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Multidimensional Influences on Early Mathematical Skills: A Study of Elementary School Learners

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ABSTRACT: *This study investigates the multifaceted influences on mathematical performance among elementary school students, focusing on various parental, technological, school-related, and social-emotional factors. Utilizing a descriptive-correlational research design, the study analyzed data from a sample of pupils at Lawaan III Elementary School, assessing how these different dimensions impact specific areas of mathematical proficiency, such as number identification, quantity discrimination, and problem-solving skills. The findings reveal significant correlations between certain parental and home environment factors, such as educational resources and parental engagement, with specific mathematical skills like number identification and missing number patterns. Conversely, technology-related factors, while prevalent in usage, did not show a significant impact on the mathematical performance, suggesting that their role might be more about engagement than educational effectiveness. Similarly, school-related factors like resource availability and teacher support, typically assumed to be crucial for academic success, did not demonstrate a significant direct impact on the measured outcomes. Additionally, social-emotional factors, although generally believed to influence academic performance, showed no significant direct correlation in this setting. These results underscore the complexity of factors influencing educational outcomes and suggest that effective interventions might require a more nuanced understanding of the interactions between these variables. This study contributes to the educational research by highlighting the need for comprehensive approaches that consider both traditional and non-traditional influences on learning.*

Key words*: Early Childhood Education, Early grade mathematics assessment, Mathematical literacy, Parental involvement in education*.

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1. Introduction

Mathematical literacy is a core competency that enables individuals to make sense of numerical information, analyze quantitative data, and apply mathematical reasoning in solving everyday challenges. It transcends basic arithmetic by incorporating skills such as pattern recognition, logical analysis, and data interpretation necessary for informed decision-making (NCTM, 2022). As a critical foundation for academic success, especially in science, technology, engineering, and mathematics (STEM) fields, it supports innovation and economic resilience in increasingly digitized societies (Tan & Rivera, 2023; Yu & Alonto, 2024). High mathematical competence also correlates with improved career readiness, equipping individuals with transferable analytical skills crucial for adaptability in rapidly evolving work environments (Cruz & Ocampo, 2023; Suson, 2024; Lee & del Rosario, 2021; Velasco et al., 2022).

Identifying the early predictors of mathematical literacy is essential, as the foundational years significantly shape a child's long-term academic development. Early math support has been shown to reduce disparities and prevent achievement gaps from widening as students advance in school (Rodriguez & Yang, 2023; Villanueva & Santos, 2023; Suson, 2019; Bautista & Cruz, 2022). Findings from global assessments like the TIMSS and PISA continue to reveal wide gaps in math outcomes. The Philippines' 2019 TIMSS score of 297—far below the global mean of 500—and its 79th ranking in PISA 2018 highlight the urgency for improved early math instruction (UNESCO, 2023; OECD, 2020).

The Early Grade Mathematics Assessment (EGMA) provides a diagnostic framework for evaluating early numeracy skills. It measures areas such as number recognition, quantity comparison, pattern identification, and basic calculations, enabling educators to tailor instruction to specific learner needs (Lorenzo & Vega, 2023; Tanaka & Molina, 2022; Reyes & Dominguez, 2023). Empirical studies from countries such as Vietnam, Malawi, and Uganda have shown that targeted instructional practices using EGMA data can lead to marked gains in student math outcomes (Ngozi & Mensah, 2022; Pham et al., 2023). The OECD (2021) continues to stress that foundational numeracy is indispensable for equipping learners with the cognitive tools needed to succeed in a data-driven, globally connected society.

To address these concerns, the Department of Education in the Philippines has implemented initiatives including the K–12 Basic Education Reform and the Matatag Curriculum, emphasizing early proficiency in numeracy, problem-solving, and analytical thinking (DepEd, 2023). Still, challenges remain as many students lack mastery of basic math concepts, limiting their academic and career prospects. This study seeks to evaluate the mathematical literacy of early-grade learners through EGMA while exploring the contextual factors that shape their performance. Through localized, evidence-based analysis, the research aims to contribute to informed educational reforms and advocate for policies that build a more equitable and numerate society (Manlapig & Soriano, 2023; Flores & Chua, 2024).

2. Literature Review

The interplay between socioeconomic background and educational achievement, especially in mathematical literacy, is well-documented in educational research. Studies consistently show that parents' highest educational attainment and family income levels are significant predictors of a child's success in mathematics during early schooling years (Smith & Davis, 2021). Furthermore, empirical evidence suggests that children from higher socioeconomic backgrounds are more likely to have superior skills in areas like number identification and basic arithmetic operations, which are critical foundations of mathematical literacy (Johnson & Lee, 2022). This correlation points to the need for educational policies that address disparities in learning opportunities, ensuring that all children, regardless of their familial economic status, have access to quality mathematical education.

On the assessment front, the Early Grade Mathematics Assessment (EGMA) has proven to be a valuable tool in quantifying pupils' mathematical abilities across various dimensions. According to recent findings, the EGMA effectively measures critical aspects of mathematical literacy such as number identification, quantity discrimination, pattern recognition, and problem-solving skills (Lee & Thompson, 2022). These components are essential for gauging the overall mathematical competencies of pupils and identifying specific areas where intervention is needed. The use of EGMA highlights not only the levels of mathematical understanding among young learners but also serves as a benchmark for educational standards and curriculum effectiveness, guiding educators in tailoring instruction that meets the diverse needs of their students (Brown & Roberts, 2023).

3. Methodology

This study utilized a descriptive-correlational research design to explore the mathematical literacy of pupils at Lawaan III Elementary School, employing the Early Grade Mathematics Assessment (EGMA). A total of 93 pupils across grades 1 to 3 were selected using convenience sampling due to accessibility and willingness to participate. The primary instrument for assessing mathematical proficiency was the EGMA toolkit, which included tasks like number identification, quantity discrimination, pattern recognition, and arithmetic operations, allowing for a comprehensive evaluation of students' skills. These assessments were conducted through a mix of oral and written tasks to accommodate different literacy levels among pupils, ensuring all could participate effectively. Additionally, supplementary data were gathered via questionnaires distributed to pupils and their parents to collect demographic and contextual information, such as educational

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background, family income, and environmental factors. This method facilitated an understanding of the influences on pupils' mathematical literacy. The analysis involved descriptive statistics to delineate pupils' competencies and correlational analyses to identify significant predictors of mathematical literacy. The study's reliability and validity were underpinned by the standardized nature of the EGMA, proven through previous research and field testing, ensuring consistent and accurate data collection. This approach not only illuminated the current state of mathematical skills among pupils but also guided targeted educational interventions.

4. Results and Discussions

Table 1. Parental and Home Environment.

Indicators	Mean	VD
My parents regularly help me with my homework.	2.33	D
I feel emotionally supported by my family.	2.71	A
I have access to books, internet, and other learning materials at home.	2.13	D
My family expects me to perform well in school.	2.26	D
My home environment provides a quiet space for studying.	2.03	D
Grand Mean	2.29	D

Table 1 reveals that pupils generally perceive their home environment as lacking in several key educational support areas, with most indicators falling into the 'disagree' category. The data shows that regular parental assistance with homework is infrequent, with a mean score of 2.33, and access to educational resources like books and the internet is also limited, scoring even lower at 2.13. Although the pupils feel relatively more supported emotionally by their families, as indicated by a higher score of 2.71, they report that their families have lower expectations for their academic performance and provide inadequate study environments, with scores of 2.26 and 2.03, respectively. The overall Grand Mean of 2.29 further emphasizes a general lack of comprehensive support in their home environments, suggesting a need for targeted interventions to enhance educational support at home.

Table 2. Technology-Related Factors.

Indicators	Mean	VD
I have reliable access to computers/tablets for schoolwork.	1.89	D
Using technology improves my learning experience.	3.30	SA
I spend a lot of time on social media or video games.	2.70	A
Technology often distracts me from studying.	3.33	SA
I easily adapt to using new educational software or platforms.	2.15	D
Grand Mean	2.67	A

Table 2 assesses pupils' perceptions of technology-related factors impacting their education, revealing mixed responses across various indicators. The mean scores indicate that reliable access to computers or tablets for schoolwork is notably low at 1.89, classified as 'disagree' (D), pointing to a significant gap in essential technological resources. Conversely, pupils perceive technology positively in enhancing their learning experiences and in terms of distraction, with high scores of 3.30 and 3.33, respectively, both classified as 'strongly agree' (SA). This suggests that while technology is seen as beneficial and engaging, it also frequently distracts them from studying. Additionally, the time spent on social media or video games is perceived moderately with a score of 2.70, falling into the 'agree' (A) category, indicating a significant engagement in these activities. However, adaptability to new educational software or platforms is another area of concern, scoring low at 2.15 ('disagree'). The overall Grand Mean of 2.67 falls under 'agree' (A), reflecting a generally positive yet complex relationship with technology among pupils, where its benefits are acknowledged alongside challenges like distraction and access issues.

Table 3 presents the pupils' perceptions of various school-related factors that influence their educational experience, revealing generally positive views. Pupils feel strongly supported by their teachers, as indicated

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by a high mean score of 3.42, categorized as 'strongly agree' (SA), suggesting a nurturing and helpful teaching environment.

Table 3. School-Related Factors.

Indicators	Mean	VD
My teachers are supportive and help me succeed.	3.42	SA
My school provides adequate resources (e.g., books, labs, facilities).	2.80	A
I feel safe at school.	3.29	SA
My classmates are supportive and help me with schoolwork	2.87	A
I participate in extra-curricular activities provided by my school.	2.55	A
Grand Mean	2.97	A

Similarly, the sense of safety at school is also rated highly at 3.29, falling into the 'strongly agree' (SA) category, which points to a secure learning atmosphere. While the provision of school resources like books, labs, and facilities receives a lower score of 2.80, it still falls within the 'agree' (A) range, indicating moderate satisfaction with the resources available. Classmate support is perceived positively with a score of 2.87 ('agree'), showing a good level of peer assistance. However, participation in extracurricular activities scores slightly lower at 2.55, also under 'agree', reflecting a less robust engagement in these additional educational opportunities. Overall, the Grand Mean of 2.97 falls under 'agree' (A), illustrating a generally supportive school environment that fosters safety, learning, and collaboration, despite some areas for improvement in resource provision and extracurricular involvement.

Table 4. Social-Emotional Factors.

Indicators	Mean	VD
I am confident in my academic abilities.	2.40	A
I have positive relationships with my classmates.	2.99	A
I can manage my emotions well when faced with challenges.	2.63	A
I feel supported by my friends.	2.92	A
I am able to manage stress effectively.	2.66	A
Grand Mean	2.72	A

Table 4 evaluates the pupils' perceptions regarding social-emotional factors related to their school experience, displaying an overall positive sentiment with all indicators classified under 'agree' (A). The data suggests that pupils feel moderately confident in their academic abilities, scoring 2.40, which indicates a reasonable level of self-assuredness. Relationships with classmates are viewed quite positively, with a higher score of 2.99, suggesting a supportive peer environment that contributes positively to their social interactions. Emotional management in the face of challenges scores slightly lower at 2.63, indicating a good but potentially improvable ability to handle emotional stressors. Support from friends is rated similarly high at 2.92, reflecting a strong network of peer support that plays a crucial role in the pupils' social-emotional development. The ability to manage stress effectively is rated at 2.66, showing that while pupils are generally adept at handling stress, there is room for enhancement in this area. The Grand Mean of 2.72 across all indicators aligns with the 'agree' (A) category, illustrating that, overall, pupils feel supported and are able to navigate the social and emotional aspects of their educational experience effectively, though certain areas could benefit from targeted support and resources.

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Table 5. Learners' Performance

Indicators	Mean	VD

Number Identification	80	Satisfactory
Quantity Discrimination	81	Satisfactory
Missing Number (Patterns)	80	Satisfactory
Addition And Subtraction Level 1	81	Satisfactory
Addition And Subtraction Level 1	80	Satisfactory
Word Problem- Solving Skill	81	Satisfactory

Table 5 illustrates that learners' performances across various mathematical competencies are uniformly classified as 'Satisfactory'. Specifically, the learners scored 80 in both Number Identification and Missing Number (Patterns), indicating adequate abilities in recognizing numbers and identifying sequential patterns—fundamental skills in mathematics. Additionally, their ability to discriminate between quantities is also satisfactory, with a score of 81, demonstrating effective discernment of numerical differences. The scores for Addition and Subtraction Level 1 reflect a solid understanding of basic arithmetic, with one aspect scoring 81 and another 80, suggesting a consistent grasp across these operations. Similarly, their competence in solving word problems is also marked satisfactory with a score of 81, showing a good ability to apply mathematical concepts to real-world scenarios. Collectively, these results underscore a sound foundational knowledge in mathematics among the learners, although they indicate a potential for further academic growth and mastery beyond the satisfactory level.

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

Constructs	r-value	t-value	P value	Remarks	Decision
Number Identification	-0.206	-2.08	0.04	Significant	Do not reject
Quantity Discrimination	0.066	0.653	0.515	Not Significant	Do not reject
Missing Number	0.209	2.115	0.037	Significant	Do not reject
Addition_Level_1	-0.162	-1.629	0.107	Not Significant	Do not reject
Subtraction Level 1	0.034	0.339	0.735	Not Significant	Do not reject
Word Problem	-0.108	-1.075	0.285	Not Significant	Do not reject

Table 6 explores the correlation between the parental and home environment and learners' performance across various mathematical tasks, utilizing r-values, t-values, and p-values to determine significance. The results show a significant relationship in two areas: Number Identification and Missing Number (Patterns). Number Identification has an r-value of -0.206, a t-value of -2.08, and a p-value of 0.04, indicating a significant correlation, suggesting that elements within the home environment may inversely affect this skill. Similarly, Missing Number (Patterns) shows a positive significant correlation with an r-value of 0.209, a t-value of 2.115, and a p-value of 0.037, pointing towards a positive influence of the home setting on this mathematical ability. Conversely, other areas such as Quantity Discrimination, Addition Level 1, Subtraction Level 1, and Word Problem Solving did not show significant correlations. Their p-values (0.515, 0.107, 0.735, and 0.285, respectively) indicate that the home environment's impact on these skills is not statistically significant, suggesting that other factors might be influencing performance in these areas. The decision across all metrics was to 'Do not reject,' indicating the null hypothesis is not refuted except where statistically significant relationships exist. This mixed result highlights the complex interplay between home environmental factors and specific mathematical skills, suggesting targeted areas for intervention to potentially enhance learner outcomes.

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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	-0.088	-0.873	0.385	Not Significant	Do not reject
Quantity Discrimination	0.11	1.099	0.275	Not Significant	Do not reject
Missing Number	0.137	1.368	0.175	Not Significant	Do not reject
Addition_Level_1	-0.001	-0.013	0.99	Not Significant	Do not reject
Subtraction Level 1	0.119	1.185	0.239	Not Significant	Do not reject
Word Problem	-0.075	-0.741	0.46	Not Significant	Do not reject

Table 7 investigates the impact of technology-related factors on learners' performance in various mathematical areas, revealing no significant correlations across all metrics. Specifically, the study found that technology factors such as access to and use of digital tools do not significantly affect skills like Number Identification, Quantity Discrimination, Missing Number, Addition Level 1, Subtraction Level 1, and Word Problem Solving, as indicated by high p-values well above the significance threshold ($p < 0.05$). For instance, Number Identification and Word Problem Solving showed slight negative correlations, with r-values of -0.088 and -0.075 respectively, yet neither were statistically significant. Similarly, positive but insignificant correlations were observed in Quantity Discrimination, Missing Number, and Subtraction Level 1, with p-values ranging from 0.175 to 0.275. The almost zero correlation in Addition Level 1 with a p-value of 0.99 particularly underscores the minimal impact of technology on this skill. These results collectively suggest that technology's role in enhancing mathematical performance might be limited or influenced by other mediating factors, thus pointing towards a need for further investigation or a reevaluation of how technology is integrated into mathematical learning.

Table 8 examines the relationships between various school-related factors and learners' performance in mathematical tasks, with none of the correlations reaching statistical significance. The study explores how elements such as teacher support, resource availability, and school environment might impact areas like Number Identification, Quantity Discrimination, Missing Number, Addition Level 1, Subtraction Level 1, and Word Problem Solving.

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

Constructs	r-value	t-value	P value	Remarks	Decision
Number Identification	-0.108	-1.072	0.286	Not Significant	Do not reject
Quantity Discrimination	0.126	1.252	0.213	Not Significant	Do not reject
Missing Number	0.193	1.95	0.054	Not Significant	Do not reject
Addition_Level_1	-0.024	-0.242	0.809	Not Significant	Do not reject
Subtraction Level 1	-0.027	-0.27	0.787	Not Significant	Do not reject
Word Problem	-0.116	-1.157	0.25	Not Significant	Do not reject

Each of these areas displayed p-values well above the threshold for significance, indicating no strong evidence that school factors have a measurable impact on these mathematical skills.For instance, the correlation for Number Identification and Word Problem Solving showed slight negative values with r-values of -0.108 and -0.116 respectively, but with p-values of 0.286 and 0.250, they did not demonstrate significant effects. Similarly, a modest positive correlation was noted in Quantity Discrimination and Missing Number, with r-values of 0.126 and 0.193, and p-values of 0.213 and 0.054 respectively, the latter just missing the typical significance mark. However, even these modest correlations were not statistically compelling. For Addition and Subtraction Level 1, the correlations were almost negligible with r-values of -0.024 and -0.027 and p-values of 0.809 and 0.787 respectively. These findings suggest that while school factors might intuitively be expected to influence educational outcomes, in this case, they do not show a statistically significant relationship with the mathematical performance of the learners. This could imply that other variables, possibly outside the school environment, play a more decisive role in influencing these particular areas of mathematical achievement, or it may indicate the need for a deeper investigation into the specific school-related factors being analyzed.

Table 9 explores the relationship between social-emotional factors and learners' performance across various mathematical skills, revealing no statistically significant correlations. Despite some negative and

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positive r-values, none of the correlations were strong enough to meet the statistical threshold for significance, indicated by p-values in all cases.

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

Constructs	r-value	t-value	P value	Remarks	Decision
Number Identification	-0.172	-1.729	0.087	Not Significant	Do not reject
Quantity Discrimination	-0.189	-1.903	0.06	Not Significant	Do not reject
Missing Number	-0.052	-0.518	0.606	Not Significant	Do not reject
Addition_Level_1	0.003	0.033	0.974	Not Significant	Do not reject
Subtraction Level 1	0.051	0.509	0.612	Not Significant	Do not reject
Word Problem	-0.191	-1.926	0.057	Not Significant	Do not reject

The results show slight negative correlations in Number Identification, Quantity Discrimination, and Word Problem Solving with r-values of -0.172, -0.189, and -0.191 respectively. Although these are negative, the closest p-values for Quantity Discrimination and Word Problem Solving are 0.060 and 0.057, nearly approaching significance but still not crossing the conventional threshold ($p < 0.05$). These findings suggest a potential, albeit non-significant, inverse relationship where higher social-emotional challenges might correspond to lower performance in these areas. Conversely, Missing Number and Subtraction Level 1 show very low negative and positive correlations respectively with r-values of -0.052 and 0.051, and high p-values of 0.606 and 0.612, indicating very weak associations. Addition Level 1 showed virtually no correlation with an r-value of 0.003 and a p-value of 0.974, suggesting no impact of social-emotional factors on this skill at all. Overall, these results indicate that while social-emotional factors might intuitively affect learning outcomes, in this dataset they do not show a significant direct impact on mathematical performance. This could mean that the effect of these factors is either too subtle to detect with the sample size and methodology used, or that other factors not measured here play more substantial roles in influencing mathematical skills.

5. Discussion

The findings provide insights into the various factors influencing learners' mathematical performance, from parental involvement and home environments to school and social-emotional factors. Significant relationships in the study, such as the correlation between the parental environment and specific mathematical skills (e.g., Number Identification and Missing Number), suggest that home factors play a critical role in shaping early mathematical abilities. This aligns with research by Desimone (2019), who found that parental engagement in homework and educational activities significantly impacts children's academic outcomes. Similarly, Fuchs and Fuchs (2020) and Suson (2019) highlighted the importance of home resources, such as books and educational materials, in fostering an environment conducive to learning. However, the lack of significant impact from technology-related factors on mathematical skills, despite the high usage and distraction potential noted, resonates with findings by Greenfield (2021), who argues that not all technological engagement is beneficial for learning, particularly when it serves more as a distraction than an educational tool.

On the school-related front, the absence of significant correlations between school factors like resource availability and teacher support with mathematical performance challenges common educational assumptions. This might suggest that while such resources are essential, their direct impact on specific learning outcomes can be less straightforward than anticipated. This is supported by the work of Hattie (2022), who posits that the quality of educational interactions—rather than sheer quantity of resources—may hold more substantial effects on learning outcomes. Furthermore, the minimal impact of social-emotional factors found in this study contrasts with research by Jones et al. (2019), who documented a strong link between emotional well-being and academic performance. This discrepancy could indicate variability in how social-emotional dynamics play out in different educational settings, as suggested by Rimm-Kaufman and Sandilos (2021), who emphasize the contextual nature of these relationships. The overall findings highlight the complexity of educational dynamics and suggest that enhancing educational outcomes involves a multifaceted approach that considers more than just the conventional variables, as noted by Darling-Hammond and Ifill-Lynch (2023).

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6. Conclusion

The study at Lawaan III Elementary School reveals complex factors influencing mathematical performance among elementary pupils. Key findings challenge conventional views on the impact of technological, social-emotional, and school-related factors. Notably, the home environment, including resource availability and parental involvement, significantly correlates with mathematical skills, underscoring its critical role in educational support. Conversely, technology, while often seen as beneficial, shows no significant effect, suggesting its efficacy is context-dependent. Similarly, the limited influence of school and social-emotional factors indicates a need for deeper exploration into how these elements interact in educational settings, pointing towards the importance of quality interactions and specific pedagogical approaches. These insights call for a comprehensive, context-sensitive approach in educational strategies to enhance learning outcomes, especially in mathematics, prompting a reevaluation of traditional educational methods and resource allocation.

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