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Early Numeracy Support and Mathematical Readiness among Key Stage 1 Learners

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ABSTRACT

This study investigated how early numeracy support contributed to the mathematical readiness of Key Stage 1 learners at Cauayan North Central School. A cross-sectional explanatory-predictive design was employed, and participants were selected through proportionate stratified random sampling across grade levels and class sections. Data were gathered using the Early Numeracy Support and Mathematical Readiness Battery, which demonstrated strong content validity, internal consistency, and inter-rater agreement. Partial least squares structural equation modeling was applied to assess the measurement model, estimate the predictive influence of early numeracy support, and determine out-of-sample predictive performance. Findings showed that early numeracy support was often provided, with guided counting and access to concrete and visual materials receiving the highest ratings. Mathematical readiness was at the developing level, with stronger performance in numeral recognition, counting, and quantity comparison than in basic operations and the application of mathematical ideas to simple situations. The measurement model satisfied the established criteria for reliability, convergent validity, and discriminant validity. Early numeracy support significantly predicted mathematical readiness ($\beta = .617$, $p < .001$) and explained 38.1% of its variance. The model also demonstrated predictive relevance across all readiness domains. The findings indicate that consistent, differentiated, and developmentally appropriate numeracy support strengthens foundational mathematical learning. Schools should intensify daily numeracy routines, targeted intervention, formative assessment, and home-based mathematics activities, particularly in operations, pattern recognition, and practical problem solving.

Keywords: *Early numeracy support; Foundational mathematics; Key Stage 1 learners; Mathematical readiness; Partial least squares structural equation modeling; Predictive modeling*

INTRODUCTION

Children encounter mathematics long before they learn formal symbols and written procedures. They compare the sizes of objects, notice patterns, count items, divide materials during play, and judge whether one group has more or fewer objects than another. These ordinary experiences form the beginnings of numeracy. Early numeracy includes counting, number recognition, quantity comparison, understanding the relationship between numbers and amounts, and using simple mathematical ideas to solve familiar problems. These skills do not develop at the same pace among all children, which makes purposeful support during the first years of schooling necessary. Raghubar and Barnes (2017) explained that counting, identifying numbers, and comparing or manipulating quantities are strong foundations for later mathematical learning. Shuey and Kankaraš (2018) likewise identified numeracy as one of the main areas of early development that contributes to children's educational progress and later well-being.

Mathematical readiness refers to a learner's preparation to understand and participate in increasingly formal mathematics lessons. It involves more than the ability to recite number names or answer simple computation exercises. A mathematically ready child can connect spoken numbers with written symbols, represent quantities, recognize relationships, continue patterns, explain simple reasoning, and apply mathematical ideas in everyday situations. Readiness also draws upon language, attention, working memory, cognitive flexibility, and the confidence to attempt unfamiliar tasks. The Organisation for Economic Co-operation and Development includes emergent numeracy, executive function, language, and social-emotional development among the closely connected abilities that shape children's readiness for school learning (OECD, 2020). Ten Braak et al. (2022) also found that executive function helped explain how mathematical abilities developed in kindergarten were associated with mathematics and reading achievement in later grades.

The quality of children's early numerical understanding matters because mathematical learning develops progressively. Learners who understand quantity, number order, and basic numerical relationships are better prepared to study addition, subtraction, place value, measurement, and problem solving. Learners who have not formed these ideas may depend heavily on memorization without understanding why a procedure works. Such difficulty can become more noticeable as lessons demand greater reasoning and independence. Ten Braak et al. (2022) reported that kindergarten mathematics performance predicted achievement in both mathematics and reading during the elementary years. Using international assessment data, Chang (2023) also found that early numeracy skills contributed to later mathematics achievement and were associated with learners' confidence in mathematics. These findings show that readiness built during the primary years can influence not only immediate classroom performance but also the learner's willingness and capacity to handle more demanding mathematical tasks.

Early numeracy support refers to the planned assistance given to children as they develop these basic understandings. It may include teacher-guided counting, the use of concrete objects, visual representations, mathematical conversations, games, songs, stories, problem-solving activities, formative assessment, timely feedback, and tasks suited to the learner's present ability. Effective support allows children to move from handling actual objects to using drawings, symbols, and mental strategies. Björklund et al. (2020) described early mathematics education as the provision of stimulating activities and learning environments organized by teachers to extend children's mathematical concepts and skills. Intervention research has also shown that structured mathematics instruction can improve children's learning when activities follow clear developmental goals and respond to what learners already know (Watts et al., 2017). Digital resources may add value when they are carefully selected and connected with classroom instruction, as shown by the gains observed in the randomized study of interactive mathematics applications conducted by Outhwaite et al. (2019).

Support for early numeracy is not confined to formal lessons. Children also build mathematical knowledge through conversations and activities at home, such as counting household objects, using money, measuring ingredients, reading clocks, arranging items, playing board games, and discussing shapes or distances. These experiences help children see that mathematics is part of daily life rather than a subject limited to worksheets and examinations. Susperreguy et al. (2020) found that the home numeracy environment predicted growth in children's mathematical skills during kindergarten. Their findings suggest that meaningful number-related interactions between children and adults can strengthen the work done by teachers. School support and home experiences may therefore complement each other, particularly when parents and teachers use understandable language and encourage children to explain their thinking instead of focusing only on correct answers.

The need to strengthen foundational mathematics is especially clear in Philippine basic education. UNICEF Philippines (2023) reported that only 17 percent of Filipino learners reached the minimum mathematical standard expected by the end of primary education, based on the Southeast Asia Primary Learning Metrics. The same report noted that many children continue to fall behind in basic literacy and numeracy and that participation in early childhood education remains limited for a substantial number of young children. These conditions point to learning difficulties that may have begun before or during the first years of formal schooling. Addressing mathematical difficulties only when learners reach the higher grades may be too late for some children because misconceptions and weak number foundations may already have affected their participation, confidence, and progress. Stronger support during Key Stage 1 can help schools identify learning needs while mathematical ideas are still being formed.

Although international and national studies establish the importance of early mathematics, broad assessment results do not fully explain how numeracy support is provided within individual schools or how it relates to the readiness of particular groups of learners. Children enter school with different preschool experiences, home resources, language backgrounds, learning opportunities, and levels of confidence. A strategy that assists one learner may not be sufficient for another. Teachers need school-level evidence that can help them determine which forms of support are available, how consistently these are provided, and whether learners possess the knowledge and dispositions needed for formal mathematics. Examining these conditions among Key Stage 1 learners can provide a clearer basis for planning classroom activities, differentiated instruction, intervention materials, family involvement, and learner progress monitoring.

For this reason, the study examine the support provided for children's foundational mathematical learning and the extent to which learners demonstrate readiness for mathematics. Conducting the study at Cauayan North Central School will allow the researcher to obtain evidence drawn from the actual experiences and learning conditions of its Key Stage 1 learners. The findings may help teachers recognize areas where learners require added guidance and identify practices that contribute to number understanding, reasoning, engagement, and confidence. They may also guide the preparation of appropriate instructional activities and school-based interventions. By examining early numeracy support together with mathematical readiness, the study aims to contribute practical knowledge that can help children enter succeeding mathematics lessons with stronger understanding and a more secure foundation for learning.

Literature Review

Developmental Sequence of Early Numeracy Skills

Early numeracy develops through a sequence of related abilities rather than through a single skill learned at one time. Children usually begin with verbal counting and recognition of small quantities before gaining a firmer understanding of cardinality, number comparison, written numerals, number order, and basic operations. Litkowski et al. (2020) examined the performance of 801 children across several early numeracy domains and found that mathematical skills followed different developmental timelines during the preschool years. Basic counting tasks were generally mastered earlier, while skills involving numerical relationships and operations developed at later stages. This progression means that learners of the same age may demonstrate different levels of mathematical readiness, even when they have received similar classroom instruction. A child who can recite number words may still experience difficulty connecting those words with actual quantities or determining which of two numbers is greater. Early numeracy support must therefore consider the order in which mathematical ideas develop and provide activities suited to the learner's current understanding rather than relying solely on age or grade-level expectations.

Mathematical Language and Everyday Numeracy Experiences

Mathematical readiness is closely related to a child's ability to understand and use language associated with numbers, quantities, positions, sizes, and relationships. Words such as more, fewer, equal, before, after, near, far, first, and last help learners interpret numerical tasks and explain how they arrived at an answer. King and Purpura (2021) found that children's mathematical language knowledge mediated the relationship between direct numeracy activities and early mathematics skills. Children who frequently engaged in counting, number identification, and other mathematics-related activities were more likely to develop mathematical vocabulary, which was then associated with stronger numeracy performance. This finding suggests that merely exposing learners to numbers may not be sufficient. Adults must also talk about the mathematical meaning of an activity, ask children to describe quantities, and encourage them to explain comparisons or patterns. Classroom and home activities become more useful when children are given opportunities to hear mathematical terms, use them in conversation, and connect them with concrete experiences.

Assessment and Targeted Numeracy Support

Early assessment allows teachers to identify specific areas of strength and difficulty before weak foundational skills interfere with more advanced mathematics. Hellstrand et al. (2020) established reliability and validity evidence for an early numeracy assessment designed to identify children at risk of mathematical learning difficulties. The assessment covered several numeracy components and was tested among kindergarten, Grade 1, and Grade 2 learners, showing that early mathematical performance should be examined through multiple skills rather than through a single total score. Assessment should also include the strategies children use when solving tasks. Sunde et al. (2024) found that Grade 1 learners' strategies for solving single-digit addition problems predicted their mathematics achievement three years later. Strategy use provided information beyond what was obtained from a standardized mathematics test because it showed whether learners depended on counting all objects, counted from a larger number, recalled known facts, or used number relationships. These findings support regular classroom assessment that examines both correct answers and the reasoning processes behind them, allowing teachers to provide support that directly addresses each learner's needs.

Emotional Conditions of Mathematical Readiness

A learner's emotional response to mathematics can influence participation, persistence, and willingness to solve unfamiliar problems. Mathematical readiness therefore includes not only knowledge and skills but also a sense of security when engaging in number-related activities. Svraka et al. (2024) studied 488 kindergarten children and found that higher general anxiety was associated with lower mathematics achievement. The relationship was already visible before formal primary mathematics instruction had fully developed, suggesting that anxiety can affect early mathematical performance. Quane (2025) likewise showed that young learners' attitudes toward mathematics were shaped by their classroom experiences and by how they viewed mathematical tasks and materials. The use of manipulatives did not automatically produce positive attitudes because the way activities were presented and discussed also mattered. Learners may become hesitant when mathematics is treated mainly as a search for quick correct answers. Supportive instruction should allow children to handle materials, discuss possible solutions, make reasonable errors, and attempt tasks without embarrassment. Such conditions can strengthen confidence and help learners approach mathematics as understandable and manageable.

METHODS

Research Design

The study employed a cross-sectional explanatory-predictive design supported by latent-variable modeling. It examined whether differences in early numeracy support explained meaningful variations in the mathematical readiness of Key Stage 1 learners. Data were collected at one point during the school year without altering the learners' regular mathematics instruction or assigning them to experimental conditions. Early numeracy support and mathematical readiness were treated as multidimensional constructs represented by several observable indicators. Partial least squares structural equation modeling was incorporated into the design because the study sought to evaluate the explanatory strength and predictive relevance of early numeracy support rather than limit the investigation to a simple correlation between total scores. The design also allowed the quality of the measurement components and the relationship between the two main constructs to be assessed within a single analytical model.

Research Locale

The investigation was conducted at Cauayan North Central School in Turayong, Cauayan City, Isabela. The school provided an appropriate setting because it maintained complete Key Stage 1 classes and implemented classroom activities intended to strengthen foundational mathematical learning. Numeracy instruction was

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delivered through regular mathematics periods, guided practice, concrete learning materials, remediation activities, and classroom-based assessment. Data collection took place in familiar learning spaces within the school to reduce discomfort among the children. The administration of the instruments was coordinated with class advisers so that regular lessons, scheduled assessments, and other school activities were not unnecessarily interrupted.

Participants and Sampling Technique

The participants were Key Stage 1 learners who were officially enrolled at Cauayan North Central School during the period of data collection. Eligible learners had participated in regular mathematics instruction and had secured written permission from a parent or legal guardian. Each learner also provided assent before taking part in the assessment. Learners who had prolonged absences during the administration period or who did not complete the required consent and assent procedures were not included. Proportionate stratified random sampling was used to maintain representation across grade levels and class sections. Official class registers served as the sampling frames, and eligible learners were selected through computer-generated random numbers. When a selected learner declined participation or was unavailable throughout the scheduled administration period, another learner was randomly selected from the same stratum.

Research Instrument

Data were gathered through the Early Numeracy Support and Mathematical Readiness Battery, which was developed specifically for the objectives of the study. The first component measured early numeracy support through orally administered statements accompanied by child-friendly pictorial response choices. Its indicators covered guided counting and number conversations, access to concrete and visual materials, scaffolded practice, corrective feedback, differentiated learning opportunities, and mathematics-related activities completed with adult guidance. The second component consisted of performance-based tasks that assessed numeral recognition, counting and cardinality, quantity comparison, number sequencing, pattern recognition, basic operations, and the application of number ideas to simple situations. Parallel grade-appropriate forms were prepared, but each form followed the same test blueprint and construct domains.

The initial instrument was examined by specialists in early childhood education, mathematics education, educational assessment, and research methodology. They evaluated the clarity, developmental suitability, relevance, and alignment of every indicator with the study variables. Item-level content validity indices ranged from .83 to 1.00, while the scale-level content validity index based on the average method reached .95. Statements and tasks identified as lengthy, ambiguous, or beyond the expected ability of Key Stage 1 learners were revised or removed. A small group of learners also participated in cognitive interviews to determine whether the directions, pictures, number terms, and response choices were understood as intended.

The revised instrument was pilot-tested in a comparable public elementary school that was not included in the main investigation. Pilot participants completed the same administration procedures planned for the actual study. The Early Numeracy Support component obtained a Cronbach's alpha coefficient of .92, while the Mathematical Readiness component yielded a coefficient of .89. The combined standardized reliability coefficient was .91, indicating strong internal consistency. Item analysis showed acceptable difficulty and discrimination values for the performance tasks. Items that produced weak discrimination or repeated misunderstanding were revised before the final administration. Scoring guides were also tested by independent raters, and the agreement between scorers reached a Cohen's kappa coefficient of .93.

Data Gathering Procedure

Permission to conduct the investigation was secured from the appropriate education authorities and the school administration. After approval had been granted, the researcher coordinated with Key Stage 1 teachers regarding the administration schedule, available learning spaces, and procedures for distributing parental consent forms. The purpose of the study was explained in language appropriate for both parents and children. Participation remained voluntary, and only learners with completed parental consent and personal assent were included.

The Early Numeracy Support component was administered orally to prevent differences in reading ability from affecting the learners' responses. Each statement was read using standardized wording, and the learner selected the picture that best represented the frequency or consistency of the support received. The Mathematical Readiness component was administered individually or in small supervised groups using counters, number cards, picture sets, and printed activity sheets. Instructions were delivered consistently, and practice examples were provided before the scored tasks began. Learners were allowed brief rest periods when signs of tiredness or reduced attention appeared.

Completed instruments were checked immediately for unanswered items and scoring errors. Performance responses that required judgment were reviewed independently by trained scorers using the approved scoring rubric. Disagreements were discussed and resolved before the scores were entered into the data file. Names were replaced with identification codes, and separate files were maintained for consent records and research data. The encoded dataset was checked against the original forms before statistical analysis was performed.

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Data Analysis

The data were screened for incomplete responses, unusual values, coding errors, and response patterns that suggested inattentive participation. Mathematical readiness results from the grade-appropriate forms were converted into grade-equated scale scores so that the learners' performance could be analyzed within a common metric. Medians and interquartile ranges were used to summarize individual ordinal indicators, while means, standard deviations, confidence intervals, and score distributions were reported for the composite measures.

Partial least squares structural equation modeling was used as the principal statistical treatment. The measurement model was examined before the relationship between the main variables was interpreted. Indicator loadings, Cronbach's alpha, rho_A, composite reliability, and average variance extracted were evaluated to establish indicator reliability, internal consistency, and convergent validity. Discriminant validity was examined through the heterotrait-monotrait ratio of correlations. Indicators that did not meet acceptable measurement standards were reviewed according to both statistical evidence and conceptual relevance rather than being removed solely to improve model values.

The structural model estimated the predictive contribution of early numeracy support to mathematical readiness. The standardized path coefficient was tested through bootstrapping with 5,000 resamples. The analysis reported the coefficient estimate, 95 percent confidence interval, probability value, coefficient of determination, and effect size. Predictive relevance was assessed through the Stone-Geisser Q^2 value, while out-of-sample predictive performance was examined using the PLSpredict procedure. A probability level of .05 guided statistical decisions, although conclusions placed greater emphasis on confidence intervals, effect sizes, explained variance, and predictive accuracy than on statistical significance alone.

Ethical Consideration

The study observed the principles of voluntary participation, respect for children, confidentiality, fairness, and protection from harm. Written informed consent was obtained from the parent or legal guardian of each learner, while assent was obtained directly from the child. Learners were informed that they could decline to answer a question, request a break, or withdraw without losing grades, privileges, or access to school services. No learner was pressured by teachers, classmates, or school personnel to participate.

The activities were designed to resemble familiar classroom tasks and did not expose the participants to physical risk, public embarrassment, or unnecessary academic pressure. Administration was stopped when a learner showed discomfort, fatigue, or unwillingness to continue. Individual results were not announced in class or used as part of official classroom grades. Findings were presented only in summarized form, and no information that could identify a learner appeared in the manuscript.

Research records were managed in accordance with the Data Privacy Act of 2012. Printed forms were stored in a secured location, while electronic files were protected through passwords and restricted access. Identification codes were used in place of names throughout data encoding and analysis. Consent documents were stored separately from the assessment results. Data were retained only for the period required for verification and publication, after which electronic and printed records were securely deleted or destroyed according to the approved research protocol.

RESULTS AND DISCUSSION

Table 1. *Level of Early Numeracy Support among Key Stage 1 Learners*

Early Numeracy Support Dimension	Mean	Standard Deviation	Interpretation
Guided counting and number conversations	3.34	0.51	Consistently Provided
Access to concrete and visual materials	3.29	0.56	Consistently Provided
Scaffolded numeracy practice	3.21	0.57	Often Provided
Corrective and explanatory feedback	3.15	0.60	Often Provided
Differentiated learning opportunities	2.91	0.66	Often Provided
Adult-guided mathematics activities at home	2.83	0.70	Often Provided
Overall Early Numeracy Support	3.12	0.48	Often Provided

Scale: 3.26 to 4.00 = Consistently Provided; 2.51 to 3.25 = Often Provided; 1.76 to 2.50 = Sometimes Provided; 1.00 to 1.75 = Rarely Provided.

The overall mean of 3.12 indicated that early numeracy support was often provided to the learners. Guided counting and number conversations obtained the highest mean of 3.34, followed by access to concrete and visual materials with a mean of 3.29. These results showed that learners regularly encountered oral counting, number naming, counters, number cards, pictures, and other materials that helped make mathematical ideas visible and understandable.

Differentiated learning opportunities received a lower mean of 2.91. This result suggested that support was present, but activities were not always adjusted according to individual learning needs. Some learners may have received the same task, pacing, and level of assistance despite differences in their numeracy abilities. Adult-guided mathematics activities at home obtained the lowest mean of 2.83 and the largest standard deviation of 0.70. The variation indicated that home-based numeracy experiences were not equally available to all learners. Some children may have received regular guidance from adults, while others depended mainly on school instruction.

The pattern agreed with King and Purpura (2021), who explained that direct numeracy activities became more useful when adults also helped children understand and use mathematical language. The lower result for home-based support indicated a need for simple parent-guided activities that could be completed using common household materials. The school could provide short activity cards involving counting utensils, comparing quantities, arranging objects, and identifying numbers in daily routines.

Table 2. *Mathematical Readiness of Key Stage 1 Learners*

Mathematical Readiness Domain	Mean Score	Standard Deviation	Interpretation
Numeral recognition	82.10	9.34	Ready
Counting and cardinality	78.64	10.06	Developing
Quantity comparison	74.30	10.81	Developing
Number sequencing	70.18	11.27	Developing
Pattern recognition	67.92	11.86	Developing
Basic numerical operations	58.76	12.41	Emerging
Application to simple mathematical situations	55.04	13.08	Emerging
Overall Mathematical Readiness	69.56	9.72	Developing

Scale: 80.00 to 100.00 = Ready; 65.00 to 79.99 = Developing; 50.00 to 64.99 = Emerging; below 50.00 = Beginning.

The overall readiness score of 69.56 placed the learners at the developing level. This result showed that most learners possessed several foundational skills but had not yet demonstrated consistent mastery across all mathematical domains. Numeral recognition produced the highest score of 82.10 and was the only domain classified as ready. Learners were generally able to identify written numbers and connect common number symbols with their spoken names.

Counting and cardinality reached a mean score of 78.64, while quantity comparison obtained 74.30. These findings indicated that many learners could count objects and distinguish larger from smaller groups. However, their performance became weaker when tasks required them to arrange numbers, recognize patterns, perform operations, or apply mathematical ideas to unfamiliar situations.

Basic numerical operations received a mean score of 58.76, while application to simple mathematical situations recorded the lowest mean of 55.04. These results revealed a clear difficulty in moving from number recognition and counting toward mathematical reasoning and problem solving. Some learners could identify a number or count a set of objects but struggled when they were asked to combine quantities, separate groups, select an operation, or explain how they arrived at an answer.

The lower performance in operations and application supported the developmental pattern discussed by Litkowski et al. (2020), who found that counting skills generally developed before more complex number relationships and operations. The findings also suggested that classroom instruction needed to provide more opportunities for learners to use numbers in meaningful situations rather than depend heavily on number naming and repeated written exercises.

Table 3. *Reliability and Convergent Validity of the Measurement Model*

Construct	Outer Loading Range	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted	Interpretation
Early Numeracy Support	0.721 to 0.867	0.913	0.917	0.932	0.696	Reliable and Valid
Mathematical Readiness	0.708 to 0.884	0.904	0.909	0.923	0.633	Reliable and Valid

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All retained indicators produced loadings above 0.70, showing that they adequately represented their respective constructs. Early numeracy support obtained a Cronbach's alpha of 0.913 and a composite reliability coefficient of 0.932. Mathematical readiness yielded a Cronbach's alpha of 0.904 and a composite reliability coefficient of 0.923. These coefficients indicated strong internal consistency without reaching values that would suggest unnecessary repetition among the indicators.

The average variance extracted values were 0.696 for early numeracy support and 0.633 for mathematical readiness. Both values exceeded the minimum acceptable level of 0.50, which showed that the constructs explained more than half of the variance in their indicators. The results confirmed that the measurement components had adequate convergent validity. The reliability and validity evidence allowed the structural relationship between the two constructs to be interpreted with greater confidence.

Table 4. *Heterotrait-Monotrait Ratio of Correlations*

Construct	Early Numeracy Support	Mathematical Readiness
Early Numeracy Support	1.000	0.684
Mathematical Readiness	0.684	1.000

The heterotrait-monotrait value between early numeracy support and mathematical readiness was 0.684. This value was below the recommended upper boundary of 0.85, indicating satisfactory discriminant validity. Early numeracy support and mathematical readiness were therefore sufficiently distinct from one another. The first construct described the assistance, materials, practice, feedback, and learning opportunities received by the child, while the second represented the learner's demonstrated mathematical knowledge and ability.

The discriminant validity result was important because it showed that a learner's exposure to numeracy support was not identical to the learner's readiness score. A child could receive frequent support but still require additional time to master particular skills. In the same way, some learners could demonstrate readiness because of previous experiences that were not fully captured by the school-based support measures.

Table 5. Structural Model for Early Numeracy Support and Mathematical Readiness

Structural Path	Standardized Beta	Standard Error	t-value	p-value	95% Confidence Interval	Effect Size f^2	Decision
Early Numeracy Support → Mathematical Readiness	0.617	0.052	11.865	< 0.001	0.512 to 0.704	0.616	Supported

Model Indicator	Obtained Value	Interpretation
Coefficient of determination, R^2	0.381	Moderate explanatory power
Adjusted R^2	0.377	Moderate explanatory power
Stone-Geisser Q^2	0.287	Predictive relevance established
Standardized root mean square residual	0.067	Acceptable model fit
Inner variance inflation factor	1.000	No collinearity concern

Early numeracy support had a positive and statistically significant effect on mathematical readiness, as shown by the standardized path coefficient of 0.617. The positive coefficient indicated that learners who received more consistent numeracy support tended to demonstrate stronger mathematical readiness. The bootstrapped t-value of 11.865 and probability value below 0.001 confirmed that the relationship was unlikely to have occurred by chance. The confidence interval ranged from 0.512 to 0.704 and did not include zero, providing further evidence of a stable positive effect.

The effect size of 0.616 indicated that early numeracy support made a substantial contribution to the model. The coefficient of determination showed that early numeracy support explained 38.1 percent of the variance in mathematical readiness. This was a meaningful proportion for an educational model involving young learners because readiness may also be influenced by language ability, attendance, executive function, preschool experience, health, family involvement, and the amount of time available for practice.

The remaining 61.9 percent of unexplained variance showed that numeracy support alone could not account for every difference in learner readiness. The result did not reduce the importance of support. Instead, it indicated that early mathematics development was shaped by several interacting factors. Strengthening classroom support would likely improve readiness, but the school would also need to consider attendance, parental involvement, learner confidence, language comprehension, and specific learning difficulties.

The strongest result of the study was the substantial positive effect of early numeracy support on mathematical readiness. The finding showed that support was not merely associated with pleasant classroom experiences. It had a meaningful statistical contribution to the learners' ability to recognize numbers, understand quantities, follow sequences, identify patterns, perform operations, and solve simple mathematical situations. This finding was consistent with Hellstrand et al. (2020), who emphasized that early numeracy should be assessed through several related skills so that difficulties could be identified before they became more serious.

Table 6. *PLSpredict Results for Mathematical Readiness Domains*

Mathematical Readiness Domain	Q^2 Predict	PLS-SEM RMSE	Linear Model RMSE	Model with Lower Prediction Error
Numeral recognition	0.338	7.42	7.51	PLS-SEM
Counting and cardinality	0.352	8.11	8.26	PLS-SEM
Quantity comparison	0.291	8.74	8.68	Linear model
Number sequencing	0.263	9.18	9.34	PLS-SEM
Pattern recognition	0.227	9.61	9.55	Linear model
Basic numerical operations	0.198	10.72	10.96	PLS-SEM
Application to mathematical situations	0.176	11.20	11.46	PLS-SEM

All Q^2 predict values were above zero, indicating that the model had predictive relevance for every mathematical readiness domain. The PLS-SEM model produced lower prediction errors than the linear benchmark model in five of the seven domains. It performed better in predicting numeral recognition, counting and cardinality, number sequencing, basic operations, and application to mathematical situations.

The linear model produced slightly lower errors for quantity comparison and pattern recognition. The differences were small, but they indicated that early numeracy support did not predict every readiness skill with the same degree of accuracy. Other variables may have played a stronger role in the development of comparison and pattern skills. Overall, the results demonstrated medium out-of-sample predictive power because the PLS-SEM model performed better than the benchmark model for most, but not all, indicators.

The Q^2 value of 0.287 for the structural model also confirmed that early numeracy support had practical predictive relevance. The model was therefore useful not only for explaining the observed relationship but also for estimating which learners were more likely to demonstrate stronger readiness based on the support they received. Hair et al. (2022) explained that predictive assessment strengthened PLS-SEM findings because a model should demonstrate usefulness beyond the data used to estimate its structural relationships.

Overall Discussion

The results presented a mixed but educationally meaningful picture. Early numeracy support was generally available, particularly through guided counting and concrete materials. However, differentiated support and adult-guided home activities were less consistent. Mathematical readiness remained at the developing level, with stronger performance in numeral recognition and counting than in operations and problem application. This gap suggested that learners had gained basic familiarity with numbers but had not consistently developed the deeper understanding needed to use numbers flexibly.

The significant path from early numeracy support to mathematical readiness showed that improvements in support were likely to produce meaningful improvements in learner outcomes. Support should therefore move beyond repeated counting and number identification. Learners needed structured opportunities to combine and separate quantities, explain their strategies, compare possible solutions, recognize number relationships, and solve simple problems drawn from familiar experiences.

Assessment results also showed that a single class-wide activity would not adequately address all learner needs. Some children required reinforcement in number recognition and counting, while others needed targeted assistance in operations, patterns, or mathematical application. Regular formative assessment could help teachers identify these differences and group learners according to current skill needs. Sunde et al. (2024) found that the strategies children used in early addition provided useful information about their later mathematics achievement. Teachers should therefore examine not only whether an answer was correct but also how the learner obtained it.

The findings supported the preparation of a structured early numeracy enhancement program for Key Stage 1. Such a program could include skill-based learner grouping, short daily numeracy sessions, guided mathematical conversations, concrete-to-representational activities, operation-based games, simple problem-solving tasks, and home activity cards. Priority should be given to basic numerical operations and the application of mathematics to everyday situations because these domains received the lowest readiness scores. Continued monitoring would allow teachers to determine whether the support provided led to measurable progress in mathematical readiness.

CONCLUSION

The early numeracy support was often provided to Key Stage 1 learners, particularly through guided counting, number conversations, and the use of concrete and visual materials, yet support remained less consistent in differentiated instruction and adult-guided mathematics activities at home. The learners demonstrated a developing level of mathematical readiness, with stronger performance in numeral recognition, counting, and quantity comparison, but weaker performance in basic operations and the application of mathematical ideas to simple situations. The structural model further showed that early numeracy support had a significant and substantial positive influence on mathematical readiness, confirming that learners who received more consistent and responsive support were more likely to develop stronger foundational mathematics skills. Based on these findings, the school should strengthen its early numeracy program by providing short daily intervention sessions, skill-based grouping, concrete-to-representational activities, mathematical conversations, and problem-solving tasks suited to the learners' current abilities. Teachers should use regular formative assessments to identify specific gaps and adjust instruction accordingly, while parents should be provided with simple home-based numeracy activities that use familiar objects and routines. Particular attention should be given to basic operations, pattern recognition, and the application of mathematics in everyday situations because these areas showed the greatest need for improvement.

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