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Factors Affecting the Numeracy Skills of Key Stage 2 Learners

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Abstract

Multiple interrelated factors strongly shape the development of numeracy skills in Key Stage 2 learners. Based on this premise, this study examined the extent to which factors affect the numeracy skills of 145 Key Stage 2 learners as a basis for an intervention plan. Using a descriptive research design, data were collected through a valid and reliable researcher-made instrument and analyzed using descriptive and comparative statistics. Findings revealed that learning motivation, learning environment, and teacher competence exerted a strong influence on numeracy skills, while learning facilities had a moderate effect. Comparative analysis showed that age and grade level significantly affect learning motivation, environment, and facilities, whereas sex influences perceptions of teacher competence. These results highlight that both individual learner characteristics and classroom context determine numeracy development. Hence, the study underscores the importance of addressing these factors to effectively enhance numeracy outcomes.

Keywords: *Numeracy skills, key stage 2, learning motivation, learning environment, teacher competence, learning facilities.*

Bio-profiles

Nelan Jane M. Chiva has been a public school teacher in the Department of education in the Philippines for 6 years and is currently teaching in the United States of America, where she has been working for 4 years. She earned her Bachelor's Degree in Education, major in General Education, from Negros Oriental State University in Guihulngan City, Negros Oriental, Philippines, in 2014. She is currently pursuing her Master's Degree in Education, major in Administration and Supervision, at STI West Negros University in Bacolod City, Negros Occidental, Philippines. Her research focuses on the factors affecting the numeracy skills of Key Stage 2 learners, which will serve as the basis for an intervention plan.

Dr. Lisa C. Cañedo received her Ph. D in Education and is a brilliant academician at STI West Negros University in Bacolod City. Her background in basic and higher education is broad. Currently, Dr. Caedo is a Master Teacher I of the Manjuyod District, Division of Negros Oriental, Department of Education. She is also one of the pool of professors for the School of Graduate Studies at STI West Negros University. As a faculty member, she serves as a research adviser and guide to

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master's and doctoral students. Research in modern and real-life educational issues, such as the implementation of modules and teacher self-efficacy, is her expertise.

Introduction

Rationale

Numeracy is a fundamental skill that learners must acquire and apply to effectively use mathematics in real-life situations (UNESCO, 2017). This focus aligns with the United Nations' Sustainable Development Goal on ensuring inclusive and equitable quality education for all (United Nations, 2015). It also supports the Graduate School's research theme on equity and access, which aims to develop educational models and paradigms.

Consistent with the above-mentioned directions, national policies also emphasize numeracy as a critical learning priority. The Early Language, Literacy and Numeracy Program (ELLN) and the Enhanced Basic Education Act of 2013 (K to 12 law) of the Department of Education (DepEd) specifically identify numeracy as an essential competency for all learners and establish a clear policy basis for examining the factors that affect numeracy skills (DepEd, 2015). Most recently, the Academic Recovery and Accessible Learning (ARAL) Act was enacted to provide a statutory mandate for targeted interventions in reading and mathematics to close learning gaps and to give clear legal authority to investigate factors that affect learners' numeracy skills.

However, it is sad to note that many learners continue to exhibit limited numeracy proficiency. In fact, Latiban and Mendez (2022) identified several contributing factors that significantly affect students' numeracy performance. Narrowing the focus, the researcher considered that learning motivation, learning environment, learning facilities, and teacher competence could impact the numeracy skills of Key Stage 2 learners in the research venue.

Despite these efforts, many learners continue to demonstrate low levels of numeracy proficiency. DepEd has been making every effort to pinpoint and fix math learning gaps among students. However, recent mathematics assessment results remain concerning. In the international scene, only 66% of students attained at least Level 2 proficiency in mathematics (OECD, 2023). Additionally, the school, which is the research venue, has not met its numeracy proficiency targets. Based on the Beginning of the School Year (BOSY) Rapid Math Assessment (RMA) results of the school year 2025–2026, which reflect learners' prior performance at the end of School Year 2024-2025, 14% of Key Stage 2 learners are non-proficient, 28% are low proficient, and no learners reached grade-level or advanced proficiency.

These results highlight the urgency of identifying key factors influencing numeracy skills to support targeted intervention efforts.

In this regard, the researcher was motivated to examine factors that could affect the numeracy skills of Key Stage 2 learners, providing a basis for developing an intervention plan.

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Literature Review

In this section, a detailed survey of concept and research literature, both foreign and domestic, about the correlates of numeracy skill acquisition in Key Stage 2 students is undertaken. Numeracy itself is not seen as simply mathematics, but as the "ability and confidence to use mathematical concepts in various real-life contexts". Theoretical underpinnings and individual characteristics: Siegler, Thompson, and Schneider's Theory of Numerical Development suggests that learning numbers comes from improvements in understanding of number magnitude. A crucial internal attribute is motivation: according to Eccles & Wigfield (2020), "interest in the learning activity depends on expectancy (expectations of success) and value (instrumental or intrinsic importance).

In a local context, motivation and concentration correlate with achievement of Grade 6 pupils (Wheeler & Cabigas, 2024), while according to Jaen and Baccay (2024), motivation can serve as a significant correlate regardless of gender. In environmental and institutional contexts, Talucad (2025) confirms that the security of the home environment is a factor in the development of early numeracy skills, while Niu et al. (2022) confirm that positive interactions in the classroom correlate with achievement.

Conversely, Timotheou et al. (2022) and Namome & Moodley (2021) confirmed that even the effectiveness of computer-based learning is limited by the scarcity or faulty functioning of the available computers. As far as facilities are concerned, according to Azubuike (2025) and Tagalog and Oco (2025), the provision of facilities and the manipulation of physical materials in the home and school learning environments are very important in creating and enriching the numeracy learning experience of younger children. A significant correlate of students' achievement is the teacher's competence. According to Goos et al., "teacher competence has been conceptualized as the mastery of knowledge to teach students and to promote real-life mathematical reasoning skills". Shinn et al. (2025) concluded that competent and likable teachers are beneficial for all students, and Ponomariovien et al. (2025) and Guo (2020) noted that timely feedback focused on students' progress enables students to track their own growth.

Meanwhile, gender as a variable produces conflicting results. While Hutchison et al. (2019) and Tosto et al. (2016) concluded that sex differences were not evident for the skills measured and the perceived context, Villalon et al. (2024) found that sex differences were evident in the local context of secondary schools. Rodriguez et al. (2020) found that boys held slightly more positive attitudes toward mathematics than girls, but Cabuquin & Abocejo (2023) found no significant differences in numerical ability between boys and girls.

Theoretical Underpinnings

This study is built on Siegler, Thompson, and Schneider's (2011) Integrated Theory of Numerical Development, which posits that the main element of numerical development is the continually expanding knowledge of numerical magnitude. Like Piaget, who believes the development of numerical thought is dependent on mental schemas, this theory sees numerical development as the process of continually increasing the number and variety of numbers whose values the mind comprehends and internalizes. In relation to the mind's way of learning and processing mathematics, the theory provides insight into how abilities develop from childhood to adulthood. It answers the 'how' of the mental operations involved in numerical reasoning and solving

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mathematics. It provides answers to the learning competencies for children in Key Stage 2. The theory states that the correct understanding of numerical magnitude as the basic principle in numerical development is the unifying element. Given the importance of concrete experience for schema development, the Integrated Theory is applied to understand the influences that can shape children's numerical knowledge. It analyzes the reasons behind individual differences in gaining numerical competency. It explains why a breakdown at the very basics, like poor environmental conditions, is so debilitating for acquiring high-level math skills.

Objectives

This study aimed to determine the extent to which factors affect the numeracy skills of Key Stage 2 learners in one public elementary school in a small-sized division in the Negros Island Region for the school year 2024-2025. Specifically, it sought to answer the following questions: 1) extent of factors affecting the numeracy skills of key stage 2 learners in learning motivation, learning environment, learning facilities, and teacher competence; 2) the extent of factors affecting the numeracy skills of key stage 2 learners when grouped by age, grade level, and sex; and 3) the significant difference in the extent to which factors affect the numeracy skills of key stage 2 learners when grouped and compared according to the aforementioned variables.

Methodology

In this section, the methodology for conducting the study is presented to maintain the research's scientific rigor. The components are as follows: research design, locale, respondents, instruments used to gather data, instrument administration, ethical measures, scheme of analysis, and statistical methods.

Research Design

The researcher employed a descriptive research design to determine and analyze factors influencing the numeracy skills of Key Stage 2 students. The descriptive design is a research design used to describe people, events, or situations as they naturally exist (Siedlecki, 2020). This type of design can be used to determine the particular qualities and differences of a population. A descriptive design is particularly suitable for this research, as it aims to investigate the status of intermediate students' numeracy skills. This design enables the researcher to assess the degree of impact of identified variables (learning motivation, learning environment, learning facilities, and teachers' competence) on existing numeracy skills at that moment in time.

The study involved the recording and analysis of these variables in their present status, uninfluenced by the manipulation involved in the experiment, and this helps the researcher to attain valid data representative of the learners. Eventually, this design serves to obtain baseline data for the development of targeted interventions.

The research is being conducted at a public elementary school in one small division of Negros Island Region during the school year 2024-2025. Being a banner school, it receives recognition for its excellent leadership and active stakeholder involvement, and serves a particular group of 231 intermediate learners (grades 4-6). This particular school site prides itself on academic

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and holistic development, having been cited as an outstanding school program and PTA implementer. Active and not stagnant, the school also garners distinction in various co-curricular and extracurricular competitions, such as the Division champion in Sports Writing and Photojournalism and 2nd placer in division-level volleyball. With a positive, innovation-driven community that considers aesthetics, performance, and competition, the site is considered an appropriate environment to study the factors affecting numeracy skill development.

Locale of the Study

The research was conducted at a public elementary school in one small division of Negros Island Region during the school year 2024-2025. Being a banner school, it receives recognition for its excellent leadership, active stakeholder involvement, and service to 231 intermediate learners (grades 4-6). This particular school site prides itself on academic and holistic development, having been cited as an outstanding school program and PTA implementer. Active and not stagnant, the school also garners distinction in various co-curricular and extracurricular competitions, such as being the Division champion in Sports Writing and Photojournalism and the 2nd placer in division-level volleyball. With a positive, innovation-driven community that considers aesthetics, performance, and competition, the site is considered an appropriate environment to study the factors affecting numeracy skill development.

Respondents of the Study

The study sampled 145 Key Stage 2 pupils from a population of 231. The sample size was determined using Cochran's formula to ensure a representative sample at the specified confidence levels and margins of error. To ensure a proportional distribution across subgroups, stratified random sampling was used, followed by random selection to improve precision.

Data Gathering Instrument

A researcher-designed survey questionnaire composed of two parts was used in this study to assess the factors affecting the numeracy abilities of Key Stage 2 students. The first part collects respondents' profiles, such as age, grade, and sex. In contrast, the second part is the survey proper, comprising 40 items evenly distributed across four dimensions: motivation to learn, learning environment, learning facilities, and teacher's competence. The 5-point Likert scale used for each item and respondents' perceptions was: 5-Always, 4-Often, 3-Sometimes, 2-Rarely, and 1-Almost Never.

Instrument Validity and Reliability

To ensure the instrument's appropriateness, it underwent rigorous validation by three education experts, including an Education Program Supervisor, a Head Teacher, and a Master Teacher. Following Mohajan's (2017) principles, these experts evaluated the tool using Good and Scates' criteria, resulting in a validation index of 5.00, indicating "excellent" validity.
Reliability, on the other hand, was established through a pilot test with 30 non-participant learners from Grades 4 to 6. Data were analyzed using Cronbach's Alpha to assess internal consistency, as it

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is suitable for items that are not simply correct or incorrect. The computed alpha reached 0.850, confirming "good" reliability. This ensures the self-developed questionnaire consistently measures the factors that affect numeracy skills among Key Stage 2 learners.

Data Gathering Procedure

The researcher wrote a letter addressed to the principal requesting permission/approval to conduct this study. As respondents were students, parental consent was considered before the questionnaires were administered. To ensure that all students in the said group could retrieve the administered questionnaires immediately, my sister personally hand-carried and distributed them to all respondents on my behalf. Those who were unable to be in school during the actual administration of the questionnaire were given their questionnaires at a later date. My sister and I visited the absentees until we reached a 100 percent response rate.

Research Ethics Protocol

Consistent with the ethical principles of voluntary participation and truthfulness, this study fully complies with R.A. 10173, or the Data Privacy Act of 2012, ensuring that all private information is secure and safe. Formal permission was also obtained from the school authorities, and a documented form was prepared for their permission to the study, which describes the advantages and risks. The learners were also informed of their right to ask questions and to withdraw from the study at any time without suffering any consequences. Regarding anonymity, all personal characteristics were discarded, and all data were kept confidential only during the study period and not beyond. This was achieved through balanced data presentation and permanently secured, eventually deleted data files, thereby honoring the individual's right.

Analytical and Statistical Schemes

Objective No. 1 employed descriptive statistics and mean scores to evaluate the extent of factors affecting the numeracy skills of key stage 2 learners in learning motivation, learning environment, learning facilities, and teacher competence. Objective No. 2 also used descriptive statistics and mean scores to evaluate the extent to which factors affect the numeracy skills of key stage 2 learners, grouped by age, grade level, and sex. Objective No. 3 used comparative statistics and the Mann-Whitney U test to determine whether there was a significant difference in the extent to which factors affect the numeracy skills of key stage 2 learners across groups defined by the aforementioned variables.

Results and Discussion

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Motivation, Learning Environment, Learning Facilities, and Teachers' Competence

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Table 1

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to the Learning Motivation

Items	Mean	Interpretation
I am motivated to…		
1. solve routine math problems	4.03	Great Extent
2. apply math skills beneficial for my daily activities	3.89	Great Extent
3. test my ability in basic math through mental computation	3.81	Great Extent
4. put extra effort into learning math, even when it is difficult.	3.79	Great Extent
5. work with peers in doing computations.	4.14	Great Extent
6. improve my fundamental math knowledge with my siblings.	3.74	Great Extent
7. learn more techniques in solving when I am rewarded/recognized by my math teacher.	3.88	Great Extent
8. perform more challenging math problems.	3.63	Great Extent
9. correct my work with timely feedback from my teacher.	3.46	Moderate Extent
10. Try different ways to solve math problems.	3.58	Great Extent
Overall Mean	**3.79**	**Great Extent**

Table 1 illustrates the extent to which learning motivation affects the numeracy skills of Key Stage 2 learners, yielding an overall mean of 3.79, interpreted as a "great extent". This suggests that motivation is a primary driver of numerical development. The highest mean of 4.14 highlights that working with peers on computations significantly boosts engagement. Conversely, the lowest mean of 3.46 regarding correcting work after teacher feedback indicates only a moderate influence. This finding partially diverges from Ponomariovienė et al. (2023), who emphasize feedback as a critical motivator. Ultimately, these results align with Wheeler and Cabigas (2024) and Epson et al. (2025), confirming that as motivation increases, mathematics achievement and numeracy learning significantly improve.

Table 2

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Environment

Items	Mean	Interpretation
My study area is…		
1. free from noise and distractions.	3.39	Moderate Extent
2. a small room intended for studying alone.	3.44	Moderate Extent
3. an open but comfortable space.	3.82	Great Extent
4. well-lighted and ventilated.	3.95	Great Extent
5. filled with Math learning resources.	3.06	Moderate Extent
6. a place where there is someone to ask whenever I need to.	4.27	Great Extent
7. clean and free of sores.	3.94	Great Extent
8. with functional computer units/tablets for use.	2.83	Moderate Extent
9. is complete with properly arranged tables and other furniture.	4.08	Great Extent
10. is a location with a strong internet connection.	3.71	Great Extent
Overall Mean	**3.65**	**Great Extent**

Table 2 illustrates the influence of the learning environment on the numeracy skills of Key Stage 2 learners, yielding an overall mean of 3.65, or a "great extent". The highest mean of 4.27

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underscores the value of a study area where immediate personal assistance is available. Conversely, the lowest mean of 2.83 for functional computer access suggests that technical faults or limited device availability hinder digital learning. This aligns with Timotheou et al. (2022) and Namome and Moodley (2021), who found that inadequate technological support significantly weakens mathematics performance in primary pupils.

Table 3

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Facilities

Items	Mean	Interpretation
The learning facilities…		
1. like textbooks and other learning tools have improved my comprehension of mathematical topics.	3.57	Great Extent
2. are strategically arranged and easy to locate.	3.08	Moderate Extent
3. use computers, calculators, and the like improves my ability to learn and practice math.	3.11	Moderate Extent
4. provide useful resources that help me improve my numeracy skills.	3.52	Great Extent
5. for tutoring and study groups, add support to my numeracy learning options.	3.16	Moderate Extent
6. are of good quality and varied, which help me learn arithmetic.	3.24	Moderate Extent
7. are situated in peaceful study areas that allow me to focus better when working on arithmetic tasks.	3.50	Great Extent
8. are interactive learning tools, such as smartboards and math games, useful for exploring complex math concepts.	2.51	Moderate Extent
9. are well-maintained, clean, and functional.	3.10	Moderate Extent
10. support my practice of computing numbers.	3.46	Moderate Extent
Overall Mean	**3.23**	**Moderate Extent**

Table 3 illustrates the influence of learning facilities on numeracy skills, yielding an overall mean of 3.23, interpreted as a "moderate extent". The highest mean of 3.57 indicates that traditional tools, such as textbooks, remain foundational for comprehension. Conversely, the lowest mean of 2.51 for advanced facilities such as smartboards suggests a lack of purposeful instructional guidance or that teacher training limits their effectiveness. This finding aligns with Miller (2018), who noted that while interactive technologies significantly boost engagement, they often yield only modest gains in traditional achievement.

Table 4

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Teachers' Competence

Items	Mean	Interpretation
My Math teacher…		
1. demonstrates mastery of math concepts and content.	4.70	Very Great Extent
2. uses effective teaching methods that make complex math concepts easier to understand.	4.57	Very Great Extent
3. provides clear instructions for performing the math learning task.	4.66	Very Great Extent

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4.	uses engaging activities and materials that make learning math interesting.	4.05	Great Extent
5.	participates in professional development opportunities to stay current with effective math teaching practices.	3.89	Great Extent
6.	provides helpful feedback on my math assignments and tests.	3.98	Great Extent
7.	gives additional support and resources to help those who are struggling with math."	4.15	Great Extent
8.	fits the teaching strategies to the needs and level of the learners	3.94	Great Extent
9.	encourages me to improve my math skills.	4.56	Very Great Extent
10.	demonstrates problem-solving techniques effectively.	4.49	Great Extent
Overall Mean		**4.28**	**Great Extent**

Table 4 illustrates the influence of teacher competence on numeracy skills, yielding a high overall mean of 4.28, interpreted as "great extent". The highest mean of 4.70 underscores that teachers' mastery of mathematical concepts is a primary driver of student success. Conversely, the lowest mean of 3.89 for participation in professional development suggests that while training is beneficial, its impact depends on consistent classroom application. This finding aligns with Park et al. (2025) regarding the positive effect of instructional competence on achievement, though it remains inconsistent with Tagalog and Oco (2025).

Table 5

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Motivation when grouped according to Age

Items	**Younger**		**Older**	
	Mean	**Interpretation**	**Mean**	**Interpretation**
I am motivated to…				
1. solve routine math problems	3.89	Great Extent	4.14	Great Extent
2. apply math skills beneficial for my daily activities	4.11	Great Extent	3.71	Great Extent
3. test my ability in basic math through mental computation	4.00	Great Extent	3.65	Great Extent
4. put extra effort into learning math, even when it is difficult.	4.14	Great Extent	3.51	Great Extent
5. work with peers in doing computations.	4.26	Great Extent	4.05	Great Extent
6. improve my fundamental math knowledge with my siblings.	4.26	Great Extent	3.31	Moderate Extent
7. learn more techniques in solving when I am rewarded/recognized by my math teacher.	4.18	Great Extent	3.63	Great Extent
8. perform more challenging math problems.	4.14	Great Extent	3.21	Moderate Extent
9. correct my work with timely feedback from my teacher.	4.22	Great Extent	2.85	Moderate Extent
10. Try different ways to solve math problems.	3.88	Great Extent	3.34	Moderate Extent
Overall Mean	**4.11**	**Great Extent**	**3.54**	**Great Extent**

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Table 5 shows the influence of learning motivation on numeracy skills across age groups, with both younger and older learners showing high agreement, with mean scores of 4.11 and 3.54, respectively. A marked disparity surfaced regarding item 9, where younger learners (4.22) were significantly more motivated by timely teacher feedback than older learners (2.85). This suggests that while younger students remain reliant on teacher guidance, older learners develop greater independence. These results align with Guo (2020) on age-based feedback responses and Campanilla (2024), reinforcing the idea that sustained motivation is essential for superior mathematical outcomes.

Table 6

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to the Learning Environment when grouped according to Age

Items	Younger		Older	
	Mean	Interpretation	Mean	Interpretation
My study area is…				
1. free from noise and distractions.	3.91	Great Extent	2.96	Moderate Extent
2. a small room intended for studying alone.	4.09	Great Extent	2.91	Moderate Extent
3. an open but comfortable space.	4.37	Great Extent	3.38	Moderate Extent
4. well-lighted and ventilated.	4.46	Great Extent	3.54	Great Extent
5. filled with Math learning resources.	2.94	Moderate Extent	3.15	Moderate Extent
6. a place where there is someone to ask whenever I need to.	4.49	Very Great Extent	4.09	Great Extent
7. clean and free of sores.	4.49	Very Great Extent	3.50	Great Extent
8. with functional computer units/tablets for use.	3.35	Moderate Extent	2.40	Low Extent
9. is complete with properly arranged tables and other furniture.	4.75	Very Great Extent	3.54	Great Extent
10. is a location with a strong internet connection.	3.88	Great Extent	3.58	Great Extent
Overall Mean	**4.08**	**Great Extent**	**3.30**	**Moderate Extent**

Table 6 highlights how the learning environment impacts numeracy skills across age groups, with younger learners reporting a higher mean of 4.08 (great extent) compared to 3.30 (moderate extent) for older learners. This disparity suggests that younger students are more sensitive to their physical surroundings and study areas for skill development. Conversely, older learners exhibit greater independence, making environmental features less central to their progress. These findings support Talucad (2025), who noted that external learning environments significantly influence early numeracy, confirming that younger learners require more structured environmental support than their older counterparts.

Table 7

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to the Learning Facilities when grouped according to Age

Items	Younger	Older

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	Mean	Interpretation	Mean	Interpretation
The learning facilities…				
1. like textbooks and other learning tools have improved my comprehension of mathematical topics.	3.66	Great Extent	3.49	Moderate Extent
2. are strategically arranged and easy to locate.	2.98	Moderate Extent	3.16	Moderate Extent
3. use computers, calculators, and the like improves my ability to learn and practice math.	3.46	Moderate Extent	2.83	Moderate Extent
4. provide useful resources that help me improve my numeracy skills.	4.05	Great Extent	3.10	Moderate Extent
5. For tutoring and study groups, add support to my numeracy learning options.	3.35	Moderate Extent	3.00	Moderate Extent
6. are of good quality and varied, which help me learn arithmetic.	3.57	Great Extent	2.98	Moderate Extent
7. are situated in peaceful study areas that allow me to focus better when working on arithmetic tasks.	3.82	Great Extent	3.25	Moderate Extent
8. are interactive learning tools, such as smartboards and math games, useful for exploring complex math concepts.	2.80	Moderate Extent	2.28	Low Extent
9. are well-maintained, clean, and functional.	3.48	Moderate Extent	2.80	Moderate Extent
10. support my practice of computing numbers.	3.89	Great Extent	3.10	Moderate Extent
Overall Mean	**3.51**	**Great Extent**	**3.00**	**Moderate Extent**

Table 7 illustrates the influence of learning facilities on numeracy skills across age groups, with younger learners reporting a higher mean of 3.51 (great extent) compared to 3.00 (moderate extent) for older learners. This indicates that younger students rely more heavily on hands-on, concrete resources to support their developing skills and engagement. In contrast, older learners demonstrate a shift toward abstract reasoning and foundational independence, reducing their reliance on physical materials. These results align with Tagalog and Oco (2025), confirming that while learning facilities and manipulatives positively influence mathematical development, their impact is most pronounced during earlier developmental stages.

Table 8

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Teachers' Competence when grouped according to Age

Items	Younger		Older	
	Mean	Interpretation	Mean	Interpretation
My Math teacher…				

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1.	demonstrates a mastery of math concepts and content.	4.88	Very Great Extent	4.56	Very Great Extent
2.	uses effective teaching methods that make complex math concepts easier to understand.	4.68	Very Great Extent	4.48	Great Extent
3.	provides clear instructions for performing the math learning task.	4.68	Very Great Extent	4.64	Very Great Extent
4.	uses engaging activities and materials that make learning math interesting.	4.06	Great Extent	4.04	Great Extent
5.	participates in professional development opportunities to stay current with effective math teaching practices.	3.71	Great Extent	4.04	Great Extent
6.	provides helpful feedback on my math assignments and tests.	4.03	Great Extent	3.94	Great Extent
7.	gives additional support and resources to help those who are struggling with math.”	3.92	Great Extent	4.34	Great Extent
8.	fits the teaching strategies to the needs and level of the learners	3.72	Great Extent	3.76	Great Extent
9.	encourages me to improve my math skills.	4.74	Very Great Extent	4.41	Great Extent
10.	demonstrates problem-solving techniques effectively.	4.64	Very Great Extent	4.36	Great Extent
Overall Mean		**4.31**	**Great Extent**	**4.26**	**Great Extent**

Table 8 presents the influence of teacher competence on numeracy skills across age groups, with both younger (4.31) and older learners (4.26) reporting a ″great extent″ of agreement. A notable difference emerged in item 9, where younger learners (4.74) showed greater sensitivity to teacher encouragement than older learners (4.41). This implies that younger students rely more on external motivation and guidance, whereas older students prioritize a teacher's ability to facilitate self-directed learning. These findings support Templado (2026) by confirming that younger learners are more strongly motivated by perceived teacher competence than their older counterparts.

Table 9

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Motivation when grouped according to Grade Level

Items	Grade 4		Grade 5		Grade 6	
	Mean	**Interpretation**	**Mean**	**Interpretation**	**Mean**	**Interpretation**
I am motivated to…						
1. solve routine math problems	3.62	Great Extent	3.62	Great Extent	4.21	Great Extent
2. apply math skills beneficial for my daily activities	4.04	Great Extent	4.04	Great Extent	3.60	Great Extent

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3. test my ability in basic math through mental computation	4.09	Great Extent	4.09	Great Extent	3.60	Great Extent
4. put extra effort into learning math, even when it is difficult.	4.15	Great Extent	4.15	Great Extent	3.13	Moderate Extent
5. work with peers in doing computations.	4.16	Great Extent	4.16	Great Extent	4.00	Great Extent
6. improve my fundamental math knowledge with my siblings.	4.33	Great Extent	4.33	Great Extent	2.87	Moderate Extent
7. learn more techniques in solving when I am rewarded/recognized by my math teacher.	4.27	Great Extent	4.27	Great Extent	3.49	Moderate Extent
8. perform more challenging math problems.	4.18	Great Extent	4.18	Great Extent	2.64	Moderate Extent
9. correct my work with timely feedback from my teacher.	4.29	Great Extent	4.29	Great Extent	2.30	Low Extent
10. Try different ways to solve math problems.	3.95	Great Extent	3.95	Great Extent	2.74	Moderate Extent
Overall Mean	**4.11**	**Great Extent**	**4.11**	**Great Extent**	**3.26**	**Moderate Extent**

Table 9 illustrates the influence of learning motivation on numeracy skills across grade levels, with Grade 4 and Grade 5 learners reporting identical mean scores of 4.11 (great extent). This suggests that younger learners are highly responsive to teacher encouragement and reinforcement. Conversely, Grade 6 learners reported a lower mean of 3.26 (moderate extent), potentially due to increased academic demands or shifting interests. These findings align with Wheeler and Cabigas (2024), confirming that while motivation remains a factor for Grade 6 pupils, its impact on numeracy outcomes tends to moderate as students transition into higher elementary levels.

Table 10

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Environment when grouped according to Grade Level

Items	Grade 4 Mean	Grade 4 Interpretation	Grade 5 Mean	Grade 5 Interpretation	Grade 6 Mean	Grade 6 Interpretation
My study area is…						
1. free from noise and distractions.	3.89	Great Extent	4.09	Great Extent	2.15	Low Extent
2. a small room intended for studying alone.	4.27	Great Extent	3.58	Great Extent	2.34	Low Extent

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3.	an open but comfortable space.	4.44	Great Extent	4.07	Great Extent	2.87	Moderate Extent
4.	well-lighted and ventilated.	4.53	Very Great Extent	4.40	Great Extent	2.87	Moderate Extent
5.	filled with Math learning resources.	2.73	Moderate Extent	3.84	Great Extent	2.72	Moderate Extent
6.	a place where there is someone to ask whenever I need to.	4.53	Very Great Extent	4.44	Great Extent	3.81	Great Extent
7.	clean and free of sores.	4.45	Great Extent	4.53	Very Great Extent	2.81	Moderate Extent
8.	with functional computer units/tablets for use.	3.38	Moderate Extent	2.74	Moderate Extent	2.26	Low Extent
9.	is complete with properly arranged tables and other furniture.	4.85	Very Great Extent	4.21	Great Extent	3.06	Moderate Extent
10.	is a location with a strong internet connection.	3.84	Great Extent	4.00	Great Extent	3.30	Moderate Extent
Overall Mean		**4.09**	**Great Extent**	**3.99**	**Great Extent**	**2.82**	**Moderate Extent**

Table 10 reveals that the learning environment significantly influences Grades 4 and 5 learners, with mean scores of 4.09 and 3.99, respectively. This suggests that younger students remain highly dependent on structured classrooms and supportive study areas to build foundational numeracy concepts. Conversely, Grade 6 learners reported a lower mean of 2.82, indicating that the physical environment becomes a less dominant factor as they face increased curriculum demands. This shift aligns with Sonnenschein et al. (2022), who observed that as students progress to higher grade levels, they develop greater autonomy and rely less on external environmental supports.

Table 11

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Facilities when grouped according to Grade Level

Items	Grade 4		Grade 5		Grade 6	
	Mean	Interpretation	Mean	Interpretation	Mean	Interpretation
The learning facilities…						
1. like textbooks and other learning tools have improved my comprehension of mathematical topics.	3.47	Moderate Extent	4.28	Great Extent	3.02	Moderate Extent
2. are strategically arranged and easy to locate.	2.67	Moderate Extent	4.02	Great Extent	2.70	Moderate Extent

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3.	use computers, calculators, and the like improves my ability to learn and practice math.	3.64	Great Extent	2.84	Moderate Extent	2.74	Moderate Extent
4.	provide useful resources that help me improve my numeracy skills.	3.93	Great Extent	4.28	Great Extent	2.36	Low Extent
5.	for tutoring and study groups, add support to my numeracy learning options.	3.07	Moderate Extent	4.23	Great Extent	2.28	Low Extent
6.	are of good quality and varied, which help me learn arithmetic.	3.45	Moderate Extent	4.00	Great Extent	2.30	Low Extent
7.	are situated in peaceful study areas that allow me to focus better when working on arithmetic tasks.	3.60	Great Extent	4.40	Great Extent	2.57	Moderate Extent
8.	are interactive learning tools, such as smartboards and math games, useful for exploring complex math concepts.	3.04	Moderate Extent	2.42	Low Extent	1.98	Low Extent
9.	are well-maintained, clean, and functional.	3.55	Great Extent	3.30	Moderate Extent	2.40	Low Extent
10.	support my practice of computing numbers.	3.76	Great Extent	4.35	Great Extent	2.28	Low Extent
Overall Mean		**3.42**	**Moderate Extent**	**3.81**	**Great Extent**	**2.46**	**Low Extent**

Table 11 reveals that learning facilities influence numeracy skills to varying degrees across grade levels, with Grade 5 reporting the highest mean of 3.81 (great extent). Grade 4 followed with a moderate extent (3.42), while Grade 6 reported a low extent (2.46). These results suggest that the impact of physical resources diminishes as learners transition from concrete materials to abstract, independent study. This finding aligns with Sonnenschein et al. (2022), who observed that while material-rich environments strongly support younger elementary students, this association weakens as learners advance and develop greater academic autonomy.

Table 12

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Teacher Competence when grouped according to Grade Level

Items	Grade 4	Grade 5	Grade 6

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	Mean	Interpretation	Mean	Interpretation	Mean	Interpretation
My Math teacher…						
1. demonstrates a mastery of math concepts and content.	4.89	Very Great Extent	4.65	Very Great Extent	4.53	Very Great Extent
2. uses effective teaching methods that make complex math concepts easier to understand.	4.71	Very Great Extent	4.53	Very Great Extent	4.43	Great Extent
3. provides clear instructions for performing the math learning task.	4.67	Very Great Extent	4.63	Very Great Extent	4.66	Very Great Extent
4. uses engaging activities and materials that make learning math interesting.	4.20	Great Extent	3.84	Great Extent	4.06	Great Extent
5. participates in professional development opportunities to stay current with effective math teaching practices.	3.51	Great Extent	4.42	Great Extent	3.85	Great Extent
6. provides helpful feedback on my math assignments and tests.	3.80	Great Extent	4.63	Very Great Extent	3.60	Great Extent
7. gives additional support and resources to help those who are struggling with math.”	3.82	Great Extent	4.30	Great Extent	4.40	Great Extent
8. fits the teaching strategies to the needs and level of the learners	3.73	Great Extent	4.02	Great Extent	3.51	Great Extent
9. encourages me to improve my math skills.	4.78	Very Great Extent	4.72	Very Great Extent	4.15	Great Extent
10. demonstrates problem-solving techniques effectively.	4.85	Very Great Extent	3.93	Great Extent	4.57	Very Great Extent
Overall Mean	**4.30**	**Great Extent**	**4.37**	**Great Extent**	**4.18**	**Great Extent**

Table 12 illustrates the impact of teacher competence on numeracy skills across grade levels, with all groups reporting a ″great extent″ of agreement (means: 4.30-4.37). A notable disparity appears in item 6 regarding teacher feedback; Grade 5 learners reported the highest mean (4.63), suggesting this stage is critical for constructive error correction. Conversely, the lower perceived

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impact in Grades 4 and 6 suggests a shift toward guided practice or exam-oriented learning. This aligns with Guo (2020) and Padawag (2025), confirming that while teacher competence remains vital, the influence of specific feedback evolves as students' self-regulated learning patterns change through the grades.

Table 13

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Motivation when grouped according to Sex

Items	Male Mean	Interpretation	Female Mean	Interpretation
I am motivated to…				
1. solve routine math problems	4.15	Great Extent	3.93	Great Extent
2. apply math skills beneficial for my daily activities	3.89	Great Extent	3.89	Great Extent
3. test my ability in basic math through mental computation	3.69	Great Extent	3.90	Great Extent
4. put extra effort into learning math, even when it is difficult.	3.82	Great Extent	3.78	Great Extent
5. work with peers in doing computations.	4.11	Great Extent	4.18	Great Extent
6. improve my fundamental math knowledge with my siblings.	3.62	Great Extent	3.84	Great Extent
7. learn more techniques in solving when I am rewarded/recognized by my math teacher.	4.08	Great Extent	3.71	Great Extent
8. perform more challenging math problems.	3.38	Moderate Extent	3.83	Great Extent
9. correct my work with timely feedback from my teacher.	3.32	Moderate Extent	3.58	Great Extent
10. Try different ways to solve math problems.	3.40	Moderate Extent	3.73	Great Extent
Overall Mean	**3.75**	**Great Extent**	**3.83**	**Great Extent**

Table 13 depicts the influence of learning motivation on numeracy skills by sex, with both males (3.75) and females (3.83) reporting a "great extent." A notable disparity emerged in item 8, where males (3.83) reported higher motivation to tackle challenging problems than females (3.75). This suggests that male learners are more responsive to challenge-based or competitive tasks. While this contradicts Jaen and Baccay (2024), who found motivation to be gender-neutral, it supports Rodríguez et al. (2020), who observed that boys often exhibit more positive motivational variables and attitudes toward mathematics than girls.

Table 14

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Environment when grouped according to Sex

Items	Male	Female

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	Mean	Interpretation	Mean	Interpretation
My study area is…				
1. free from noise and distractions.	3.23	Moderate Extent	3.51	Great Extent
2. a small room intended for studying alone.	3.26	Moderate Extent	3.59	Great Extent
3. an open but comfortable space.	3.65	Great Extent	3.96	Great Extent
4. well-lighted and ventilated.	3.82	Great Extent	4.06	Great Extent
5. filled with Math learning resources.	2.94	Moderate Extent	3.15	Moderate Extent
6. a place where there is someone to ask whenever I need to.	4.12	Great Extent	4.39	Great Extent
7. clean and free of sores.	3.92	Great Extent	3.96	Great Extent
8. with functional computer units/tablets for use.	3.05	Moderate Extent	2.65	Moderate Extent
9. is complete with properly arranged tables and other furniture.	4.06	Great Extent	4.10	Great Extent
10. is a location with a strong internet connection.	3.46	Moderate Extent	3.91	Great Extent
Overall Mean	**3.55**	**Great Extent**	**3.73**	**Great Extent**

Table 14 illustrates the impact of the learning environment on numeracy skills by sex, with both males (3.55) and females (3.73) reporting a "great extent." The most significant difference occurred in item 10, where females (3.91) reported greater reliance on strong internet connectivity than males (3.46). This suggests that female learners may utilize online resources more effectively for mathematical practice. These results align with Suana (2018) regarding gendered perceptions of internet utility for academic growth. However, they diverge from Hutchison et al. (2019), who suggest that connectivity benefits both genders equally in acquiring complex skills.

Table 15

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Facilities when grouped according to Sex

Items	Male Mean	Interpretation	Female Mean	Interpretation
The learning facilities…				
1. like textbooks and other learning tools have improved my comprehension of mathematical topics.	3.52	Great Extent	3.60	Great Extent
2. are strategically arranged and easy to locate.	2.82	Moderate Extent	3.30	Moderate Extent
3. use computers, calculators, and the like improves my ability to learn and practice math.	3.23	Moderate Extent	3.01	Moderate Extent
4. provide useful resources that help me improve my numeracy skills.	3.34	Moderate Extent	3.68	Great Extent

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5.	for tutoring and study groups, add support to my numeracy learning options.	3.05	Moderate Extent	3.25	Moderate Extent
6.	are of good quality and varied, which help me learn arithmetic.	2.91	Moderate Extent	3.51	Great Extent
7.	are situated in peaceful study areas that allow me to focus better when working on arithmetic tasks.	3.48	Moderate Extent	3.53	Great Extent
8.	are interactive learning tools, such as smartboards and math games, useful for exploring complex math concepts.	2.51	Moderate Extent	2.51	Moderate Extent
9.	are well-maintained, clean, and functional.	3.09	Moderate Extent	3.11	Moderate Extent
10.	support my practice of computing numbers.	3.08	Moderate Extent	3.76	Great Extent
Overall Mean		**3.10**	**Moderate Extent**	**3.33**	**Moderate Extent**

Table 15 presents the influence of learning facilities on numeracy skills by sex, with both males (3.10) and females (3.33) reporting a "moderate extent." The most significant disparity occurred in item 10, where females (3.76) reported a "great extent" regarding facilities for numerical computation compared to males (3.08). This suggests that female learners may experience better access to or engagement with these resources. These findings align with Villalon et al. (2024) regarding resource-driven gender disparities. However, they contradict Salami and Spangenberg (2024), who argue that enhanced facilities benefit the mathematics achievement of both genders equally.

Table 16

Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Teachers' Competence when grouped according to Sex

Items	Male Mean	Interpretation	Female Mean	Interpretation
My Math teacher…				
1. demonstrates a mastery of math concepts and content.	4.63	Very Great Extent	4.76	Very Great Extent
2. uses effective teaching methods that make complex math concepts easier to understand.	4.49	Great Extent	4.63	Very Great Extent
3. provides clear instructions for performing the math learning task.	4.66	Very Great Extent	4.65	Very Great Extent
4. uses engaging activities and materials that make learning math interesting.	4.09	Great Extent	4.01	Great Extent
5. participates in professional development opportunities to stay current with effective math teaching practices.	3.75	Great Extent	4.00	Great Extent
6. provides helpful feedback on my math assignments and tests.	3.72	Great Extent	4.19	Great Extent

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7.	gives additional support and resources to help those who are struggling with math."	3.98	Great Extent	4.29	Great Extent
8.	fits the teaching strategies to the needs and level of the learners	3.55	Great Extent	3.90	Great Extent
9.	encourages me to improve my math skills.	4.45	Great Extent	4.65	Very Great Extent
10.	demonstrates problem-solving techniques effectively.	4.48	Great Extent	4.49	Great Extent
Overall Mean		**4.18**	**Great Extent**	**4.36**	**Great Extent**

Table 16 illustrates the impact of teacher competence on numeracy skills by sex, with both males (4.18) and females (4.36) reporting a "great extent." A significant variation surfaced in item 6, where females (4.19) rated teacher feedback higher than males (3.82). This suggests that while both benefit, female learners may more readily use feedback as a performance guide, whereas males might require a differently structured form of support. These findings align with King (2016) and Nemiño (2023), confirming that teacher competence and effective feedback practices often yield more pronounced benefits for the mathematics achievement of female learners.

Table 17

Difference in the Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Motivation when grouped according to Age, Grade Level, and Sex

Variable	**Category**	**N**	**Mean Rank**	**Mann-Whitney U**	***p*-value**	***Sig. level***	**Interpretation**
Age	Younger	65	92.45	1335.50	0.000	0.05	Significant
	Older	80	57.19				
Sex	Male	65	70.61	2444.50	0.222		Not Significant
	Female	80	74.94				
Variable	**Category**	**N**	**Mean Rank**	**Kruskal-Wallis H test**	***p*-value**	***Sig. level***	**Interpretation**
	Grade 4	55	92.85	43.400	0.000	0.05	Significant
	Grade 5	43	83.30				
	Grade 6	80	40.35				

Table 17 reveals significant differences in the impact of learning motivation on numeracy skills when grouped by age (p = 0.00) and grade level (p = 0.00), though no significant difference by sex (p = 0.22). Younger learners and lower grade levels exhibited higher mean ranks, suggesting that motivation and engagement evolve as academic complexity increases. Conversely, the results indicate that sex does not fundamentally alter how learners approach mathematical tasks. These findings align with Epson et al. (2025) regarding developmental variations and Rodriguez et al.

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(2020), confirming that gender is not a primary determinant of numeracy motivation in primary education.

Table 18

Difference in the Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Environment when grouped according to Age, Grade Level, and Sex

Variable	Category	N	Mean Rank	Mann-Whitney U	*p*-value	*Sig. level*	Interpretation
Age	Younger	65	95.06	1166.00	0.000	0.05	Significant
	Older	80	55.08				
Sex	Male	65	68.28	2330.50	0.294		Not Significant
	Female	80	76.84				
Variable	**Category**	**N**	**Mean Rank**	**Kruskal-Wallis H test**	***p*-value**	***Sig. level***	**Interpretation**
Grade Level	Grade 4	55	96.35	65.044	0.00	0.05	Significant
	Grade 5	43	87.07				
	Grade 6	80	32.81				

Table 18 indicates significant differences in the learning environment's impact on numeracy when analyzed by age (p = 0.00) and grade level (p = 0.00), while sex (p = 0.294) remains non-significant. Younger learners and those in lower grades show higher mean ranks, suggesting that environmental structure is more critical during earlier developmental stages. As students progress, they develop greater autonomy in managing their study routines, reducing environmental sensitivity. Conversely, the lack of significant sex-based differences suggests that male and female learners experience comparable environmental influences, receiving similar opportunities and physical conditions for their numeracy development.

Table 19

Difference in the Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Learning Facilities when grouped according to Age, Grade Level, and Sex

Variable	Category	N	Mean Rank	Mann-Whitney U	*p*-value	*Sig. level*	Interpretation
Age	Younger	65	82.77	1965.00	0.012	0.05	Significant
	Older	80	65.06				
Sex	Male	65	68.85	2330.50	0.284		Not Significant
	Female	80	76.37				

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Variable	Category	N	Mean Rank	Kruskal-Wallis H test	*p*-value	*Sig. level*	Interpretation
Grade Level	Grade 4	55	79.92	31.029	0.000	0.05	Significant
	Grade 5	43	93.51				
	Grade 6	80	46.14				

Table 19 demonstrates significant differences in the impact of learning facilities on numeracy when categorized by age (p = 0.012) and grade level (p = 0.00), whereas sex (p = 0.284) remains non-significant. Younger learners and Grade 5 students rely more on physical resources to facilitate understanding, while older students transition toward academic independence. These findings contradict Gonzales et al. (2022) regarding age effects on specific calculation abilities but align with Lopez (2025), confirming that resource utility varies across grades. This underscores the need to provide developmentally appropriate facilities that support evolving learner needs, regardless of gender.

Table 20

Difference in the Extent of Factors Affecting the Numeracy Skills of Key Stage 2 Learners according to Teachers' Competence when grouped according to Age, Grade Level, and Sex

Variable	Category	N	Mean Rank	Mann-Whitney U	*p*-value	*Sig. level*	Interpretation
Age	Younger	65	72.87	2591.50	0.973	0.05	Not Significant
	Older	80	73.11				
Sex	Male	65	65.24	2095.50	0.044		Significant
	Female	80	79.31				
Variable	**Category**	**N**	**Mean Rank**	**Kruskal-Wallis H test**	***p*-value**	***Sig. level***	**Interpretation**
Grade Level	Grade 4	55	71.94	3.407	0.182	0.05	Not Significant
	Grade 5	43	82.09				
	Grade 6	80	65.93				

Table 20 indicates that teacher competence affects numeracy skills consistently across age (p = 0.973) and grade level (p = 0.182), but there is a significant difference by sex (p = 0.044). This suggests that male and female learners respond uniquely to instructional styles or classroom interactions. These results align with Cabuquin and Abocejo (2023) regarding age and grade stability, and support Loquias (2025) in identifying gender as a significant factor in perceived teaching competence. Ultimately, while high-quality instruction benefits all Key Stage 2 learners, its influence is specifically moderated by students' sex rather than their developmental stage.

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Conclusion

From this study's results, the more teachers focus on intrinsic motivation, teaching competence, and socio-environmental factors, the more likely they are to be effective in numeracy development for Key Stage 2 students. In Key Stage 2, both teacher competence and the classroom support environment "to a great extent" influence numeracy application, while material facilities for learning have the least influence among all. Hence, classroom support and intrinsic motivation play a greater role in how pupils apply numeracy skills than the mere existence of material facilities. This also means that, in upper elementary and for the high percentage of female learners advancing to higher grades, success in learning rests heavily on teachers' commitment and the quality of their teaching. Moreover, it emphasizes that Key Stage 2 children are a diverse group and each one's response to extrinsic factors is moderated by age and grade level. At higher grades, reliance on the environment and physical facilities decreases as autonomy develops, while at younger ages, dependence on this environment is high. Teacher competence, on the other hand, is significantly moderated by sex only. While age and grade level do not appear to be significant factors in mediating teachers' competence perceptions, sex moderates how male and female pupils feel and react toward teaching competence. This also means that boys and girls will behave differently to teachers' instructions and classroom corrections. In the end, all these add to the understanding of the "middle years" and emphasize that all numeracy interventions need to be developmentally appropriate. The study shows that, no matter how dependent pupils become on environmental and motivational factors, as they mature, teachers' relationships and communication skills toward them remain a significant factor in learning mathematics. From this result, stakeholders are encouraged to abandon the "one size fits all" approach and invest in pedagogically qualified and motivational teaching techniques and skills to address the specific developmental characteristics and sex preferences in learning of Filipino students.

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Authorship Contribution Statement

Chiva: Lead researcher, data analyst, and manuscript developer. **Cañedo**: Thesis adviser, technical consultant, and quality assurance oversight

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Conflict of Interest

There are no commercial or financial relationships that could give rise to a potential conflict of interest. Acquisition, interpretation, and presentation of the data (as presented here) were not influenced by friends, relatives, or any interested party. Responsibility for the entire project and for the final submission rests with the authors.

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