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# Article

# Unraveling the Nexus of Play-Based Learning Approach and Numeracy in Early Childhood Education

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Abstract: This study explores the effectiveness of play-based learning in enhancing the numeracy skills of kindergarten learners, as perceived by parents and teachers, and its relationship with actual numeracy outcomes. Employing a quantitative, descriptivecorrelational research design, the study gathered data from 25 kindergarten parents and 5 teachers across five schools. Data collection instruments included Parental and Teacher Questionnaires, as well as a Numeracy Assessment for kindergarten learners focusing on number recognition and counting. Results indicated that both parents and teachers perceived play-based learning as highly effective, respectively. However, statistical analysis revealed negligible negative correlations between the perceived effectiveness of play and learners' numeracy skills, suggesting that numeracy development is influenced by a combination of factors beyond play alone. These findings highlight the multifaceted nature of early childhood numeracy development, emphasizing the need to integrate play with intentional, evidence-based instructional strategies. The study concludes that while play-based learning is a valuable pedagogical tool, its full potential is realized when combined with targeted interventions that address specific skill gaps. This research provides a foundation for optimizing play-based strategies to support holistic early childhood education.

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



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## Introduction

Numeracy is a critical foundational skill that underpins later success in mathematics and other cognitive domains (Aunio, 2019). It is essential for understanding quantities, spatial reasoning, and logical thinking, which play a

significant role in everyday problem-solving (Bernabini et al., 2020; Peconcillo et al., 2020). Early numeracy skills are highly predictive of academic performance, particularly in mathematics and sciences, during later school years (Charitaki et al., 2020; Suson, 2019). Moreover, these skills enhance problem-solving abilities and decision-making processes in real-world situations (King & Purpura, 2021). Numeracy development supports lifelong learning and adaptability, which are crucial in the modern economy (Thomas & Tazouti, 2021). Deficits in early numeracy can lead to significant learning difficulties, negatively impacting overall educational outcomes (Nur et al., 2022). Early interventions focusing on numeracy skills have shown positive effects on students' readiness for formal schooling (Susperreguy et al., 2020). Such foundational skills also prepare children for success in logical reasoning and computational thinking (Braeuning et al., 2020). Therefore, fostering numeracy in early childhood is essential to building a strong academic foundation and ensuring future educational success.

The kindergarten years are a critical period for cognitive, emotional, and social development (Aunio et al., 2021). During this stage, children begin to develop essential life skills, including problem-solving, creativity, and collaboration (Vasoya & Vansdadiya, 2023). Play, as a natural mode of learning for young children, stimulates their cognitive and social development (Nur et al., 2022). Through play, children explore the world around them, develop critical thinking skills, and build foundational concepts such as numbers and patterns (King & Purpura, 2021). This period also lays the groundwork for emotional intelligence and social interaction skills (Skwarchuk, 2020). Importantly, playbased learning strategies encourage children to engage deeply with learning materials in a meaningful way (Warmansyah et al., 2022). Evidence also suggests that play fosters language development, which is closely linked to numeracy skills (Méndez et al., 2019). Therefore, integrating play as an educational tool in kindergarten is essential for holistic child development.

Play-based learning has proven to be an effective method for developing numeracy skills in early childhood (Vasoya & Vansdadiya, 2023). Activities such as counting games and number puzzles enhance children's ability to understand numerical relationships and patterns (Warmansyah et al., 2022; Suson, 2019). Play encourages active engagement, making abstract concepts like addition and subtraction more accessible (Susperreguy et al., 2020). Additionally, play fosters curiosity, which drives children to explore mathematical ideas creatively (King & Purpura, 2021). Structured play, such as role-playing or building blocks, helps children understand spatial and numerical concepts (Thomas & Tazouti, 2021). Evidence indicates that incorporating play into educational settings increases children's motivation and retention of mathematical concepts (Bernabini et al., 2020).

Despite the growing recognition of play-based learning, gaps remain in understanding its specific impact on enhancing numeracy skills in kindergarten learners (King & Purpura, 2021). Research has yet to comprehensively assess the

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level of numeracy skills in kindergarten learners, particularly in terms of critical subskills such as number recognition, counting, and pattern identification (Bernabini et al., 2020). Moreover, the effectiveness of various types of play, such as structured versus unstructured activities, in numeracy development has not been thoroughly examined (Susperreguy et al., 2020). Little is known about how socioeconomic and linguistic factors influence the outcomes of play-based numeracy interventions (Méndez et al., 2019). Additionally, while early numeracy interventions have shown promise, their sustainability and long-term impact on children's academic trajectories remain unclear (Charitaki et al., 2020). There is also limited evidence on the role of teacher training and parental involvement in optimizing play-based learning environments for numeracy (Vasoya & Vansdadiya, 2023). Future research needs to investigate culturally relevant and inclusive play methods to address the diverse needs of learners (Nur et al., 2022). Finally, robust assessment tools to evaluate the effectiveness of play-based learning interventions are still lacking, further emphasizing the need for in-depth studies (Warmansyah et al., 2022). Addressing these gaps will provide critical insights into tailoring early educational practices for optimal numeracy development.

This research has the potential to transform early childhood education by showcasing the importance of integrating play into the development of numeracy skills. It can provide educators with practical strategies to create engaging and playful learning environments that enhance academic outcomes. Policymakers can use the findings to design curricula that balance structured learning with creative play, ensuring that all children build essential numeracy skills. Parents will also gain insights into the role of play in fostering their child's cognitive and mathematical growth, empowering them to support learning at home. Additionally, the study could address educational disparities by identifying approaches that are effective across diverse socioeconomic and cultural contexts. Ultimately, this research aims to contribute to a more inclusive, effective, and engaging approach to early education.

#### Methodology

The study employed a quantitative research design to explore the relationship between play-based learning and numeracy skill development in kindergarten learners. This descriptive-correlational study utilized surveys and assessments to gather data from 25 kindergarten parents and 5 teachers across five elementary schools. The instruments included a Parental Involvement Questionnaire, a Teacher Questionnaire, and a Numeracy Assessment for Kindergarten Learners. The questionnaires captured perceptions and practices related to play-based numeracy strategies, while the assessment evaluated learners' numeracy skills, specifically in number recognition and counting. Data collection followed a three-stage process: Preliminary, Data Gathering, and Post

Data Gathering. In the preliminary stage, instruments were validated, permissions obtained, and pilot testing conducted. During data gathering, questionnaires were administered with clear instructions to ensure respondent comprehension and data integrity. In the post-gathering stage, responses were verified, and data analyzed using statistical software. Scoring for the Parental and Teacher Questionnaires employed a 5-point Likert scale, with numerical ratings from 1 (Not Effective) to 5 (Very Effective). The numeracy assessment utilized a similar scale, where scores of 4.21–5.00 indicated advanced skills, and scores below 1.80 reflected beginning levels.

Results and Discussion

Table 1. Level of Effectiveness of Play in Enhancing the Numeracy Skills of the 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.	4.60	Very Effective
2	I recognize that play-based learning helps my child develop a positive attitude towards mathematical concepts.	4.44	Very Effective
3	I understand that using play in mathematics education allows my child to grasp numerical ideas more effectively.	4.52	Very Effective
4	I see how play-based approaches encourage my child to solve math problems and think critically.	4.28	Very Effective
5	I observe that my child's engagement in playful math activities contributes to improved spatial reasoning skills.	4.48	Very Effective
6	I acknowledge that play provides my child with practical experiences to apply math concepts in real-world scenarios.	4.28	Very Effective
7	I appreciate how play-based learning supports my child in understanding patterns and relationships in mathematics.	4.32	Very Effective
8	I recognize the benefits of playful exploration of shapes and geometry in enhancing my child's creativity and spatial awareness.	4.20	Effective
9	I notice that math-related games and activities in early education contribute to my child's comfort with numbers.	4.48	Very Effective
10	I understand that using play as a teaching strategy helps my child connect abstract mathematical ideas with tangible experiences.	4.36	Very Effective
11	I see how play-driven mathematics education encourages my child to collaborate with peers and improve communication skills.	4.36	Very Effective
12	I observe that my child's self-confidence in mathematics grows through engaging in hands-on play-based learning.	4.44	Very Effective
13	I believe that playful math experiences ignite my child's curiosity and enthusiasm for learning.	4.40	Very Effective
14	I recognize that play-based math activities facilitate the development of my child's mathematical language and vocabulary.	4.28	Very Effective
15	I understand that integrating play into early mathematics education nurtures my child's lifelong interest in learning and applying mathematical concents	4.60	Very Effective
	Aggregate Weighted Mean	4.40	Very Effective

The data presented in Table 1 reflects parents' perceptions of the effectiveness of play-based learning in enhancing the numeracy skills of kindergarten learners. With an aggregate weighted mean of 4.40, the findings indicate that parents overwhelmingly rate play-based approaches as "Very Effective" in fostering numeracy development. Indicators such as enhancing understanding of mathematics (4.60), developing a positive attitude toward mathematical concepts (4.44), and enabling practical application of math concepts (4.28) were rated highly, suggesting that parents recognize the multifaceted benefits of play in early education. Furthermore, aspects like improved spatial reasoning skills (4.48), fostering curiosity and enthusiasm (4.40), and boosting self-confidence (4.44) highlight the holistic impact of play-based learning. Parents also value the role of play in nurturing abstract mathematical understanding through tangible experiences (4.36) and fostering collaboration and communication skills among children (4.36). The lowest-rated indicator, though still "Effective," relates to the exploration of shapes and geometry (4.20), suggesting potential areas for enhanced emphasis. Overall, the data underscores parents' strong endorsement of play as a powerful educational strategy for developing numeracy skills and building a positive, lifelong relationship with mathematics in early learners.

Table 2. Leve	el of Effectiveness	of Play in E	inhancing the	e Numeracy	Skills of the	Kindergarten	Learners as
perceived by	Teachers						

S/N	Indicators	WM	Verbal
0/11	indicators		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.	5.00	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	5.00	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 individual strengths.	4.40	Very Effective
8	Engaging in mathematical play can reduce math anxiety among young children, promoting positive attitudes towards mathematics and enhancing their confidence in tackling math-related tasks.	4.60	Very Effective

	Aggregate Weighted Mean	4.80	Very Effective
	for lifelong learning and success.		Effective
15	Play-based learning in mathematics not only supports academic growth but also nurtures critical thinking, problem-solving, and creativity, skills that are essential	4.80	Very
14	mathematical concepts, setting the stage for success in later stages of their education.	5.00	Effective
	Playful math experiences help children build a solid foundation for more advanced		Verv
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
12	Integrating play into math education fosters a positive emotional connection to the subject, which can contribute to long-term motivation and engagement in mathematical learning.	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.	4.60	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
9	Play-based math instruction encourages children to explore mathematical ideas at their own pace, promoting a deeper understanding and mastery of foundational concepts.	4.80	Very Effective

The data in Table 2 reveals teachers' perceptions of the effectiveness of play-based learning in enhancing the numeracy skills of kindergarten learners, with an aggregate weighted mean of 4.80, classified as "Very Effective." Teachers universally agree on the benefits of play-based learning, with several indicators achieving a perfect weighted mean of 5.00, such as creating an engaging and enjoyable learning environment, encouraging collaboration and communication, and supporting the development of advanced mathematical concepts. Indicators like fostering foundational skills such as counting and spatial reasoning (4.80) and reducing math anxiety (4.60) highlight the multifaceted advantages of integrating play in mathematics education. Additionally, teachers value how play-based learning supports executive functions (4.80), caters to diverse learning styles (4.40), and promotes a growth mindset (4.60), emphasizing its role in addressing individual needs and reducing barriers to math learning. Teachers also note that playful activities enable children to experiment, build confidence, and connect mathematical concepts to real-world applications (4.80Overall, the data underscores the transformative potential of play in early childhood mathematics education.

The data in Table 3 illustrates the numeracy skills of kindergarten learners in terms of number recognition, with an aggregate weighted mean of **4.53**, categorized as "Advanced." Learners demonstrate strong capabilities in fundamental number recognition, such as identifying numerals up to 10 (4.56) and understanding ordinal placement within a set (4.52).

C/			Verbal
J/	Indicators	WM	Descriptio
IN			n
1	Recognize numerals up to 10	4.56	Advanced
2	Identify the placement of objects (e.g. 1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup> , etc.) in a given set	4.52	Advanced
3	Recognizes coins and bills (up to Php 20)	4.56	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	4.52	Advanced
5	Separates sets of concrete objects of equal quantities up to 10 (i.e., beginning division)	4.44	Advanced
6	Groups sets of concrete objects of equal quantities up to 10 (i.e., beginning multiplication)	4.48	Advanced
7	Measures length, capacity and mass of objects using nonstandard measuring tools	4.68	Advanced
8	Distinguishes the time of day and tells time by the hour (using analog clock)	4.48	Advanced
	Aggregate Weighted Mean	4.53	Advanced

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

Their ability to recognize and distinguish coins and bills up to Php 20 (4.56) further underscores their foundational financial literacy. Skills involving early mathematical operations, such as grouping and separating sets of objects up to 10, were also rated "Advanced," with means of 4.48 and 4.44, respectively, indicating readiness for concepts like multiplication and division. Learners excel in measurement-related tasks, such as using nonstandard tools to measure length, capacity, and mass (4.68), which achieved the highest rating. Additionally, their ability to distinguish the time of day and tell time by the hour on an analog clock (4.48) reflects well-rounded numeracy development. Overall, the findings confirm that kindergarten learners possess advanced numeracy skills in number recognition, grouping, measurement, and early operational concepts, showcasing a robust readiness for more complex mathematical learning.

Table	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	4.52	Advanced					
2	Rote counts up to 20	4.56	Advanced					
3	Counts objects up to 10	4.68	Advanced					
4	The child can count up to: 1 2 3 4 5 6 7 8 9 10 and above	4.68	Advanced					
5	Sequences numbers	4.68	Advanced					
6	The child can recognize numerals up to: 1 2 3 4 5 6 7 8 9 10 and above	4.52	Advanced					
7	Solves simple addition problems	4.56	Advanced					
8	Solves simple subtraction problems	4.52	Advanced					
9	Compares and arrange objects according to a specific attribute (e.g. size, length, quantity or duration)	4.68	Advanced					
	Aggregate Weighted Mean 4.60 Advanced							

(C

The data in Table 4 highlights the numeracy skills of kindergarten learners in terms of counting, with an aggregate weighted mean of 4.60, categorized as "Advanced." Learners exhibit exceptional proficiency in fundamental counting skills, such as counting up to and beyond 20 (4.52) and rote counting up to 20 (4.56). They demonstrate strong abilities in counting objects up to 10 (4.68) and sequencing numbers accurately (4.68), indicating their mastery of essential numerical patterns. Advanced skills are also evident in recognizing and comparing numbers (4.52) and solving simple arithmetic operations, such as addition (4.56) and subtraction (4.52). Additionally, learners excel in comparing and arranging objects based on attributes like size, length, or quantity (4.68), reflecting their understanding of order and categorization. The high ratings across all indicators confirm that kindergarten learners are well-equipped with advanced counting skills, which are crucial for their readiness to tackle more complex mathematical concepts. This strong foundation in counting not only supports their numerical fluency but also enhances their logical reasoning and problem-solving abilities, preparing them for future academic challenges in mathematics.

Table 5. 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	Compute d t- value	p- value	Decision	Result
Parents Teachers *significant at	66.04 72.00 p<0.05	8.35 3.16	-5.96	-1.555	0.131	Do not reject Ho	Not Significant

Table 5 presents a comparative analysis of parents' and teachers' perceptions regarding the effectiveness of play in enhancing the numeracy skills of kindergarten learners. The computed t-value of -1.555, with a corresponding pvalue of 0.131, suggests that the mean difference between parents' and teachers' perceptions is not statistically significant. This finding implies that parents and teachers, on average, do not significantly differ in their opinions about the efficacy of play-based learning in fostering numeracy skills. The decision to "not reject Ho" indicates that there is no significant evidence to support a difference in perception between the two groups. This outcome aligns with the idea that collaboration between parents and teachers is crucial for the holistic development of children, including their mathematical abilities (Epstein, 2011). Epstein emphasized the importance of parental involvement in education and its positive impact on learner's academic achievement and overall well-being. Research emphasizes the importance of collaboration between home and school environments to create a more seamless educational experience for children (Desforges & Abouchaar, 2003). When parents and teachers share common educational goals and practices, children are more likely to experience continuity in their learning journey. Additionally, such collaboration can positively influence children's attitudes

toward learning and contribute to their overall academic success (Henderson & Mapp, 2002). Therefore, the agreement between parents and teachers regarding the effectiveness of play-based learning provides a foundation for a harmonious and supportive educational environment for young learners.

Variables	r-value	Strength of Correlation	p - value	Decision	Result
Play and Number Recognition	-0.075	Negligible Negative	0.721	Do not reject Ho	Not Significant
Play and Counting	-0.119	Negligible Negative	0.572	Do not reject Ho	Not Significant

Table 6. Test of Significant Relationship between the Effectiveness of Play and Numeracy Skills of the Learners

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

Table 6 presents the relationship between the effectiveness of play and numeracy skills of kindergarten learners and reveals negligible negative correlations for both Number Recognition (r = -0.075) and Counting (r = -0.119). The strength of these correlations is characterized as very weak, and the p-values for both associations are greater than the conventional significance level of 0.05, leading to the decision "Do not reject Ho" (null hypothesis). This implies that, at the 0.05 significance level, there is no significant relationship between parents' and teachers' perceptions of play effectiveness and the numeracy skills of kindergarten learners in terms of Number Recognition and Counting. The findings suggest that factors beyond play alone contribute to numeracy skill development, emphasizing the need for a multifaceted approach considering individual differences among learners. The examination of the relationship between the perceived effectiveness of play and numeracy skills in kindergarten learners, as presented in Table 15, aligns with existing research emphasizing the multifaceted nature of early childhood development. The negligible negative correlations found for both Number Recognition and Counting suggest that the effectiveness of play, as perceived by parents and teachers, does not significantly correlate with the numeracy skills of kindergarten learners. This finding resonates with the work of Gelman and Gallistel (1978), who proposed that children's understanding of numbers involves conceptual and procedural knowledge. The lack of a significant relationship may underscore the importance of considering various factors influencing numeracy skill development beyond instructional methods alone. Additionally, play alone may not be the sole determinant of numeracy skills, which is consistent with the research of Baroody (2003), who discussed the development of adaptive expertise and flexibility in mathematical understanding. Baroody highlighted integrating of conceptual and procedural knowledge as essential for a comprehensive understanding of mathematics. The current study's results, indicating a negligible correlation, align with the idea that numeracy skill development involves a

complex interplay of factors, including cognitive processes, instructional methods, and individual differences among learners.

#### Discussion

The findings of the study suggest that while both parents and teachers perceive play-based learning as highly effective in enhancing numeracy skills, the lack of a statistically significant correlation between the perceived effectiveness of play and the actual numeracy skills of learners indicates the multifaceted nature of early mathematical development. Research highlights that numeracy skill acquisition is influenced by various factors, including home environment, language development, and socio-cultural contexts, rather than solely relying on instructional methods (Aunio, 2019). Furthermore, the minimal correlation might reflect the need for targeted interventions that integrate play with other pedagogical strategies, such as structured mathematical language development and culturally relevant teaching approaches (Purpura et al., 2019). Additionally, this aligns with findings that early numeracy development is enhanced by combining play with guided, intentional learning experiences, where educators scaffold mathematical concepts within engaging and meaningful activities (Cohrssen & Niklas, 2019). Teachers' insights into incorporating play to foster collaboration and reduce math anxiety highlight its role in building foundational confidence, but they also point to the necessity of balancing unstructured play with goal-directed interventions to address specific skill gaps (Grimmond et al., 2022). Ultimately, these findings suggest a need for future research to explore how play-based methods can be integrated with other evidence-based practices to support the holistic development of numeracy skills in young learners.

## Conclusion

The study concludes that play-based learning is perceived by both parents and teachers as highly effective in enhancing the numeracy skills of kindergarten learners, with strong endorsements for its role in fostering engagement, critical thinking, and mathematical confidence. However, the lack of a significant correlation between the perceived effectiveness of play and the actual numeracy outcomes indicates that numeracy development is influenced by a combination of factors beyond play alone, such as individual learner differences, home environments, and instructional strategies. This highlights the importance of integrating play-based approaches with intentional, structured interventions to address specific numeracy skills like counting and number recognition. The findings underscore the need for a multifaceted pedagogical approach that

combines the strengths of play with targeted teaching methods, creating a holistic framework for early childhood education that supports cognitive, social, and emotional growth. Future efforts should focus on further exploring these complex relationships to optimize educational practices for young learners.

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