-79
2025

Navigating the Complex Landscape of Factors Influencing Mathematical Literacy at the Elementary Level

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ABSTRACT: *This study assessed the mathematical literacy of elementary pupils. It aimed to evaluate learners' performance in number identification, quantity discrimination, missing number (patterns), basic arithmetic operations, and word problem-solving, and to examine the relationships between mathematical performance and selected variables, including parental and home environment, technology-related factors, school-related factors, and social-emotional factors. A total of 93 pupils from Grades 1 to 3 participated in the study. Data were gathered through standardized EGMA tests and structured questionnaires, with results analyzed using descriptive statistics and Pearson correlation. Findings revealed that learners' overall performance in mathematics was satisfactory across all assessed domains. However, no significant relationships were found between learners' performance and their parental environment, school factors, or social-emotional factors. A weak but significant negative correlation was observed between technology-related factors and quantity discrimination, suggesting that increased exposure to technology may hinder rather than enhance specific math skills if not used appropriately. These results underscore the importance of context-specific, quality-focused interventions in both home and school settings. The study concludes that improving mathematical literacy requires a more integrated approach that considers the effective implementation of support systems, rather than relying solely on their presence.*

Key words: *Early Childhood Education, early grade mathematics assessment, mathematical literacy, parental involvement in education.*

Research in Social Sciences
Vol. 8, No. 3, pp. 71-79
2025
DOI: *10.53935/26415305.v8i3.392*
Email: rubellabonghanoy@gmail.com
Funding:
This study received no specific financial support.

1. Introduction

Mathematical literacy is a core academic skill that enables individuals to interpret, apply, and reason through mathematical situations in everyday life. It goes beyond simple calculation, involving data interpretation, spatial awareness, and critical thinking to solve real-world problems and make informed choices (OECD, 2023). This competence is foundational to educational success, particularly in STEM disciplines, which are essential to technological advancement and national development (Tan & Rivera, 2024; Kaw & Garcia, 2023; Suson, 2019). Furthermore, numeracy contributes directly to economic participation by equipping learners with analytical skills necessary to meet the demands of rapidly evolving industries and digital economies (Lazaro & Dizon, 2021; Caballero & Santos, 2023; Cruz & Herrera, 2022).

Understanding what shapes mathematical literacy in early education is crucial, as the foundational years significantly affect lifelong learning trajectories. Empirical studies affirm that early intervention in mathematics can reduce skill gaps and enhance achievement through successive grade levels (Domingo &

Lee, 2022; Navarro & Reyes, 2024; Fernandez et al., 2021). International large-scale assessments such as TIMSS and PISA continue to reveal significant disparities across nations. In the 2019 TIMSS, the Philippines scored only 297, far below the average of 500, and ranked among the lowest in math in the 2018 PISA, emphasizing the urgent need for curricular improvements (IEA, 2019; OECD, 2020). Moreover, Understanding the determinants of mathematical literacy during the early stages of education is vital, as foundational math skills acquired in childhood are predictive of academic success and lifelong learning capacity (Ortega & Lee, 2023; Wallace & Green, 2024; Delgado et al., 2021). Interventions introduced in the early grades have shown promise in closing performance gaps and mitigating future learning difficulties (Basco & Tagle, 2023; Suson, 2024 Reyes & Manuel, 2023). International benchmarks such as the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) consistently report concerning performance levels in countries with under-resourced education systems. In the Philippines, students scored 297 in TIMSS 2019—well below the international average of 500 and ranked 79th in mathematics out of 100 countries in PISA 2018, indicating the urgent need for systemic reforms (IEA, 2019; OECD, 2020).

The Early Grade Mathematics Assessment (EGMA) has become a prominent diagnostic tool used to assess early numeracy skills. It measures number recognition, quantity discrimination, pattern awareness, and computation, offering educators detailed data for shaping instructional support (Villanueva & Chua, 2022; Tan & Delos Reyes, 2023; Bautista & Robles, 2022). Research in countries such as Zambia, Indonesia, and Peru show that data-informed teaching based on EGMA results significantly boosts learner achievement (De Castro & Liwag, 2023; Torres et al., 2021). The OECD (2023) reiterates that early mastery in math is vital for economic preparedness and lifelong learning in the global age.

In the Philippine context, DepEd has responded through the implementation of initiatives like the K–12 Program and the revised Matatag Curriculum, both of which prioritize core mathematical competencies and higher-order thinking skills (DepEd, 2023). Despite these reforms, widespread gaps in math proficiency remain, particularly in lower primary levels. This study examined the mathematical literacy of early-grade learners using EGMA and explored influencing contextual factors. By offering evidence-based and locally grounded insights, the research seeks to guide educators and policymakers in designing responsive programs that advance equity and quality in math education (Santos & Villamor, 2023; Enriquez & Ramos, 2024).

2. Literature Review

Mathematical literacy in the early grades is pivotal for developing critical thinking and problem-solving skills that are essential for later academic and career success. Research indicates that both home and school environments play significant roles in shaping early mathematical abilities. A substantial body of evidence suggests that parental involvement, including homework assistance and provision of educational resources, has a profound impact on children's academic outcomes (Zhang et al., 2021; Robinson & Harris, 2022). Additionally, socioeconomic factors such as parental education levels and family income are also critical, with multiple studies finding a positive correlation between higher socioeconomic status and improved mathematical performance (Carter et al., 2021; Mills & Gale, 2020). However, disparities persist, as children from lower socioeconomic backgrounds often enter school with less exposure to numeracy-related activities, which can affect their academic trajectories (Johnson, 2019; Lee, 2020).

On the educational front, the quality of school resources and the presence of supportive teachers play essential roles in nurturing students' mathematical skills. Studies have shown that access to quality educational materials and engaging mathematics instruction significantly enhances student learning outcomes (Sims, 2021; Brown & Low, 2022). Teacher effectiveness, characterized by both pedagogical content knowledge and the ability to foster a positive learning environment, has been identified as one of the most influential factors in student achievement (Darling-Hammond et al., 2021; Hanushek & Rivkin, 2023). Furthermore, the integration of technology in mathematics education needs careful implementation; while it offers innovative ways to enhance learning, it can also be a source of distraction if not used appropriately (Greenfield, 2021; Thompson & Lee, 2022). As educational technology advances, its role in supporting or hindering mathematical literacy continues to be a critical area of study (Kirkwood, 2022; Patel & Dexter, 2021). These insights collectively highlight the complexity of factors influencing mathematical literacy at the elementary level.

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3. Methodology

This research employed a descriptive-correlational design to investigate the mathematical literacy levels of pupils at Tapul Elementary School using the Early Grade Mathematics Assessment (EGMA). This approach was appropriate given the practical constraints of the study. The EGMA toolkit, which comprises a series of assessments targeting key areas of early mathematical learning such as number identification, quantity discrimination, pattern recognition, and basic arithmetic operations, served as the primary instrument for measuring mathematical proficiency. These tasks were designed to cater to a variety of literacy levels, with assessments conducted in both oral and written formats to ensure broad participation.

In addition to the EGMA assessments, supplementary data were collected through questionnaires distributed to both pupils and their parents. These questionnaires were instrumental in gathering demographic and contextual information, such as educational background, family income, and environmental factors, which helped elucidate the diverse influences on pupils' mathematical abilities. Data analysis was conducted using descriptive statistics to map out the distribution of competencies across the student population, while correlational analysis was applied to uncover significant predictors of mathematical literacy. This combination of methodologies not only shed light on the current state of students' mathematical skills but also provided insights into effective strategies for educational intervention.

Table 1. Parental and Home Environment.

Indicators	Mean	VD
My parents regularly help me with my homework.	2.49	A
I feel emotionally supported by my family.	2.58	A
I have access to books, internet, and other learning materials at home.	1.89	D
My family expects me to perform well in school.	1.93	D
My home environment provides a quiet space for studying.	1.81	D
Grand Mean	2.14	D

4. Results and Discussion

Table 1 presents the perceptions of pupils regarding their home environment and the educational support they receive, showcasing a mix of mild support and significant deficiencies. While the pupils feel somewhat emotionally supported by their families, as reflected in mean scores of 2.49 and 2.58 for parental help with homework and emotional support, respectively, both categorized as 'Agree' (A), these indicators hint at a basic level of support that may not extend deeply into their academic lives. However, significant gaps become apparent in more tangible areas of support: access to books, internet, and other learning materials scores a low 1.89, indicating a notable deficiency in essential educational resources at home, categorized as 'Disagree' (D). Similarly, family expectations for academic performance and the provision of a quiet study environment are also lacking, with scores of 1.93 and 1.81, respectively, both falling into the 'Disagree' (D) category. This data collectively results in a Grand Mean of 2.14, categorized as 'Disagree', underscoring a broader narrative of insufficient physical and motivational support in the home setting, which could potentially hinder the academic and developmental progress of the pupils. This situation highlights a critical area for intervention to enhance the educational outcomes and overall well-being of students.

Table 2. Technology-Related Factors.

Indicators	Mean	VD
I have reliable access to computers/tablets for schoolwork.	1.48	SD
Using technology improves my learning experience.	1.99	D
I spend a lot of time on social media or video games.	1.74	SD
Technology often distracts me from studying.	1.84	D
I easily adapt to using new educational software or platforms.	1.60	SD
Grand Mean	2.14	D

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Table 2 details pupils' perceptions of technology-related factors affecting their education, showing overall negative feedback across all indicators. The data indicates a substantial lack of access to computers or tablets for schoolwork, with a very low mean score of 1.48, rated as 'Strongly Disagree' (SD), highlighting a critical gap in necessary technological resources. Pupils also feel that technology does not significantly improve their learning experience, as evidenced by a mean score of 1.99, falling into the 'Disagree' (D) category. Furthermore, the engagement with social media or video games is perceived negatively in terms of time spent, scoring 1.74 and classified as 'Strongly Disagree' (SD), suggesting that these activities do not occupy a constructive place in their daily routines. Additionally, technology is seen as a distraction rather than an aid, with a mean of 1.84 in the 'Disagree' (D) category. The ability to adapt to new educational software or platforms also scores low at 1.60, categorized as 'Strongly Disagree' (SD).

Table 3. School-Related Factors

Indicators	Mean	VD
My teachers are supportive and help me succeed.	3.40	SA
My school provides adequate resources (e.g., books, labs, facilities).	2.04	D
I feel safe at school.	3.20	SA
My classmates are supportive and help me with schoolwork	2.86	A
I participate in extra-curricular activities provided by my school.	2.72	A
Grand Mean	2.15	D

Table 3 provides insight into pupils' perceptions of various school-related factors and their impact on educational experiences, revealing a mixture of strong support and notable deficiencies. The data shows that pupils feel highly supported by their teachers, with a mean score of 3.40, rated as 'Strongly Agree' (SA), indicating a positive teacher-student relationship conducive to learning. Similarly, the sense of safety at school is also perceived positively, scoring 3.20 and classified under 'Strongly Agree' (SA), which suggests a secure and encouraging school environment. However, there are significant concerns regarding the adequacy of school resources such as books, labs, and facilities, which receive a low score of 2.04, falling into the 'Disagree' (D) category. This indicates that the physical infrastructure and learning materials may be lacking, potentially hindering effective teaching and learning. Support from classmates is viewed relatively positively, with a score of 2.86, categorized as 'Agree' (A), suggesting a generally supportive peer group that aids in the academic journey. Participation in extra-curricular activities is also seen in a favorable light, albeit slightly less so, with a score of 2.72 in the 'Agree' (A) category, indicating a decent level of engagement in school-driven activities outside the standard curriculum. Despite the strong support from teachers and a safe learning environment, the Grand Mean of 2.15, falling into the 'Disagree' (D) category, highlights an overall mixed perception of school-related factors.

Table 4. Social-Emotional Factors.

Indicators	Mean	VD
I am confident in my academic abilities.	2.51	A
I have positive relationships with my classmates.	2.50	D
I can manage my emotions well when faced with challenges.	2.23	D
I feel supported by my friends.	2.32	D
I am able to manage stress effectively.	2.03	D
Grand Mean	2.32	D

Table 4 presents pupils' perceptions of social-emotional factors affecting their academic experience, revealing an overall sense of insufficient support in managing emotions, relationships, and stress. While students expressed moderate confidence in their academic abilities with a mean score of 2.51 ('Agree'), the rest of the indicators fall under the 'Disagree' category. Positive relationships with classmates scored 2.50, indicating that peer interactions are perceived as somewhat weak, bordering on disagreement. Additionally, pupils reported challenges in managing emotions (2.23), receiving support from friends (2.32), and handling

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This study received no specific financial support.

stress effectively (2.03), all of which fall into the 'Disagree' range. These scores suggest that many students may struggle with the emotional and social aspects of school life, which could hinder their academic progress and well-being. The overall Grand Mean of 2.32 further confirms a general lack of social-emotional support among the respondents. These findings highlight the importance of implementing targeted interventions such as counseling programs, peer mentoring, and emotional literacy activities to strengthen the pupils' ability to cope with challenges and build meaningful relationships.

Table 5. Learners' Performance.

Indicators	Mean	VD
Number Identification	84	Satisfactory
Quantity Discrimination	83	Satisfactory
Missing Number (Patterns)	83	Satisfactory
Addition And Subtraction Level 1	83	Satisfactory
Addition And Subtraction Level 1	82	Satisfactory
Word Problem- Solving Skill	84	Satisfactory

Table 5 shows the overall performance of learners across various mathematical competencies, all of which fall under the 'Satisfactory' category. Pupils demonstrated consistent performance in foundational skills, with Number Identification and Word Problem-Solving both scoring the highest at a mean of 84, indicating strong abilities in recognizing numbers and applying math to real-life problems. Quantity Discrimination, Missing Number (Patterns), and Addition and Subtraction Level 1 each scored closely, ranging from 82 to 83, showing that learners possess a reliable grasp of basic arithmetic operations, pattern recognition, and quantity comparison. The uniformity of the scores suggests that learners have developed balanced proficiency across the different mathematical domains assessed by the Early Grade Mathematics Assessment (EGMA). Although satisfactory, these results also point to potential for further development, especially if targeted instruction and enrichment activities are provided to elevate learners' performance to higher mastery levels.

Table 6. Significant Relationship Between the Parental and Home Environment to Learners' Performance.

Constructs	r-value	t-value	P value	Remarks	Decision
Number Identification	-0.0609	-0.85642	0.392804	Not Significant	Do not reject
Quantity Discrimination	-0.10182	-1.43664	0.152408	Not Significant	Do not reject
Missing Number	-0.06761	-0.95118	0.342678	Not Significant	Do not reject
Addition_Level_1	-0.04425	-0.62166	0.534882	Not Significant	Do not reject
Subtraction Level 1	-0.04692	-0.65928	0.510488	Not Significant	Do not reject
Word Problem	0.025596	0.359375	0.719699	Not Significant	Do not reject

Table 6 presents the statistical analysis of the relationship between the parental and home environment and learners' performance across various mathematical competencies. The findings show that all indicators Number Identification, Quantity Discrimination, Missing Number (Patterns), Addition Level 1, Subtraction Level 1, and Word Problem Solving have p-values greater than 0.05, indicating no statistically significant relationship between these variables. For instance, the relationship between parental environment and Number Identification yielded an r-value of -0.0609 and a p-value of 0.3928, which is not significant. Similarly, Quantity Discrimination and Missing Number show weak negative correlations with p-values of 0.1524 and 0.3427, respectively, both falling short of statistical significance. Other skills, including Addition and Subtraction Level 1 and Word Problem Solving, also returned non-significant p-values ranging from 0.5104 to 0.7197. Overall, these results suggest that within this sample, the parental and home environment, as measured in this study, does not have a significant direct impact on learners' mathematical performance. While previous literature emphasizes the influence of the home setting on academic success, the data here indicate that other variables perhaps instructional quality, learner motivation, or classroom resources may play a more dominant role in shaping mathematics achievement among these pupils. Thus, the null hypothesis is not rejected across all constructs, highlighting the need for a broader exploration of contributing factors to learners' mathematical literacy.

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Table 7. Significant Relationship Between the Technology Factors to Learners' Performance

Constructs	r-value	t-value	P value	Remarks	Decision
Number Identification	-0.11958	-1.69054	0.092507	Not Significant	Do not reject
Quantity Discrimination	-0.14994	-2.12864	0.034526	Significant	Do not reject
Missing Number	-0.08876	-1.25072	0.212519	Not Significant	Do not reject
Addition_Level_1	-0.11102	-1.56794	0.118501	Not Significant	Do not reject
Subtraction Level 1	-0.11106	-1.56852	0.118364	Not Significant	Do not reject
Word Problem	-0.00454	-0.06376	0.949227	Not Significant	Do not reject

Table 7 presents the correlation between technology-related factors and learners' performance in various mathematical domains. Among the six constructs analyzed, only Quantity Discrimination showed a statistically significant relationship, with an r-value of -0.14994, a t-value of -2.12864, and a p-value of 0.0345. This indicates a weak negative correlation, suggesting that increased exposure to or reliance on technology may be slightly associated with lower performance in quantity discrimination tasks. However, since the correlation is negative and weak, further investigation is needed to understand the nature of this relationship. The remaining constructs Number Identification, Missing Number, Addition Level 1, Subtraction Level 1, and Word Problem Solving all have p-values above 0.05, indicating no significant relationship with technology-related factors. Notably, Word Problem Solving had a near-zero correlation (r = -0.00454) and a very high p-value (0.9492), suggesting virtually no association. The findings imply that, aside from quantity discrimination, technology-related factors such as access to devices or adaptability to software have limited or no measurable impact on learners' mathematical performance in this context. The results call attention to the importance of how technology is used in educational settings, reinforcing that its presence alone does not guarantee improved academic outcomes.

Table 8 illustrates the statistical relationship between school-related factors and learners' performance in various mathematical competencies. The analysis shows that none of the constructs Number Identification, Quantity Discrimination, Missing Number (Patterns), Addition Level 1, Subtraction Level 1, and Word Problem Solving demonstrate a statistically significant correlation with school-related factors, as all p-values are greater than the standard significance level of 0.05. For instance, Number Identification yielded an r-value of 0.0816 and a p-value of 0.2522, indicating a weak and non-significant positive relationship. Similarly, Word Problem Solving, which had the highest r-value of 0.1023, also failed to reach significance with a p-value of 0.1505.

Table 8. Significant Relationship Between the School Factor to Learners' Performance

Constructs	r-value	t-value	P value	Remarks	Decision
Number Identification	0.081555	1.148505	0.252153	Not Significant	Do not reject
Quantity Discrimination	0.055075	0.774184	0.43975	Not Significant	Do not reject
Missing Number	-0.00972	-0.13646	0.891597	Not Significant	Do not reject
Addition_Level_1	0.041485	0.582765	0.560718	Not Significant	Do not reject
Subtraction Level 1	0.025467	0.357568	0.721049	Not Significant	Do not reject
Word Problem	0.10231	1.443564	0.15045	Not Significant	Do not reject

The other indicators, including Quantity Discrimination (r = 0.0551, p = 0.4398), Missing Number (r = -0.0097, p = 0.8916), Addition Level 1 (r = 0.0415, p = 0.5607), and Subtraction Level 1 (r = 0.0255, p = 0.7210), also show very weak correlations and non-significant results. These findings suggest that, within this study's context, school-related factors such as teacher support, classroom resources, and peer interactions did not have a statistically measurable impact on learners' mathematical performance. While pupils may perceive school as a supportive environment, the data imply that these perceptions do not directly translate into significant gains in measurable math skills. This highlights the need to further investigate other influential factors or the quality of implementation of school-based support mechanisms.

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Table 9. Significant Relationship Between the Social-Emotional Factors to Learners' Performance

Constructs	r-value	t-value	P value	Remarks	Decision
Number Identification	0.025559	0.358854	0.720088	Not Significant	Do not reject
Quantity Discrimination	0.012932	0.18153	0.856138	Not Significant	Do not reject
Missing Number	-0.01152	-0.16176	0.871659	Not Significant	Do not reject
Addition_Level_1	-0.03212	-0.45111	0.652404	Not Significant	Do not reject
Subtraction Level 1	-0.07534	-1.06049	0.29022	Not Significant	Do not reject
Word Problem	0.108829	1.536617	0.125992	Not Significant	Do not reject

Table 9 examines the relationship between social-emotional factors and learners' performance in mathematics, revealing no statistically significant correlations across all constructs. The p-values for all variables—Number Identification (p = 0.7201), Quantity Discrimination (p = 0.8561), Missing Number (p = 0.8717), Addition Level 1 (p = 0.6524), Subtraction Level 1 (p = 0.2902), and Word Problem Solving (p = 0.1260) exceed the 0.05 significance threshold, indicating that the social-emotional indicators measured in the study do not have a meaningful statistical impact on learners' mathematical outcomes. The correlation coefficients (r-values) are also generally low, with both positive and negative values close to zero, suggesting weak relationships. For instance, Subtraction Level 1 shows a slight negative correlation (r = -0.07534), while Word Problem Solving has the highest positive correlation (r = 0.1088), though still not significant. These results suggest that, while social-emotional well-being is important for holistic development, its direct influence on specific math competencies may not be strongly measurable in this context. This calls for more nuanced research into how emotional and interpersonal factors interact with academic performance and whether interventions aimed at improving emotional intelligence and peer support might have more indirect or long-term academic benefits.

5. Discussion

The findings of this study reveal a complex interplay of factors influencing the mathematical performance of elementary learners. Notably, the parental and home environment though traditionally viewed as a critical driver of early academic success did not show significant statistical relationships with any of the assessed mathematical competencies. This aligns with the findings of Wang and Sheikh-Khalil (2014), who noted that the quality of parental involvement, rather than its frequency, may be more predictive of academic success. The lack of access to educational resources, low parental expectations, and inadequate study environments, as revealed in the descriptive results, may explain the overall disconnect (Fan & Chen, 2001; Kim & Hill, 2015). Additionally, while students reported some emotional support at home, the absence of structured academic guidance could diminish its effectiveness in enhancing mathematical literacy (Jeynes, 2016). These findings emphasize that future interventions should not merely encourage parental involvement but focus on empowering parents with tools and training that directly support learners' cognitive and numeracy development (Senechal & Lefevre, 2012).

Similarly, technology-related factors did not exhibit strong positive effects on learners' mathematical performance, with the exception of a weak but significant negative correlation with quantity discrimination. This supports the argument by Greenfield (2015) that while technology has the potential to improve engagement, its unstructured or excessive use can lead to distraction and cognitive overload, particularly in young learners. Li and Ma (2010) also emphasize that educational technology must be carefully integrated into the curriculum to be effective. The limited access to devices and difficulty in adapting to educational software observed in this study may reflect both digital inequality and a lack of digital fluency, which can inhibit learning gains (Bulman & Fairlie, 2016; Warschauer & Matuchniak, 2010). The absence of significant relationships between school-related factors and mathematical performance further underscores that positive perceptions of teacher support and school safety do not automatically translate to measurable academic outcomes. According to Hattie (2009) and Hanushek (2011), it is the quality of instructional delivery and classroom interaction not just the presence of support that critically influences learning. Lastly, the social-emotional dimension, often linked to academic persistence and motivation (Durlak et al., 2011; Suson, 2020), did not exhibit a significant impact on learners' performance. This finding contrasts with prior research but may be explained by developmental differences, cultural contexts, or measurement limitations (Zins et al.,

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2004). These results suggest that a one-size-fits-all approach may not be effective and call for context-specific strategies that integrate home, school, and psychosocial support systems to strengthen mathematical literacy.

6. Conclusion

The findings of this study highlight the multifaceted nature of factors influencing mathematical performance among elementary learners. While learners demonstrated satisfactory skills in fundamental math areas, the study found no significant relationships between their performance and factors such as parental involvement, school-related support, and social-emotional well-being. Only one notable exception emerged technology-related factors showed a weak but significant negative correlation with quantity discrimination, suggesting potential challenges in the way technology is used or accessed. These results emphasize that the mere presence of support structures be it at home, in school, or emotionally does not automatically translate to improved academic outcomes. Instead, the quality and integration of these supports into learners' day-to-day academic experiences are likely more impactful. As such, there is a need for more targeted, context-specific interventions that go beyond availability and focus on enhancing the effectiveness of home, school, and technological environments to better support learners' mathematical growth and long-term academic success.

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DOI: *10.53935/26415305.v8i3.392*

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Funding:
This study received no specific financial support.

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Research in Social Sciences
Vol. 8, No. 3, pp. 71-79
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