

Game-Based Numeracy Exposure and Early Mathematical Sense-Making Among Grade 2 Learners

Marlyn A. Julaton
Northeastern College
marlynjulaton999@gmail.com

Date Submitted:
February 25, 2026

Date Accepted:
March 29, 2026

Date Published:
April 23, 2026

DOI:
10.5281/zenodo.19709926

ABSTRACT

This study examined the association between game-based numeracy exposure and early mathematical sense-making among Grade 2 learners of Santa Isabel Sur Elementary School in the City of Ilagan, Isabela. Grounded in the view that young children learn mathematics more meaningfully through engaging and developmentally appropriate experiences, the study used a quantitative descriptive-correlational design. A researcher-made instrument with established reliability was employed to measure the extent of learners' exposure to game-based numeracy activities and their level of early mathematical sense-making. Results showed that learners had a very high extent of game-based numeracy exposure and a very high level

of early mathematical sense-making. The findings further revealed a strong positive and significant relationship between the two variables, indicating that learners who experienced numeracy more frequently through games also demonstrated better understanding of numbers, operations, patterns, and representations. Regression analysis confirmed that game-based numeracy exposure significantly predicted early mathematical sense-making, showing that playful and purposeful mathematics experiences contributed substantially to how learners interpreted and understood early mathematical ideas. The study concluded that integrating numeracy games into early grade instruction may strengthen foundational mathematics learning and support more meaningful mathematical thinking among young learners. These findings highlighted the value of enriching classroom instruction through child-friendly, interactive, and concept-focused numeracy activities.

Keywords: *game-based numeracy, early mathematical sense-making, Grade 2 learners, numeracy exposure, foundational mathematics, elementary mathematics instruction*

INTRODUCTION

Early numeracy is widely recognized as one of the strongest foundations of later academic learning because it shapes how children begin to understand quantity, number relationships, patterns, comparison, and problem solving in everyday life. In the early grades, mathematics is not simply about memorizing facts or performing isolated computations. Rather, it is a period when learners start to build meanings around numbers and operations through experiences that are concrete, engaging, and developmentally appropriate. Clements and Sarama (2016) explained that young children benefit when mathematics is presented as a sense making activity, since this encourages them to connect ideas, reason about quantities, and develop positive dispositions toward mathematics. In the Philippine context, this concern is especially

relevant because the MATATAG Curriculum for Key Stage 1 clearly emphasizes early numeracy, fluency, representation, problem solving, reasoning, and meaningful mathematical experiences for learners in Grades 1 to 3 (Department of Education [DepEd], 2023).

The growing attention to foundational learning has also made numeracy a major educational priority across countries. UNICEF and the Hempel Foundation (2024) emphasized that foundational learning, which includes basic numeracy, serves as the building block for higher order learning and broader life opportunities. This concern is particularly urgent in Southeast Asia, where recent regional evidence showed that many children still struggle to perform at expected levels in mathematics, despite modest gains in some areas. UNICEF East Asia and Pacific (2025) reported that in the region, a substantial proportion of Grade 5 learners still demonstrate mathematics skills below expected grade standards, which underscores the need to strengthen numeracy development as early as possible. Such findings suggest that schools must pay close attention not only to whether children can produce answers, but also to how they understand mathematical ideas during the earliest years of formal schooling.

For young learners, mathematical sense making develops best when they are given opportunities to explore, represent, discuss, and test ideas in ways that feel meaningful and enjoyable. The MATATAG Curriculum recognizes this by highlighting learning experiences that engage children in real, situated, visual, verbal, contextual, and symbolic forms of mathematical thinking (DepEd, 2023). In this view, early mathematics instruction should not remain confined to rote drills or repetitive worksheet routines alone. It should instead support curiosity, active participation, and flexible thinking. When children begin to explain why an answer makes sense, compare quantities using their own words, or use objects and visual models to justify their thinking, they are already showing early mathematical sense making. This dimension of learning is important because it reflects understanding rather than mere answer production, and it can guide teachers in determining whether numeracy instruction is truly helping children think mathematically.

One promising approach in this area is game based numeracy exposure. Game based learning has increasingly been recognized as a useful strategy in mathematics education because it can combine enjoyment, repetition, challenge, feedback, and interaction in ways that sustain learner engagement. Pan et al. (2022), in their systematic review of learning games in K to 12 mathematics education, noted that games can support both cognitive and motivational aspects of mathematics learning when they are intentionally designed and meaningfully integrated into instruction. More specifically for younger learners, Dan et al. (2024) found that digital game-based learning in primary mathematics has attracted growing scholarly attention because it offers structured yet engaging opportunities for children to practice mathematical ideas. Bowie and Graven (2024) further argued that mathematics games can be especially valuable in developing foundational number sense when they include design features such as built in checks, strategic calculation opportunities, accessible materials, and learner friendly facilitation. These insights suggest that game-based exposure is not valuable merely because it is entertaining, but because it can provide repeated, meaningful encounters with number concepts in forms that young children can understand and enjoy.

The relevance of game-based numeracy becomes even clearer when linked with the learning needs of early elementary pupils. In a study on an adaptive game-based mathematics app, Bang et al. (2023) found that personalized game-based experiences helped improve the mathematics learning of early elementary students. This is important because Grade 2 learners are at a sensitive stage where foundational competencies are still being formed and strengthened. At this level, children are expected to deepen their understanding of numbers, basic operations, patterns, and simple problem situations, while also learning how to interpret and represent mathematical ideas in ways that make sense to them. If learning experiences are dry, overly abstract, or disconnected from their developmental level, many pupils may participate mechanically without truly understanding what they are doing. In contrast, when numeracy experiences are embedded in games, learners are often more willing to participate, take risks, try again after mistakes, and stay engaged long enough to construct meaning from mathematical tasks.

In Santa Isabel Sur Elementary School in the City of Ilagan, Isabela, examining game-based numeracy exposure and early mathematical sense making among Grade 2 learners is therefore both timely and educationally meaningful. The study is anchored on the reality that foundational numeracy must be nurtured early, deliberately, and in ways that match how children learn best. It also responds to the need for localized evidence on whether exposure to game based numeracy activities may help young learners build better mathematical understanding, not only in terms of correct responses, but also in terms of how they interpret numbers, relationships, and simple problem situations. By focusing on Grade 2 learners, the study may contribute practical insights for classroom instruction, intervention design, and school level support for early mathematics learning. More importantly, it may help illuminate how enjoyable and purposeful learning experiences can strengthen children's early attempts to make sense of mathematics as part of their daily school life.

Literature Review

Early Numeracy as a Foundation of Later Mathematical Learning

Early numeracy has consistently been viewed as a critical foundation for later school success because it introduces children to number, quantity, comparison, patterns, and simple operations in ways that shape future mathematical understanding. Research in early mathematics has shown that children's early competence in mathematics is not limited to counting skills alone, but includes broader capacities such as reasoning, representing, comparing, and making relationships among quantities. Clements and Sarama (2016) emphasized that mathematical thinking in the early years supports later academic development and serves as an important cognitive base for more advanced learning. This perspective is reinforced by the revised Philippine Mathematics Curriculum under the MATATAG framework, which presents mathematics learning as the development of content, skills, and disposition supported by pedagogy, assessment, and appropriate resources (Department of Education [DepEd], 2023). In this sense, early numeracy should be seen not merely as preparation for later mathematics, but as a meaningful educational goal in itself.

The importance of foundational numeracy has also been highlighted in global education monitoring efforts. UNICEF and the Hempel Foundation (2024) reported that many countries have established or maintained policy attention to foundational learning, yet stronger systems and more consistent action remain necessary to accelerate improvement. In the 2025 global tracker, UNICEF further noted that only about one third of countries reported annual nationally representative large-scale assessments of reading and or mathematics in the early grades, despite slight improvements from the previous year. The same report also showed that clearly defined learning outcomes and benchmarks for foundational literacy and numeracy in Grades 1 to 3 have expanded, but implementation gaps remain across systems (UNICEF & Hempel Foundation, 2025). These findings suggest that strengthening early numeracy is not only a classroom concern but also a broader educational priority that requires deliberate instructional attention in the primary grades.

Mathematical Sense-Making in the Early Grades

Mathematical sense making refers to the learner's ability to understand mathematical ideas in meaningful ways rather than merely produce correct answers through memorized procedures. In the early grades, this includes recognizing number relationships, interpreting quantities, explaining strategies, representing ideas through objects or drawings, and deciding whether an answer is reasonable. The MATATAG Mathematics Curriculum strongly supports this orientation by aiming for mathematically rich lessons that cultivate not only content knowledge but also thinking skills and productive dispositions toward mathematics (DepEd, 2023). In this view, mathematics learning becomes more than drill or repetition because it calls learners to connect concepts and express understanding through varied forms of reasoning.

This emphasis on sense making is also consistent with contemporary mathematics education perspectives that value reasoning, representation, and mathematical discussion from the earliest years. Parviainen et al. (2023) explained that early mathematics education is meant to promote children's mathematical skills, strengthen their capacity for learning mathematics, and cultivate positive attitudes toward the subject. Their discussion of early mathematical skills also noted that numerical skills are often taught more frequently than broader mathematical thinking and reasoning skills, suggesting that early classrooms may need more intentional opportunities for children to interpret and reason about mathematics, not only practice isolated number tasks.

Game-Based Learning as a Mathematics Instructional Approach

Game based learning has drawn considerable attention in mathematics education because it combines structure, challenge, feedback, repetition, and enjoyment in ways that can sustain learner participation. A systematic review by Pan et al. (2022) found that learning games play a meaningful role in fostering mathematics education in K to 12 settings, particularly when they are integrated with clear mathematical goals rather than used simply as entertainment. Their review suggests that games may support content understanding, interaction, and learning motivation when well designed and aligned with instructional purposes. This is important for early learners because mathematical engagement in the primary grades often depends on how attractive and understandable learning tasks feel to children.

More specific evidence on the dynamics of game-based mathematics learning was offered by Moon and Ke (2020), who found that particular in game actions were associated with stronger content and cognitive engagement, and that this engagement was related to the development of mathematical thinking in a game-based context. Although their study involved older learners, it remains relevant because it shows that games can create conditions in which learners actively process mathematical ideas rather than passively receive them. This strengthens the argument that games, when purposefully used, can become vehicles for deeper thinking and not merely tools for amusement.

Russo et al. (2021) added an important classroom perspective by examining how primary teachers use games to support mathematics instruction. Their work showed that games are not simply supplementary materials but can serve multiple instructional purposes, such as introducing concepts, reinforcing skills, encouraging discussion, and increasing participation. This insight is significant for Grade 2 classrooms because learners at this stage often require structured experiences that are lively enough to hold attention while still focused enough to build conceptual understanding. The teacher's role in selecting, introducing, and facilitating games therefore remains central to whether game-based numeracy exposure becomes educationally meaningful.

Game-Based Numeracy Exposure in the Early Years

In the context of young children, game-based numeracy exposure is especially promising because early learners respond strongly to activities that involve movement, play, visual support, repetition, and immediate feedback. Bang et al. (2023) found that an adaptive game-based mathematics learning app supported personalized learning and improved the mathematics learning of early elementary students. This suggests that game-based exposure can be helpful in addressing learner differences, since games can adjust practice opportunities and provide ongoing feedback while maintaining children's interest. Although digital platforms are only one form of game-based learning, the study highlights the potential of game-oriented experiences to support foundational mathematical growth during the early elementary years.

Non digital games are also important, especially in school settings where material availability, teacher preference, or classroom conditions may shape the choice of strategy. Bowie and Graven (2024) showed that games may help develop number sense in early grade mathematics contexts when they create repeated opportunities for calculation, checking, and strategic thinking. Their study supports the view that games can make number work more participatory and more cognitively active for children. In the same

way, Vlassis et al. (2023) demonstrated that arithmetic skills in kindergarten could be developed through a game-based approach using conventional card and board games adapted to mathematical objectives. Together, these studies indicate that game-based numeracy exposure does not depend solely on technology. What matters more is the presence of mathematical purpose, learner interaction, and developmentally suitable design.

Number Sense, Representation, and Mathematical Engagement

A strong literature base connects early numeracy to number sense, which includes understanding quantities, comparing magnitudes, recognizing patterns, and using numbers flexibly. Game based activities can support this area because they often invite children to count, classify, match, estimate, compare, and make decisions. Bowie and Graven (2024) argued that mathematics games support number sense when they include opportunities for learner participation, strategy use, and checking, all of which are closely tied to mathematical understanding. Similarly, Graven et al. (2024) discussed how number stories and linked activities can stimulate mathematical engagement and mathematical talk among young learners and their caregivers. These studies suggest that numeracy develops more strongly when children are not only exposed to numbers, but are also drawn into conversations and actions that help numbers become meaningful.

This literature is especially relevant to early mathematical sense making because children construct understanding through representation and communication. When they talk about numbers, use counters, move objects, identify patterns, or explain why one quantity is greater than another, they are participating in acts of sense making. Such experiences are especially fundamental in Grade 2, where formal school mathematics begins to demand more stable understanding of operations and number relationships. A classroom that incorporates games can create repeated yet varied opportunities for learners to represent and reexamine mathematical ideas in child friendly ways.

The Teacher's Role in Facilitating Game-Based Numeracy Learning

The literature also makes clear that games do not automatically produce learning. Their effectiveness depends greatly on how teachers frame and facilitate them. Russo et al. (2021) showed that primary teachers use games in diverse ways and that their pedagogical choices shape whether games function as genuine mathematics instruction or simply as recreational breaks. Likewise, Parviainen et al. (2023) found that pedagogical awareness and professional development in mathematics were associated with more frequent teaching of early mathematical skills. These findings imply that game-based numeracy exposure becomes more meaningful when teachers deliberately align games with competencies, ask children to explain their moves, and connect game experiences to formal mathematical language and representations.

In the Philippines, this teacher role is consistent with the MATATAG curriculum's emphasis on pedagogy, assessment, and resources as supporting components of mathematics learning (DepEd, 2023). This means that classroom games should not be detached from curriculum objectives. Rather, they should be used in ways that help learners build understanding of the competencies expected at their grade level.

Assessment and Measurement of Early Mathematical Skills

A related concern in the literature involves how early mathematical learning is assessed. Outhwaite et al. (2024), in a systematic review of psychometric properties of early mathematics assessments and screeners, noted that many tools exist for measuring mathematical skills among children aged 0 to 8, but not all have strong reliability and validity evidence. Their review emphasized the importance of choosing instruments with acceptable psychometric qualities when assessing early mathematics learning. This is highly relevant to studies on Grade 2 learners because the validity of conclusions depends greatly on whether the measures used truly capture numeracy and early mathematical understanding.

This point is particularly important in studies involving mathematical sense making, since understanding is often more complex to assess than simple accuracy. Learners may arrive at correct answers without genuine understanding, or they may use meaningful but incomplete strategies that still reveal substantial sense making. As a result, researchers and teachers must use instruments that recognize more than answer correctness alone. For a study on game-based numeracy exposure, this means that assessment should be sensitive to indicators such as representation, reasoning, strategy use, and number interpretation, because these dimensions more accurately reflect early mathematical sense making.

METHODS

Research Design

The study employed a quantitative non-experimental design, specifically using a descriptive-correlational approach. The descriptive component was used to determine the extent of game-based numeracy exposure among Grade 2 learners and to assess their level of early mathematical sense-making. This design allowed the study to present how frequently learners encountered numeracy activities in game form and how they demonstrated mathematical understanding in terms of number interpretation, representation, and simple reasoning. On the other hand, the correlational component was used to examine whether a meaningful relationship existed between learners' game-based numeracy exposure and their early mathematical sense-making. This design was considered appropriate because the study sought to describe existing conditions and determine the statistical association between the two major variables without manipulating the classroom setting.

Research Locale

The study was conducted at Santa Isabel Sur Elementary School in the City of Ilagan, Isabela. The school served as an appropriate setting for the inquiry because it offered an actual primary-grade learning environment where numeracy development was actively nurtured through classroom instruction and school-based learning activities. Since the study focused on Grade 2 learners, the locale provided a realistic context for examining how game-based numeracy experiences were linked with the learners' developing ability to make sense of early mathematical ideas. The school setting also made it possible to gather data within the natural flow of classroom learning, which strengthened the practical relevance of the study.

Participants and Sampling Technique

The participants of the study were Grade 2 learners enrolled at Santa Isabel Sur Elementary School during the period of data collection. The study used total enumeration. This sampling technique was considered suitable because it allowed all learners within the target group to be included in the data gathering process, thereby providing a more complete picture of the numeracy exposure and mathematical sense-making levels present in the grade level under study. Through this approach, the researcher was able to capture the actual classroom-based condition of the learners without drawing only a partial subset from the population.

Research Instrument

The study made use of a researcher-developed structured instrument composed of two major parts. The first part measured game-based numeracy exposure, covering indicators such as participation in number games, engagement in counting and operation-based play, use of manipulatives and visual game materials, and involvement in teacher-facilitated numeracy activities presented in playful formats. The second part measured early mathematical sense-making, with items focusing on number recognition and meaning, quantity comparison, basic operation understanding, pattern awareness, and the ability to explain or represent simple mathematical ideas.

To establish content quality, the instrument was subjected to expert validation by specialists in elementary mathematics education, educational measurement, and primary teaching. Their comments were incorporated to improve clarity, age appropriateness, and alignment with the objectives of the study. After revision, the instrument underwent pilot testing with learners who were not part of the actual participants but had similar characteristics to the target group. The responses were subjected to reliability analysis using Cronbach's alpha. The game-based numeracy exposure scale obtained a Cronbach's alpha of 0.88, while the early mathematical sense-making scale yielded a Cronbach's alpha of 0.91. The overall instrument registered a Cronbach's alpha of 0.90, indicating high internal consistency and showing that the tool was reliable for use in the actual study.

The instrument used a structured response format appropriate for young learners, with teacher assistance and guided administration where necessary to ensure that the items were understood properly.

Data Gathering

Before the conduct of the study, the researcher first secured permission from the concerned school authorities to administer the instrument in the identified locale. Once approval was granted, the researcher coordinated with the school head and Grade 2 teachers regarding the schedule, procedures, and classroom arrangements for the data collection. The purpose of the study was explained clearly, and the process was organized in a manner that would not disrupt regular learning activities.

During the administration phase, the researcher personally distributed and facilitated the instrument with the assistance of the class advisers or teachers when needed. Since the participants were young learners, the instructions were explained in simple and age-appropriate language to make sure that they understood how to respond. Adequate time was given for completion, and responses were checked for completeness immediately after retrieval. The accomplished instruments were then organized, coded, and prepared for statistical treatment.

Data Analysis

The data gathered were analyzed using appropriate descriptive and inferential statistical tools. To determine the extent of game-based numeracy exposure and the level of early mathematical sense-making, the weighted mean and standard deviation were used. The weighted mean described the general tendency of the learners' responses, while the standard deviation showed the consistency or spread of their answers.

To determine the relationship between game-based numeracy exposure and early mathematical sense-making, the Pearson Correlation Coefficient was utilized. This treatment was appropriate because the study aimed to identify the degree and direction of association between the two measured variables. In addition, to determine whether game-based numeracy exposure significantly influenced early mathematical sense-making, simple linear regression was employed. This analysis made it possible to examine the predictive contribution of numeracy exposure in game-based contexts to the learners' early mathematical understanding. All statistical tests were interpreted using an appropriate level of significance.

Ethical Consideration

The study observed ethical standards throughout the entire research process. Permission to conduct the study was obtained from the appropriate school authorities before any data were collected. Since the participants were young learners, the study gave careful attention to protection, respect, and guided participation. The purpose of the study was communicated clearly to the concerned adults responsible for the learners, and participation was carried out only after proper permission procedures were observed.

The identities of the participants were not disclosed in any part of the study. All responses were treated with confidentiality and were used solely for academic purposes. The researcher ensured that the instrument contained no harmful, offensive, or emotionally distressing content. The administration of the instrument was done in a child-sensitive manner, with patience and guidance, so that the learners would

feel safe and comfortable while participating. Data gathered from the study were kept securely and were reported only in summarized form to preserve the privacy of the participants.

RESULTS AND DISCUSSION

Table 1. *Extent of game-based numeracy exposure among Grade 2 learners*

Indicators of Game-Based Numeracy Exposure	Mean	SD	Verbal Interpretation
1. Participation in number recognition games	4.41	0.53	Very High
2. Engagement in counting and quantity-matching games	4.36	0.57	Very High
3. Involvement in addition and subtraction games	4.28	0.61	Very High
4. Use of manipulatives and visual game materials	4.33	0.56	Very High
5. Participation in teacher-facilitated numeracy play activities	4.47	0.49	Very High
6. Enjoyment and active involvement during numeracy games	4.52	0.46	Very High
Overall Mean	4.40	0.54	Very High

Scale: 4.21 to 5.00, Very High; 3.41 to 4.20, High; 2.61 to 3.40, Moderate; 1.81 to 2.60, Low; 1.00 to 1.80, Very Low.

The findings showed that the Grade 2 learners had a very high extent of game-based numeracy exposure, with an overall mean of 4.40 and a standard deviation of 0.54. This result suggested that the learners were frequently exposed to numeracy experiences delivered through games and playful instructional activities. Among the indicators, enjoyment and active involvement during numeracy games obtained the highest mean of 4.52, followed closely by participation in teacher-facilitated numeracy play activities with a mean of 4.47. These results implied that the learners not only encountered game-based numeracy tasks regularly, but also responded to them with strong participation and interest.

The consistently very high means across all indicators further suggested that numeracy games had been well integrated into the learners' classroom experiences. Participation in number recognition games, counting and matching games, operation-based games, and the use of manipulatives all received favorable responses. This pattern indicated that game-based exposure did not occur in isolated instances only, but appeared to be part of a broad and repeated instructional approach. The relatively low standard deviations also suggested that the learners' responses were clustered closely around the mean, showing a fairly consistent experience across the group.

This result may be understood in light of the developmental needs of Grade 2 learners. At this stage, children respond strongly to activities that involve movement, visuals, interaction, repetition, and immediate feedback. Numeracy games provide these elements in ways that make mathematical content less intimidating and more inviting. The result therefore supported the idea that game-based exposure can create a classroom environment where young learners encounter numeracy through activities that are both meaningful and enjoyable. In practical terms, the finding suggested that the classroom context in Santa Isabel Sur Elementary School was conducive to playful and active mathematics learning, which may have laid a favorable foundation for early mathematical sense-making.

Table 2. *Level of early mathematical sense-making among Grade 2 learners*

Indicators of Early Mathematical Sense-Making	Mean	SD	Verbal Interpretation
1. Recognizing number meaning and quantity relationships	4.24	0.58	Very High
2. Comparing quantities and identifying greater or lesser values	4.19	0.61	High
3. Demonstrating understanding of simple addition and subtraction situations	4.22	0.57	Very High
4. Using pictures, objects, or drawings to represent mathematical ideas	4.31	0.54	Very High
5. Identifying and continuing simple patterns	4.27	0.55	Very High
6. Explaining simple answers or strategies in their own way	4.08	0.63	High
Overall Mean	4.22	0.58	Very High

Scale: 4.21 to 5.00, Very High; 3.41 to 4.20, High; 2.61 to 3.40, Moderate; 1.81 to 2.60, Low; 1.00 to 1.80, Very Low.

The data revealed that the Grade 2 learners demonstrated a very high level of early mathematical sense-making, as reflected by an overall mean of 4.22 and a standard deviation of 0.58. This finding indicated that the learners generally understood early mathematical ideas in meaningful ways and were able to engage with numbers, operations, and patterns beyond simple answer recall. The highest mean of 4.31 was recorded for using pictures, objects, or drawings to represent mathematical ideas, followed by identifying and continuing simple patterns at 4.27 and recognizing number meaning and quantity relationships at 4.24. These results suggested that the learners were especially strong in representing and visualizing mathematical concepts, which are central features of early sense-making.

Meanwhile, explaining simple answers or strategies in their own way posted the lowest mean of 4.08, although it was still interpreted as High. This indicated that while the learners were already capable of showing understanding through actions, objects, and visual representations, verbal explanation and articulation of thinking remained a relatively developing area. This is not unexpected among children in the early grades, since expressing mathematical reasoning in words often develops more gradually than performing or showing an idea through concrete means.

The result pointed to a favorable condition in which learners were not merely exposed to numbers but were also engaging with mathematical ideas in ways that reflected understanding. Their strong performance in quantity relationships, operations, visual representation, and pattern recognition suggested that they were already building the kinds of foundational thinking required for later mathematics learning. The findings implied that classroom experiences were supporting learners in seeing mathematics as something that could be interpreted, represented, and reasoned about, rather than memorized mechanically. This is especially important in Grade 2, where children begin to move from basic numeracy familiarity toward more stable mathematical meaning.

Table 3. *Test of relationship between game-based numeracy exposure and early mathematical sense-making among Grade 2 learners*

Variables	r-value	P-value	Decision	Interpretation
Game-Based Numeracy Exposure and Early Mathematical Sense-Making	0.71	0.000	Reject the null hypothesis	Significant positive relationship

The correlation analysis showed an r-value of 0.71 with a p-value of 0.000, indicating a significant positive relationship between game-based numeracy exposure and early mathematical sense-making among the Grade 2 learners. This meant that higher levels of exposure to numeracy through games were associated with higher levels of mathematical sense-making. The relationship was strong and positive, suggesting that

the two variables moved in the same direction. Learners who experienced more frequent and engaging game-based numeracy activities also tended to show better understanding of number meanings, operations, patterns, and representations.

This result carried important instructional meaning. It suggested that game-based numeracy exposure was not simply related to learner enjoyment or classroom participation, but was also closely linked to how children actually understood mathematics. The strong association implied that repeated encounters with numeracy in playful, interactive, and structured formats may have supported learners in building mathematical meaning more effectively. Games likely created opportunities for learners to see quantities, make comparisons, test strategies, correct mistakes, and represent their thinking using objects and visuals. These experiences may have helped transform mathematics from a passive task into an active thinking process.

The significance of the relationship also reinforced the idea that early mathematics learning is strengthened when instructional methods correspond with how children naturally learn. Young learners often make sense of new ideas through participation, repetition, immediate feedback, and visual support. Numeracy games tend to combine these features in a child-friendly manner. Thus, the result strongly suggested that classroom exposure to purposeful numeracy games may contribute to deeper mathematical understanding among Grade 2 learners. In the context of the study, the finding provided statistical support for the educational value of game-based approaches in strengthening early mathematical sense-making.

Table 4. *Simple linear regression analysis on game-based numeracy exposure as predictor of early mathematical sense-making*

Predictor Variable	B	SE B	Beta	t-value	p-value	Decision	Interpretation
Constant	1.36	0.29		4.69	0.000	Significant	
Game-Based Numeracy Exposure	0.65	0.07	0.71	9.14	0.000	Significant	Predictor

Model Summary	Value
R	0.71
R ²	0.50
Adjusted R ²	0.49
F-value	83.54
p-value	0.000

The regression analysis confirmed that game-based numeracy exposure significantly predicted early mathematical sense-making among the Grade 2 learners. The predictor variable obtained an unstandardized coefficient $B = 0.65$, a standardized beta of 0.71, a t-value of 9.14, and a p-value of 0.000, which indicated statistical significance. This meant that for every unit increase in game-based numeracy exposure, early mathematical sense-making also tended to increase. In other words, the more learners were meaningfully exposed to numeracy activities through games, the more likely they were to demonstrate stronger mathematical understanding.

The model summary further showed an R^2 of 0.50, which meant that 50 percent of the variance in early mathematical sense-making could be explained by game-based numeracy exposure. This was a substantial proportion, indicating that game-based exposure had a meaningful explanatory contribution to the learners' early mathematical understanding. While the remaining 50 percent may have been influenced by other factors such as home support, prior knowledge, teacher guidance, learner readiness, and classroom environment, the result still pointed to game-based numeracy exposure as a major contributor.

This finding strengthened the earlier correlation result by moving beyond simple association and showing predictive value. It suggested that game-based numeracy exposure was not only related to early

mathematical sense-making but also served as a statistically important factor in explaining it. For classroom practice, this implied that integrating well-planned numeracy games into early mathematics instruction may help improve the way learners understand mathematical ideas. In the context of Santa Isabel Sur Elementary School, the result supported the view that playful numeracy experiences may serve as an effective pathway toward stronger sense-making among Grade 2 learners. It also suggested that teachers who intentionally use games for number recognition, quantity comparison, operations, and pattern activities may help learners build a firmer and more meaningful foundation in mathematics.

CONCLUSION

Game-based numeracy exposure had been highly evident among Grade 2 learners and that early mathematical sense-making had likewise been strongly manifested, indicating that the learners were not only frequently engaged in numeracy activities through games but were also able to interpret, represent, and understand basic mathematical ideas in meaningful ways. The significant positive relationship between the two variables further showed that greater exposure to game-based numeracy experiences was associated with stronger early mathematical sense-making, while the regression results confirmed that such exposure served as an important predictor of learners' mathematical understanding in the early grades. Based on these findings, it was recommended that teachers continue to strengthen the use of well-planned numeracy games as part of daily mathematics instruction, particularly those that encourage number recognition, quantity comparison, patterning, simple operations, and learner explanation. Schools may also support the wider use of game-based numeracy strategies by providing developmentally appropriate materials, encouraging classroom innovation, and helping teachers design playful yet purposeful mathematics activities. In addition, future instructional efforts may place greater attention on helping learners verbalize their strategies and explain their mathematical thinking, since this area appeared slightly less developed than visual and activity-based forms of sense-making.

References

- Bang, H. J., Li, L., & Flynn, K. (2023). Efficacy of an adaptive game-based math learning app to support personalized learning and improve early elementary school students' learning. *Early Childhood Education Journal*, 51(4), 717–732. <https://doi.org/10.1007/s10643-022-01332-3>
- Bowie, L. H., & Graven, M. H. (2024). Using games to develop number sense in early grade maths clubs. *South African Journal of Childhood Education*, 14(1), Article a1493. <https://doi.org/10.4102/sajce.v14i1.1493>
- Clements, D. H., & Sarama, J. (2016). Math, science, and technology in the early grades. *The Future of Children*, 26(2), 75–94. <https://doi.org/10.1353/foc.2016.0013>
- Dan, N. N., Trung, L. T. B. T., Nga, N. T., & Dung, T. M. (2024). Digital game-based learning in mathematics education at primary school level: A systematic literature review. *EURASIA Journal of Mathematics, Science and Technology Education*, 20(4), Article em2423. <https://doi.org/10.29333/ejmste/14377>
- Department of Education. (2023). *MATATAG curriculum: Mathematics grades 1, 4 and 7*. Department of Education.
- Department of Education. (2024, March 8). *Administration of the Early Language, Literacy, and Numeracy Assessment, National Achievement Test for Grade 6, and National Achievement Test for Grade 12 for School Year 2023–2024* (DepEd Memorandum No. 016, s. 2024). Department of Education.
- Moon, J., & Ke, F. (2020). In-game actions to promote game-based math learning engagement. *Journal of Educational Computing Research*, 58(4), 863–885. <https://doi.org/10.1177/0735633119878611>
- Outhwaite, L. A., Aunio, P., Leung, J. K. Y., & Van Herwegen, J. (2024). Measuring mathematical skills in early childhood: A systematic review of the psychometric properties of early maths assessments and screeners. *Educational Psychology Review*, 36, Article 110. <https://doi.org/10.1007/s10648-024-09950-6>

- Pan, Y., Ke, F., & Xu, X. (2022). A systematic review of the role of learning games in fostering mathematics education in K-12 settings. *Educational Research Review*, 36, Article 100448. <https://doi.org/10.1016/j.edurev.2022.100448>
- Parviainen, P., Eklund, K., Koivula, M., Liinamaa, T., & Rutanen, N. (2023). Teaching early mathematical skills to 3- to 7-year-old children: Differences related to mathematical skill category, children's age group and teachers' characteristics. *International Journal of Science and Mathematics Education*, 21, 1909–1932. <https://doi.org/10.1007/s10763-022-10341-y>
- Russo, J. A., Bragg, L. A., & Russo, T. R. (2021). How primary teachers use games to support their teaching of mathematics. *International Electronic Journal of Elementary Education*, 13(4), 407–419. <https://doi.org/10.26822/iejee.2021.200>
- UNICEF. (2024). *From commitments to action: Findings from the Foundational Learning Action Tracker 2024*. UNICEF.
- UNICEF. (2025). *Foundations first: Insights from the Global Foundational Learning Action Tracker 2025*. UNICEF.
- UNICEF East Asia and Pacific. (2025, December 4). *1 in 2 children in Southeast Asia still lagging behind in reading; math shows slight improvement*. UNICEF.
- Vlassis, J., Coppé, S., Maes, N., & Schillings, P. (2023). Developing arithmetic skills in kindergarten through a game-based approach. *European Early Childhood Education Research Journal*, 31(3), 423–440. <https://doi.org/10.1080/1350293X.2022.2138740>