

Article

Leveraging The Play-Based Learning Approach as an Effective Tool for Boosting Numeracy Skills in Early Learners

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Abstract: This study examines the effectiveness of play-based learning in enhancing the numeracy skills of kindergarten learners, specifically focusing on number recognition and counting. A quantitative research design was employed, utilizing descriptive and correlational methods to assess the perceptions of parents and teachers, as well as the relationship between play and numeracy development. The findings reveal that both parents and teachers view play-based learning as highly effective. Furthermore, significant but weak positive correlations were found between the effectiveness of play and numeracy skills ($r = 0.399$ for number recognition and $r = 0.405$ for counting). While play-based learning is beneficial, the study suggests the need for complementary instructional methods to optimize its impact. These results underscore the importance of integrating play-based strategies into early childhood education to foster numeracy skills and promote a positive attitude toward mathematics. The study provides valuable insights for educators and parents in improving early numeracy instruction.

Keywords: Play-based learning, numeracy skills, early childhood education, kindergarten learners, number recognition, counting

Introduction

Early childhood education is critical for the development of foundational cognitive, social, and emotional skills, which shape a child's learning trajectory throughout their life (Ayade et al., 2019). In this context, numeracy is a key component, providing children with essential mathematical concepts that contribute to later academic success (Aunio, 2019). Numeracy skills developed during early childhood are not only foundational for academic mathematics but also for critical problem-solving and logical reasoning, which are necessary



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in everyday life (Langdon et al., 2023). These skills have far-reaching implications, including contributing to future career success in various fields (Salminen et al., 2021). Early exposure to mathematical concepts can foster curiosity and engagement, paving the way for lifelong learning (Vasoya & Vansdadiya, 2023). Hence, integrating numeracy education in the early stages of a child's development is vital for nurturing their potential (Nur et al., 2022).

In recent years, there has been an increased emphasis on the importance of developing numeracy skills in early childhood education as educators recognize the long-term academic and cognitive benefits (Vasoya & Vansdadiya, 2023). Traditional approaches to numeracy education typically emphasize direct instruction and rote memorization, which can sometimes fail to engage young learners (Nur et al., 2022). However, innovative teaching strategies such as integrating technology and using interactive methods are becoming more prevalent, allowing children to explore numeracy concepts more meaningfully (Skwarchuk, 2020). Play-based approaches that combine traditional techniques with modern, engaging methods have shown promise in enhancing children's understanding of numeracy (Aunio, 2019).

Play-based learning has gained recognition as an effective pedagogical approach that fosters cognitive development, particularly in areas such as numeracy (Grimmond et al., 2022). It emphasizes experiential learning, where children engage in meaningful play that encourages the exploration of numbers and other mathematical concepts (Hannula-Sormunen et al., 2019). Through activities like counting games, sorting, and pattern recognition, children develop a deeper understanding of numeracy in a natural and engaging manner (Cohrssen & Niklas, 2019). This type of learning aligns with cognitive development theories, which suggest that children learn best when they are active participants in the learning process (Ayade et al., 2019).

Developing numeracy skills in early learners poses various challenges, particularly in resource-limited environments (Merkley et al., 2023). Traditional instructional methods, which often emphasize rote memorization, are limited in their ability to foster a deeper understanding of mathematical concepts (Keskin & Yilmaz, 2020). These methods do not always encourage critical thinking or problem-solving, which are essential components of numeracy (Aunio, 2019). Additionally, socio-economic disparities can result in unequal access to quality education and resources that support numeracy development (Merkley et al., 2023). Children from low-income households may not have the same opportunities to develop numeracy skills, leading to achievement gaps that persist throughout their academic careers (Lestari et al., 2022).

There are significant gaps in research regarding the integration of play-based learning into numeracy education. One key area is the level of effectiveness of play in enhancing numeracy skills, such as

number recognition and counting, among kindergarten learners (Vasoya & Vansdadiya, 2023). Additionally, little research has explored the differences in perception between parents and teachers regarding the effectiveness of play-based methods (Khasanah & Purnamasari, 2023). There is also a lack of studies that investigate the direct relationship between the implementation of play-based learning and the numeracy skills children acquire, particularly in different socio-economic contexts (Merkley et al., 2022). More longitudinal research is needed to assess the long-term impact of play-based numeracy learning and how it compares to traditional instruction (Nur et al., 2022).

This study offers significant benefits for schools, teachers, and parents by highlighting the effectiveness of play-based learning in enhancing numeracy skills in early learners. The findings support the integration of innovative pedagogical approaches, such as play-based methods, to create more engaging and effective learning environments, ultimately improving academic outcomes in numeracy. Moreover, the study emphasizes the importance of their role in supporting their children's numeracy development at home, demonstrating how everyday activities and playful interactions can significantly boost early math skills.

Methodology

The methodology of this study employs a quantitative research design aimed at examining the relationships between variables related to play-based learning and numeracy skills in early childhood education. Specifically, a descriptive and correlational approach is adopted to investigate the link between parental involvement, teacher engagement, and the numeracy skills of kindergarten learners. The study follows the Input-Process-Output (IPO) model, where the inputs consist of data from three respondent groups: learners, teachers, and parents. The Parental Involvement Questionnaire, designed to measure parents' participation in their child's education and support for play-based learning, is distributed alongside a Teacher Questionnaire that captures educators' perceptions and strategies for integrating play in numeracy instruction. Additionally, a Numeracy Assessment for Kindergarten Learners evaluates children's skills in number recognition and counting.

To evaluate the responses, a five-point Likert scale is employed for both parents and teachers, ranging from 1 (Not Effective) to 5 (Very Effective), allowing the study to categorize how respondents perceive the effectiveness of play-based learning in enhancing numeracy skills. Similarly, learners' numeracy proficiency was rated on a five-point scale, ranging from 1 (Beginning) to 5 (Advanced), providing a detailed view of their performance in number recognition and counting. The data collection process is divided into three phases: Preliminary Stage

(designing and refining instruments), Data Gathering Stage (administering questionnaires and assessments), and Post Data Gathering Stage (analyzing data). Pearson's r assessed the strength of the relationship between play-based learning and numeracy skills, while a T-test for Independent Samples examined differences in perceptions between parents and teachers. This structured methodology ensures a comprehensive examination of how play-based approaches influence early numeracy development.

Results and Discussion

Table 1. Level of Effectiveness of Play in Enhancing the Numeracy Skills of Kindergarten Learners as Perceived by Parents

S/N	Indicators	WM	Verbal Description
1	I believe that incorporating play-based activities in early childhood education enhances my child's understanding of mathematics.	4.72	Very Effective
2	I recognize that play-based learning helps my child develop a positive attitude toward mathematical concepts.	4.80	Very Effective
3	I understand that using play in mathematics education allows my child to grasp numerical ideas more effectively.	4.72	Very Effective
4	I see how play-based approaches encourage my child to solve math problems and think critically.	4.68	Very Effective
5	I observe that my child's engagement in playful math activities contributes to improved spatial reasoning skills.	4.64	Very Effective
6	I acknowledge that play provides my child with practical experiences to apply math concepts in real-world scenarios.	4.56	Very Effective
7	I appreciate how play-based learning supports my child in understanding patterns and relationships in mathematics.	4.60	Very Effective
8	I recognize the benefits of playful exploration of shapes and geometry in enhancing my child's creativity and spatial awareness.	4.60	Very Effective
9	I notice that math-related games and activities in early education contribute to my child's comfort with numbers.	4.68	Very Effective
10	I understand that using play as a teaching strategy helps my child connect abstract mathematical ideas with tangible experiences.	4.68	Very Effective
11	I see how play-driven mathematics education encourages my child to collaborate with peers and improve communication skills.	4.68	Very Effective
12	I observe that my child's self-confidence in mathematics grows through engaging in hands-on play-based learning.	4.64	Very Effective
13	I believe that playful math experiences ignite my child's curiosity and enthusiasm for learning.	4.84	Very Effective
14	I recognize that play-based math activities facilitate the development of my child's mathematical language and vocabulary.	4.68	Very Effective
15	I understand that integrating play into early mathematics education nurtures my child's lifelong interest in learning and applying mathematical concepts.	4.60	Very Effective
Aggregate Weighted Mean		4.67	Very Effective

The data presented in Table 1 shows the perceptions of parents regarding the effectiveness of play-based learning in enhancing the numeracy skills of kindergarten learners. All the indicators received a very high rating, with weighted means (WM) ranging from 4.56 to 4.84, indicating a consensus that play-based learning is highly effective. The

highest-rated indicator, with a WM of 4.84, highlights parents' belief that playful math experiences ignite curiosity and enthusiasm for learning. Similarly, parents also strongly agreed (WM of 4.80) that play-based learning fosters a positive attitude towards mathematical concepts. Other highly rated items include the use of play to enhance understanding of numerical ideas (WM of 4.72) and to encourage critical thinking and problem-solving in mathematics (WM of 4.68). The aggregate weighted mean of 4.67 reflects a consistent view among parents that play-based learning is "Very Effective" in improving various aspects of their children's numeracy skills, including spatial reasoning, pattern recognition, problem-solving, and overall confidence in mathematics. This data underscores the significant value parents place on play as an essential component of early childhood education in mathematics.

Table 2. Level of Effectiveness of Play in Enhancing the Numeracy Skills of Kindergarten Learners as Perceived by Teachers

S/N	Indicators	WM	Verbal Description
1	Incorporating play-based activities in early childhood mathematics education enhances children's understanding of mathematical concepts and promotes their cognitive development	4.80	Very Effective
2	Playful math activities create an engaging and enjoyable learning environment, encouraging young children to explore mathematical ideas with curiosity and enthusiasm.	4.80	Very Effective
3	Through play, children can develop foundational mathematical skills such as counting, spatial reasoning, and pattern recognition in a natural and meaningful context.	4.80	Very Effective
4	Play-based learning allows children to experiment with mathematical concepts and develop problem-solving skills by manipulating objects, making connections, and exploring cause-and-effect relationships.	4.80	Very Effective
5	Playful math activities encourage children to collaborate and communicate with their peers, fostering social interactions that enhance their language development and mathematical thinking	4.80	Very Effective
6	Games and playful activities provide opportunities for children to apply mathematical knowledge in real-life situations, making the learning experience more practical and relevant.	4.80	Very Effective
7	Play-based math activities cater to diverse learning styles and abilities, allowing children to approach mathematical concepts in ways that align with their strengths.	4.80	Very Effective
8	Engaging in mathematical play can reduce math anxiety among young children, promoting positive attitudes toward mathematics and enhancing their confidence in tackling math-related tasks.	4.80	Very Effective
9	Play-based math instruction encourages children to explore mathematical ideas at their own pace, promoting a deeper understanding and mastery of foundational concepts.	5.00	Very Effective
10	The use of games and playful activities in early math education supports the development of executive functions such as attention, working memory, and self-regulation.	4.80	Very Effective
11	Play-based math activities promote a growth mindset, as children learn that making mistakes is a natural part of learning and that effort and perseverance lead to improvement.	5.00	Very Effective
12	Integrating play into math education fosters a positive emotional connection to the subject, which can contribute to long-term motivation	5.00	Very Effective

13	Math-related games and activities enable children to practice and reinforce mathematical skills in an enjoyable and meaningful way, leading to greater retention and application of knowledge.	5.00	Very Effective
14	Playful math experiences help children build a solid foundation for more advanced mathematical concepts, setting the stage for success in later stages of their education.	4.80	Very Effective
15	Play-based learning in mathematics not only supports academic growth but also nurtures critical thinking, problem-solving	5.00	Very Effective
Aggregate Weighted Mean		4.87	Very Effective

The data in Table 2 reflects the teachers' perceptions of the effectiveness of play-based learning in enhancing the numeracy skills of kindergarten learners. Teachers unanimously rated the majority of the indicators as "Very Effective," with weighted means (WM) consistently at 4.80 or higher, suggesting a strong consensus on the positive impact of play-based learning. Several indicators received the highest possible WM of 5.00, particularly those that emphasize how play-based instruction promotes a growth mindset, reduces math anxiety, and fosters long-term engagement with mathematical concepts. Teachers also highlighted that playful math activities help build executive functions like attention and working memory (WM of 4.80), and promote social interactions that support both language and mathematical development (WM of 4.80). The aggregate weighted mean of 4.87 suggests that teachers view play-based learning as an exceptionally effective pedagogical approach for enhancing numeracy skills, promoting cognitive and social growth, and cultivating a positive emotional connection to mathematics. This aligns with the idea that integrating play in early childhood mathematics education supports a well-rounded development that extends beyond academic proficiency, laying the foundation for lifelong learning and success.

Table 3. Level of Numeracy Skills of the Kindergarten Learners in terms of Number Recognition

S/N	Indicators	WM	Verbal Description
1	Recognize numerals up to 10	5.00	Advanced
2	Identify the placement of objects (e.g. 1st, 2nd, 3rd, etc.) in a given set	4.36	Advanced
3	Recognizes coins and bills (up to Php 20)	4.28	Advanced
4	The child can recognize the following coins and bills: 5 centavos 10 centavos 25 centavos 1 peso 5 pesos 10 pesos 20 pesos	4.28	Advanced
5	Separates sets of concrete objects of equal quantities up to 10 (i.e., beginning division)	3.36	Approaching Proficiency
6	Groups set of concrete objects of equal quantities up to 10 (i.e., beginning multiplication)	3.36	Approaching Proficiency
7	Measures length, capacity, and mass of objects using nonstandard measuring tools	4.44	Advanced
8	Distinguishes the time of day and tells time by the hour (using an analog clock)	4.00	Proficient
Aggregate Weighted Mean		4.14	Proficient

The data in Table 3 illustrates the level of numeracy skills of kindergarten learners in terms of number recognition. Most of the indicators reflect an "Advanced" level of proficiency, particularly in recognizing numerals up to 10 (WM of 5.00), identifying object placement in a sequence (WM of 4.36), and recognizing coins and bills (WM of 4.28). Learners also demonstrated advanced skills in using nonstandard measuring tools to measure length, capacity, and mass (WM of 4.44). However, in tasks related to beginning division and multiplication, such as separating and grouping sets of concrete objects, learners were rated as "Approaching Proficiency" with a WM of 3.36 for both indicators. Additionally, learners displayed a "Proficient" ability to tell time by the hour using an analog clock (WM of 4.00). Overall, the aggregate weighted mean of 4.14 indicates that the kindergarten learners are generally proficient in number recognition, though there is room for improvement in more complex numerical tasks, such as early multiplication and division concepts.

Table 4. Level of Numeracy Skills of the Kindergarten Learners in terms of Counting

S/N	Indicators	WM	Verbal Description
1	The child can count up to 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 and above	4.52	Advanced
2	Rote counts up to 20	5.00	Advanced
3	Counts objects up to 10	5.00	Advanced
4	The child can count up to 1 2 3 4 5 6 7 8 9 10 and above	4.88	Advanced
5	Sequences numbers	4.64	Advanced
6	The child can recognize numerals up to 1 2 3 4 5 6 7 8 9 10 and above	4.56	Advanced
7	Solves simple addition problems	4.36	Advanced
8	Solves simple subtraction problems	4.24	Advanced
9	Compares and arranges objects according to a specific attribute (e.g. size, length, quantity, or duration)	4.56	Advanced
Aggregate Weighted Mean		4.64	Advanced

The data in Table 4 reflects the level of numeracy skills of kindergarten learners in terms of counting. All the indicators demonstrate an "Advanced" level of proficiency, with weighted means (WM) ranging from 4.24 to 5.00. Learners are highly proficient in rote counting up to 20 (WM of 5.00) and counting objects up to 10 (WM of 5.00). They also show strong skills in sequencing numbers (WM of 4.64) and solving simple addition (WM of 4.36) and subtraction problems (WM of 4.24). The ability to recognize and count numerals up to 20 and above is also advanced, with WMs of 4.88 and 4.56, respectively. Learners demonstrated an excellent capacity to compare and arrange objects according to specific attributes such as size, length, or quantity (WM of 4.56). The aggregate weighted mean of 4.64 indicates that overall, the kindergarten learners possess advanced counting skills, showcasing a strong foundational understanding of early numeracy concepts.

Table 5. Summary of the Level of Numeracy Skills of Kindergarten Learners

Components	WM	Verbal Description
Number Recognition	4.14	Proficient
Counting	4.64	Advanced
Grand Mean	4.39	Advanced

The data in Table 5 provides a summary of the level of numeracy skills of kindergarten learners, focusing on two main components: number recognition and counting. The weighted mean (WM) for number recognition is 4.14, indicating that learners are "Proficient" in this area, showing a solid understanding of basic number identification and related tasks. In contrast, the WM for counting is higher at 4.64, categorizing the learners as "Advanced" in their ability to count, sequence numbers, and solve simple mathematical problems. The grand mean of 4.39 suggests that, overall, the kindergarten learners demonstrate an "Advanced" level of numeracy skills. This indicates that while they are proficient in number recognition, they exhibit stronger abilities in counting, which contributes to their advanced overall numeracy development.

Table 6. Test of Difference between the Parents' and Teachers' Perception on the Effectiveness of Play in Enhancing the Numeracy Skills of the Kindergarten Learners

Source of Difference	Mean	Standard Deviation	Mean Difference	Computed t-value	p-value	Decision	Result
Parents	70.12	6.05	-2.88	-1.005	0.324	Do not reject H_0	Not Significant
Teachers	73.00	4.47					

*significant at $p < 0.05$

Table 6 presents the test of difference between parents' and teachers' perceptions of the effectiveness of play in enhancing the numeracy skills of kindergarten learners. The mean perception score for parents is 70.12 with a standard deviation of 6.05, while the mean score for teachers is slightly higher at 73.00 with a standard deviation of 4.47. The mean difference between the two groups is -2.88. The computed t-value of -1.005 and the corresponding p-value of 0.324 indicate that the difference between the perceptions of parents and teachers is not statistically significant at the 0.05 level. Thus, the null hypothesis (H_0) is not rejected, meaning that there is no significant difference between parents' and teachers' perceptions regarding the effectiveness of play in enhancing the numeracy skills of kindergarten learners. Both groups generally agree on the positive impact of play-based learning on numeracy development.

Table 7. Test of a significant relationship between the effectiveness of play and numeracy skills of the learners

Variables	r-value	Strength of Correlation	p-value	Decision	Result
Play and Number Recognition	0.399*	Weak Positive	0.048	Reject Ho	Significant
Play and counting	0.405*	Weak Positive	0.044	Reject Ho	Significant

*significant at $p < 0.05$ (two-tailed)

Table 7 illustrates the test of a significant relationship between the effectiveness of play-based learning and the numeracy skills of kindergarten learners, focusing on two variables: number recognition and counting. The r-value for the relationship between play and number recognition is 0.399, indicating a weak positive correlation. Similarly, the r-value for the relationship between play and counting is 0.405, also showing a weak positive correlation. Both relationships are statistically significant, as indicated by their p-values (0.048 for number recognition and 0.044 for counting), which are both below the 0.05 threshold. Consequently, the null hypothesis (H_0) is rejected in both cases, suggesting that there is a significant positive relationship between the effectiveness of play-based learning and the development of numeracy skills (both number recognition and counting) in kindergarten learners, although with a weak strength of correlation.

Discussion

The results of the study indicate a significant relationship between play-based learning and the development of numeracy skills, such as number recognition and counting, among kindergarten learners. The weak positive correlations identified, with r-values of 0.399 for number recognition and 0.405 for counting, suggest that while play-based learning positively influences these skills, other factors may also contribute to their development. This is consistent with the findings of Anne-Françoise de Chambrier et al. (2021), who found that play-based interventions in kindergarten could significantly enhance early number skills, especially when games were introduced both in the classroom and at home (de Chambrier et al., 2021). The study further supports the effectiveness of playful learning environments in fostering mathematical understanding and promoting engagement with numeracy concepts.

Additionally, teachers' perceptions, align with research showing that play-based learning not only enhances numeracy but also reduces math anxiety and fosters a positive attitude toward mathematics (Grimmond et al., 2022). The weak positive correlations observed in the study underscore the importance of combining play-based approaches with other pedagogical strategies to achieve more significant improvements. Moreover, findings from other studies, such as Susperreguy et al.

(2020), emphasize the role of parental involvement and home numeracy environments in supporting mathematical skill growth (Susperreguy et al., 2020), further suggesting that a holistic approach involving both educators and parents can maximize the effectiveness of play-based numeracy instruction.

Conclusion

This study highlights the significant role of play-based learning in enhancing the numeracy skills of kindergarten learners, particularly in number recognition and counting. Both parents and teachers perceive play-based approaches as highly effective in fostering early mathematical skills, as evidenced by the consistently high ratings across various indicators. The significant, though weak, positive correlations between play and numeracy skills suggest that while play-based learning contributes to numeracy development, it should be supplemented with other strategies to maximize its effectiveness. This aligns with existing research emphasizing the importance of a multifaceted approach that includes classroom-based play interventions, parental involvement, and supportive home environments. Overall, the study reinforces the value of integrating play into early childhood mathematics education to create engaging and effective learning experiences that promote long-term academic success.

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