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An Empirical Study of Print Awareness and Foundational Concept Development in Early Childhood

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ABSTRACT

This study investigates the relationship between print awareness and the development of early mathematical concepts in preschool-aged children, emphasizing the pedagogical potential of fairy tales as an integrated instructional tool. Grounded in emergent literacy and early numeracy theory, the research examines how interactive storytelling, specifically, the reading of The Three Little Pigs, can be used to assess foundational skills such as letter and word recognition, text navigation, counting, ordering, classification, and basic arithmetic. A semi-structured interview methodology was employed with a sample of 50 children aged 4 to 5 years from a kindergarten in Edessa, Greece. Data were collected through a specially designed questionnaire embedded within the storytelling session. Descriptive and inferential statistical analyses revealed that while children demonstrated moderate proficiency in counting and symbol recognition, significant gaps were observed in book handling, number recitation, and computation processes. No statistically significant gender differences were identified. The findings underscore the need for targeted, developmentally appropriate interventions that bridge literacy and numeracy domains in early education. The study advocates for the strategic use of story-based learning to support dual-domain skill acquisition and highlights key practices, such as interactive dialogue, visual aids, and mathematically enriched narratives, that can enhance early learning outcomes.

Keywords: Print Awareness; Emergent Literacy; Early Childhood Education; Early Numeracy; Mathematical Concepts; Symbolic Representation

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1. Introduction

Print knowledge, the understanding of the forms, functions, and conventions of print, most vigorously develops in interactive, adult-directed environments. Recent experimental and quasi-experimental studies demonstrate that joint book reading with explicit, naturalistic focus on print (e.g., pointing at words, identifying letters, monitoring left-to-right, discussing title and author) consistently enhances children's knowledge of print (often called print referencing) and can be introduced with minimal interruption of typical read-alouts. Parent-directed and teacher-directed initiatives alike have observed increases in knowledge of print and related talk during and following the training phase, highlighting the value of regular, dialogic interaction with text features instead of sporadic teacher-directed instructions [1].

In addition to near transfer of skills, print awareness falls under the larger group of code-specific emergent literacy skills whose trajectories during the preschool years presage later word-level reading. Longitudinal analyses suggest that the development of knowledge of print and letters runs concurrently with the development of phonological awareness, and variation during preschool in code-related skills is accountable for significant differences between early reading performance on the part of young children in later grades. This placement also explains why tests of print awareness belong with tests of knowledge of letters and of phonological awareness when measuring initial literacy readiness.

Print awareness constitutes a foundational aspect of emergent literacy, encompassing a child's understanding that written language conveys meaning and functions as a mode of communication, analogous to spoken language [2,3]. In contemporary society, print is omnipresent—embedded in books, newspapers, signage, packaging, and digital interfaces. It serves as a critical tool for navigating and interpreting the world, providing structure and meaning to otherwise arbitrary sequences of letters and symbols. Without an awareness of how print operates, individuals are confronted with a visual landscape devoid of communicative coherence, underscoring the essential role print awareness plays in the early stages of literacy development.

Through interaction with environmental stimuli, children observe written language in their surroundings along with many other elements. They come to understand the structure of written language (that we read from left to right and from the top to the bottom of a page), that words are made up of letters, and that spaces separate words, essential knowledge for reading fluency and comprehension [4]. They also learn that printed words serve various functions: a book tells a story, a restaurant menu informs us of what is available, and road signs help drivers, among others.

Print awareness also involves understanding how books work. This includes knowledge of how to hold a book, how to turn its pages correctly, how to recognize the front and back covers, and how to locate the book's title. These skills assist children in navigating printed materials effectively and support independent reading [5].

The concepts of print refer to a child's ability to recognize and understand how written language is organized and used. Comprehension of these concepts is essential for the development of literacy, spelling, and writing [6]. Indeed, print awareness is one of the primary foundational skills for reading readiness.

The concepts of print, also known as elements of print awareness, refer to a foundational understanding of how written language works. This includes recognizing that books contain letters and words, and that letters come together to form words, which in turn form sentences. It involves understanding that spaces are used to separate words and that both words and sentences carry meaning. Additionally, print awareness includes knowing that books are read from front to back, pages are read from top to bottom, and words are read from left to right. It also encompasses the understanding that print serves various purposes, such as telling stories or sharing information.

Another important aspect of print awareness is the ability to distinguish written language from images. This skill helps children understand that it is the written text, not the pictures, that conveys the primary narrative or informational content in a book or document [7]. Print awareness extends beyond books to include the recognition of written language in everyday settings such as signs, labels, menus, and logos. This recognition helps children understand that written language is present everywhere and serves multiple purposes, from providing information to offering entertainment [8].

Print awareness is critical for the development of reading and comprehension skills. Without an understanding of

the concepts of print, children will struggle with both reading and writing. The development of print awareness occurs through various progressive stages.

In infancy and early toddlerhood, children begin to notice written language in their environment. This initial stage involves recognizing familiar logos and signs they frequently encounter in daily life. As children grow older, they begin to identify different types of print and understand its functions[9]. Preschool-aged children learn to handle books correctly, including how to hold them, turn pages, and identify book parts such as the cover, spine, and title page. They also begin to understand reading directionality[10]. At the next stage, children can recognize individual letters and words, understand that spaces separate words, and realize that sentences begin with capital letters and end with punctuation marks. These skills are crucial for the development of reading fluency and writing[11,12]. In the final stage, children engage in writing and experiment with writing letters and words.

While previous research has demonstrated the effectiveness of story-based approaches in fostering early literacy and numeracy, our study contributes to this field in several distinctive ways. First, it examines print awareness and foundational mathematical concepts concurrently within a story-based framework. Much of the existing research has tended to focus on literacy[13] or numeracy[14,15] in isolation, rather than considering how these two domains develop in parallel. Second, the study is situated in the Greek early childhood context, a cultural and linguistic environment that remains underrepresented in international debates, which are often dominated by Anglo-American research. Third, the methodological approach, semi-structured interviews embedded in storytelling, provides richer insights into how children articulate their emerging understandings than standardized testing alone, which is the predominant method in prior studies.

In combination, these features account for the novelty of our contribution: not only does the research draw on existing work on narrative-based teaching, it also clarifies how numeracy–literacy development might be fostered at the culturally embedded level. In doing so, it has implications for the design of both curricula and policies fashioned for furthering balanced, integrated young child education.

2. Understanding Early Mathematical Concepts

Current reviews converge on number sense as the core of foundational numeracy in the preschool period, comprising knowledge of number, number relations (e.g., magnitude comparison), and number operations with small sets[16–18]. Evidence from longitudinal and meta-analytic syntheses shows that early number sense is a powerful predictor of later mathematics achievement, even after controlling for background factors. Instruction and assessment organized around these strands yield clearer targets for practice and allow educators to align activities (e.g., counting, cardinality, subitizing, simple transformations) with children's developmental levels[19–23].

At the same time, mathematical language (terms for quantity, relations, and operations) appears to be a key mechanism linking instruction to learning. Children with richer math-specific vocabulary show stronger performance across early numeracy tasks. Home mathematical activities also contribute uniquely to early number knowledge, suggesting that classroom interventions are most effective when coupled with guidance that helps families embed quantitative talk and play into daily routines[24,25].

Developmentally, stage one entails empirical experience with numbers via concrete objects and daily experiences. This stage has been described as one of "sensory awareness of numbers," whereby children use perceptual cues (e.g., an array of dots, tangible objects) for quantitative decisions. Modern investigations substantiate that preliminary quantitative proficiency rests on children's perceptual capability for discerning and comparing tiny numerosities without formal counting, which has often been called subitizing[22,23].

In order for there to be a full experience of number, children must reach certain pre-mathematical processes and conceptions. In addition to pre-numerical conceptions of classification, order, and correspondence, much emphasis has been placed on relational and spatial thinking as necessary for supporting later numerate thinking. Seriation, one-to-one correspondence, and part–whole understanding are precursors of cardinality and arithmetic[21,26].

Specifically, the cognitive processes leading to the development of number are: classification, one-to-one correspondence, seriation, inclusion, ideas of space, conserva-

tion of continuous and discrete quantity, conservation of area and distance, and partitioning of a set. These logical-mathematical relations are the building blocks on which formal ideas of number are erected [27]. At the second stage, youngsters move on to core mathematics related to set and cardinality. They start comparing sets (more, fewer, equal) and identify equivalence. Recent longitudinal analyses reveal that proficiency with cardinality via counting is one of the most powerful predictors of mathematics performance later on, with knowledge of coordinating number words, sets of objects, and "how many" questions becoming an essential landmark [25]. Counting for small collections of objects, usually up to five objects, reinforces youngsters' understanding of one-to-one correspondence and the equivalence principle between sets.

Stage three relates to the measurement process, applied to practical affairs, e.g., length, height, area, capacity, time, and money. These ideas, most of which, with the exception of money, are continuous, allow children to connect abstract numbers with relevant, contextualized experience. Research suggests that teaching start with empirical measurement with the use of non-standard units (e.g., "hands," "blocks"), which reinforces children's knowledge of quantitative thought and initiates the use of numbers in the explanation of every-day phenomena [23,28,29].

Following this preparation, children transition to formal number concepts and operations. Instruction typically introduces numbers in progressive ranges (1–5, 0–10, and 0–20), consolidating their grasp of counting principles, cardinality, and symbolic representation. Evidence suggests that early fluency with small number ranges provides a scaffold for later success in arithmetic and place-value understanding [30].

Understanding the concept of number typically emerges gradually, with full abstraction often consolidating between the ages of 6 and 8. However, research shows that precursors of number concepts appear much earlier in the preschool years, provided children engage in structured experiences with sets, quantities, and counting [21,22]. Prior to the formal instruction of numbers, children must acquire certain logical abilities, often termed pre-numerical skills, that are foundational for numerical thinking. These include seriation (e.g., arranging objects in order of size), classification (grouping objects by features such as color or shape), class inclusion, and one-to-one correspondence. Recent longitudinal studies confirm that proficiency in these early relational and classification skills strongly predicts later arithmetic performance [26,27].

This idea of the number and the operations has its basis in youngsters' understanding of sets. Before the formal teaching of numbers, youngsters will have much to profit from practice on the concept of a set and its members and from comparing cardinalities through one-to-one correspondences. Experimental data indicate that practice with comparing very small sets, thinking about equivalence, and identifying "more/less/same" relations is quite a worthwhile step toward competence with cardinality and concepts of counting [25]. Arithmetic operations are introduced most effectively in early childhood with conceptual representations set in concrete experiences. Additionally, for instance, it is conceived as the unifying of two disjoint sets—a notion that mirrors the cognitive operation of uniting quantities. Subtraction can also be represented as the converse of adding, either via deletion of objects or recognition of the complement of one set with respect to another. Multiplication is often introduced as repeatedly adding or joining equal-sized sets, and division comes as its converse, recognized as equitable-sharing and division into equal sets. Recent findings confirm that young children's intuitive understanding of these ideas, when learned via play and concrete tasks, leads effectively to the progression from concrete to abstract arithmetic operations [23,28,30,31].

These initial understandings endow youngsters with key cognitive devices for abstraction, and they mark the necessity of developing early childhood curricula that systematically connect pre-numerical logical proficiency with the sequential introduction of set-based thought and operations.

2.1. Pre-Existing Mathematical Knowledge in Early Childhood

Existing knowledge of mathematics from preschool children is an essential factor for learning how young children acquire initial mathematical skills. Even prior to learning formal mathematical ideas at school, young children obtain numerous initial mathematical capabilities from their daily experiences and interactions with their environment. These capabilities, such as informal counting, identification of tiny sets, and comparative quantity, are the precursors for further

formal learning[23,27].

Historic research illustrated that young children have intuitive processes for handling numerical information[32–35]. Recent studies validate these initial findings, and infants have been found to have approximate number sense and discrimination for small numerosities[36,37]. This line of work indicates that humans are born primed, biologically, for perceiving and discriminating quantity, yet input from the environment and from culture, like language and symbolic notation, helps refine these innate capacities for formal mathematics.

Young children also acquire many socially and physically oriented understandings of numerical ideas. These are learned from play, family experience, and involvement with daily routine, supporting previous descriptions[38,39] and supporting recent results showing that the home numeracy environment, such as parental discussion of numbers and play with counting games, forecasts children's future numeracy achievements[40,41]. Of key importance, children need to learn how to associate symbolic number words with genuine amounts, a correspondence that marks a development point on their progression from informal to formal mathematics[25,42].

Daily life supplies testimony for this initial proficiency. Prekindergartners often know how to punch the right number on a TV remote control to get their preferred show, recite part of the number sequence for games such as hide-and-seek, or know the difference between getting one and getting two candies. Number words are one of the first and most intuitive types of numerical knowledge, with both linguistic and conceptual aspects. Spontaneous use of sentences such as "I am three years old" or "I have two friends" suffices to show this nascent symbolic knowledge. Historical studies of children's knowledge of number words[34,38] have been supplemented with newer cross-linguistic investigations showing that the organization of number word systems has an impact on children's learning counting and cardinality knowledge[43,44].

Reciting the number sequence ("one, two, three, four...") is a source of enjoyment for young children, who often perceive it as a form of play. They delight in pushing themselves to recite as many numbers as possible, which provides a sense of maturity and competence. Initially, learning the verbal number sequence is largely mechanical and devoid of quantitative meaning—it resembles the rote memorization of a poem or the alphabet. Gradually, however, children shift into a functional learning phase in which number words become tied to actual quantities. This developmental progression, originally described by Fuson[34], remains a useful framework and has been supported by recent cross-linguistic studies that trace how children in diverse languages move from rote recitation to true understanding of cardinality[43,44].

Another foundational skill that emerges early and plays a critical role in number development is subitizing, the rapid, accurate, and confident recognition of small quantities without counting. Subitizing enables children to perceive small numerosities (typically up to four items) instantly and holistically[38]. More recent research highlights that subitizing is not merely a perceptual shortcut but a crucial building block for later arithmetic, supporting children's ability to recognize numerical patterns, form number combinations, and develop efficient strategies for larger sets[23,36]. By grouping objects into twos or threes, subitizing also facilitates faster and more organized counting of larger sets.

The ability to count collections of objects develops once children have acquired at least partial control of the verbal number sequence. However, fluency in reciting number words does not guarantee accurate object counting. International research shows that even children who can recite numbers beyond twenty may still struggle to coordinate one-to-one correspondence, object tracking, and cardinality[25]. Common errors include:

- Lack of synchronization between verbal counting and object pointing (e.g., skipping or double-counting items).
- Poor organizational strategies, such as losing track of which objects have been counted.
- Failure to attribute cardinality to the last number word, leading to repetitive recounting rather than recognition that the final number represents the set's total.

This last difficulty, described in French research as comptage-numérotage (number-tagging), is distinct from true counting (comptage), where the child understands both the procedure and the quantitative significance of the final number word[27].

It is important to emphasize that these early number-related skills are often fragile, inconsistent, and highly context-dependent. Children may apply numbers effectively in everyday situations (e.g., "I have two cookies") with-

out fully grasping their abstract properties or underlying logic[40,41]. Their use of number words and counting strategies is therefore opportunistic and situational, shaped by home numeracy experiences, play, and cultural practices.

The construction of numerical knowledge is a complex, long-term developmental process, but it begins remarkably early. The role of education is thus to support children's emerging number sense from the outset, guiding them in ways that are both effective and developmentally appropriate. Recognizing and building upon these competencies enhances instructional quality and helps ensure a smoother transition from informal, context-bound number use to formal mathematical concepts taught in school[28,45].

2.2. The Relationship between Print Awareness and Mathematical Development

Print knowledge and the learning of initial mathematics ideas are two of the essential features of early childhood learning that touch and support each other. Attainment of these skills during the years of preschool provides the building blocks for later achievements in both reading and mathematics at the elementary level. Knowledge of basic symbols, like letters and numbers, allows youngsters to develop cognitive skills necessary for reading, writing, and arithmetic[15,46].

As explained earlier, print awareness relates to children knowing that written language has meaning and that words consist of letters arrayed in certain ways. It has been regarded as the foundation of emergent literacy and has continuously been linked with later reading proficiency[47,48]. Studies also highlight significant exposure to print-rich environments during early childhood at home and at preschool as contributing factors to children developing their knowledge of the uses and conventions of print and helping reading fluency grow[49–51].

As young children learn to identify the structure of written language, they also begin to identify mathematical patterns and structures. Mathematical ideas, like numbers, geometry, and patterns, have structural commonality with written language insofar as they are dependent upon symbolic representation of abstract thought. Mathematical knowledge acquisition, such as numerals, geometry, and number sense, progresses at the same time as print knowledge. Research indicates that identifying that symbols have meaning as letters or as numerals is an essential point of development, bridging emergent literacy and numeracy[21,28]. Mathematical concept learning in young children is best supplemented with play and language-intensive activities that promote exploration of numbers and geometry. Playing with objects and their count, identifying geometric shapes, and practicing simple problems allow children to gain an initial mathematics understanding while at the same time complementing oral language development[52,53].

Print awareness and numeracy development are therefore closely connected. Recognizing letters and numbers as meaning-bearing symbols enables children to make connections between language and mathematics at the conceptual level. Longitudinal data verify that children with rich initial literacy and numeracy development achieve higher academically across both areas[40,54].

Books and activities that combine storytelling and numbers and mathematical patterns offer double chances for learning for children. Pedagogies based on storytelling can at the same time promote vocabulary development, narrative understanding, counting, and quantitative thinking[55–57].

In summary, print knowledge and learning of initial mathematics ideas are compatible processes of learning for young children at the preschool level. Improving both areas supplies young children with a strong base for much future learning and facilitates outstanding long-range achievements for literacy, mathematics, and cognitive development overall.

3. Methodology

3.1. Purpose of the Study

This study focuses on how print awareness develops and how early mathematical concepts are acquired by preschool-aged children through the use of fairy tales. Specifically, it explores how children's engagement with storytelling can be utilized both to foster an understanding of written texts (such as letter and word recognition, and text structure) and to promote basic mathematical skills, including counting, categorization, sequencing, symbol recognition, and simple arithmetic processes. The aim of the present study is to investigate the interplay between print awareness and the acquisition of early mathematical concepts in preschool children through the use of storybooks.

3.2. Research Questions

The central objectives of the study were as follows:

- How do preschool-aged children demonstrate print awareness through their interaction with storybook elements such as cover identification, title recognition, and directional understanding of text?
- To what extent do children exhibit early mathematical competencies—including counting, ordering, comparison, symbol recognition, and basic arithmetic—when these concepts are embedded within a narrative context?
- Are there any significant differences in performance based on gender in either print awareness or early mathematical skills?

3.3. Research Instrument

Children were tested with a semi-structured interview schedule integral to the retelling of The Three Little Pigs. The tool drew on the print awareness model of Justice and Ezell[58–60] and supplemented with numeracy items informed by long-standing early mathematics developmental sequences[21,28].

Seven areas were represented on the scoring rubric: (a) book/cover recognition, (b) title recognition, (c) recitation of numbers, (d) count accuracy, (e) order and sequence, (f) symbol recognition, and (g) computation. All of the responses were scored on a scale of 0–3 on the level of proficiency: 0 = incorrect/no answer; 1 = developing knowledge; 2 = partial skill; 3 = explicit display of the ability. The rubric itself was pilot-tested with two experts (an academic and a practitioner) for content validity and development suitability.

In order to maximize reliability, 20% of the transcripts were double-coded with two independent raters who had been trained on the rubric. Inter-rater reliability was estimated with Cohen's kappa and found to have $\kappa = 0.86$, which suggests strong agreement[61]. Discrepancies were negotiated and settled by consensus prior to coding the entire dataset. Pilot work with five children not from the original sample confirmed age-appropriateness and resulted in slight revisions of wording and the addition of visual cues.

Given the small, context-specific sample, the analysis was primarily descriptive, supplemented by independent-sample *t*-tests to explore potential gender differences. Frequencies and percentages were reported for each rubric category, and children's performance was interpreted in light of developmental benchmarks from emergent literacy and numeracy literature. Exemplar responses were also recorded to illustrate typical developmental patterns. Although inferential generalizations are limited, the findings provide exploratory evidence of how print awareness and numeracy can be fostered in integrated, story-based contexts.

3.4. Research Sample

The sample consisted of 50 preschool children aged 4 to 5 years (25 boys and 25 girls) enrolled in a public kindergarten in Edessa, Greece. A convenience sampling approach was employed, primarily due to the researchers' established collaboration with the kindergarten staff and the accessibility of the site for repeated classroom visits. While convenience sampling and reliance on a single site inevitably limit the socio-economic and cultural diversity of the sample—and therefore constrain the generalizability of findings, the present study was conceived as exploratory, aiming to generate context-specific insights into the integration of print awareness and numeracy through storytelling. Informal reports from teachers suggested that the majority of participating families were from middle socioeconomic backgrounds, although SES was not systematically measured. Future studies will need to extend this work across multiple schools and demographic groups to test the broader applicability of the findings.

4. Findings

This section presents the results of the analysis of preschool children's performance on tasks assessing print awareness and early mathematical concepts. Descriptive statistics were calculated for overall scores and for each individual category: cover information recognition, number recitation, counting, ordering, comparison and sequencing, numerical symbol recognition, and computation processes. The data provide insight into the range and distribution of children's abilities across these domains, as well as potential gender-based differences.

Descriptive statistics for each assessment category are shown in **Table 1**. Total performance scores ranged from 6 to 19 ($M = 11.14$, $SD = 2.72$), indicating moderate variability in children's performance. This distribution suggests that

while some children demonstrated relatively advanced skills, others struggled across several domains, reflecting the uneven development often reported in early childhood literacy and numeracy [21].

Table 1. Descriptive Statistics by Category.

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Total Score	50	6	19	11.14	2.718
Cover Information Score	50	0	4	1.74	0.965
Number Recitation Score	50	0	1	0.46	0.503
Counting Score	50	0	5	2.34	1.099
Ordering Score	50	0	3	1.48	0.863
Comparison & Sequencing Score	50	0	4	1.92	1.007
Symbol Recognition Score	50	1	4	2.12	0.872
Computation Processes Score	50	0	2	1.08	0.724
Valid N (listwise)	50				

Among the subcategories, the highest average scores were observed in counting (M = 2.34, SD = 1.10) and symbol recognition (M = 2.12, SD = 0.87). This indicates that children were more comfortable with tasks involving tangible, concrete representations of quantity and the recognition of numerical symbols. These findings are consistent with international evidence showing that young learners often grasp symbolic associations (e.g., recognizing "3" as representing three objects) earlier than they master more abstract concepts [23]. The relatively strong scores in these categories may also reflect children's exposure to numbers in everyday contexts (e.g., digital devices, packaging, or games), suggesting that informal experiences outside school contributed positively.

By contrast, the lowest scores were observed in number recitation (M = 0.46, SD = 0.50) and computation processes (M = 1.08, SD = 0.72). The difficulty with number recitation highlights that rote verbal learning of number sequences is still fragile at this age. While many children could count objects when prompted, fewer were able to recite number sequences independently, echoing findings from longitudinal research showing that fluency in verbal number recitation typically develops later than one-to-one correspondence skills [25]. Similarly, the low scores in computation processes suggest challenges in moving beyond basic counting to perform abstract operations such as addition or subtraction. This is consistent with international findings that computational reasoning in preschool is highly dependent on explicit instruction and rich teacher "math talk" [41].

Intermediate scores were observed in ordering (M = 1.48, SD = 0.86) and comparison and sequencing (M = 1.92, SD = 1.01). These outcomes reflect partial competence: children could sometimes arrange or compare sets, but not consistently across tasks. Such variability may be partly explained by the limited socio-economic diversity of the sample. Research has shown that children from more heterogeneous backgrounds demonstrate wider variation in sequencing and comparison tasks, depending on the kinds of mathematical interactions they experience at home [40,62]. The relative uniformity of our sample may therefore have reduced score variability while also constraining the upper range of performance.

Taken together, these results suggest that while children demonstrated some foundational competencies—particularly in counting and symbol recognition—many struggled with abstract or verbal tasks, such as reciting number sequences and performing simple computations. These findings highlight the role of curriculum priorities and pedagogical practices in shaping developmental outcomes. In Greek preschools, literacy-related activities (e.g., storytelling, print referencing) often receive greater emphasis than structured numeracy, which may partly explain the discrepancy between the two domains [63].

The frequency distribution of total scores is presented in **Table 2**. Most children (58%) achieved scores within the average performance range (10–14), suggesting that the majority of participants displayed a moderate but incomplete grasp of print awareness and numeracy skills. A smaller proportion (30%) scored between 6 and 9, reflecting lower performance and indicating difficulties in multiple assessment domains. Only 12% of children demonstrated high performance, with scores between 15 and 19.

Table 2. Frequency Distribution of Total Score.

Score	Frequency	Percent	Cumulative Percent
6	1	2.0%	2.0%
6	1	2.0%	2.0%
7	1	2.0%	4.0%
8	6	12.0%	16.0%
9	7	14.0%	30.0%
10	8	16.0%	46.0%
11	7	14.0%	60.0%
12	7	14.0%	74.0%
13	4	8.0%	82.0%
14	3	6.0%	88.0%
15	2	4.0%	92.0%
16	2	4.0%	96.0%
17	1	2.0%	98.0%
19	1	2.0%	100.0%
Total	**50**	**100.0%**	**100.0%**

This distribution illustrates the uneven developmental profile typical of preschool populations, where some children progress more rapidly while others require sustained support [21]. The limited number of high performers may be partly explained by the homogeneous socio-economic background of the sample, as research shows that children from more diverse or resource-rich environments often demonstrate wider variability and higher peaks of performance [62]. Likewise, the relatively large group of low performers may reflect the limited emphasis on numeracy in Greek preschool curricula, where literacy tends to dominate early instruction [63].

International studies also highlight the influence of the home learning environment on performance distribution. For instance, Napoli and Purpura (2018) [40] and Mutaf-Yıldız et al. (2020) [41] found that families more frequently engage in literacy than numeracy activities, which can result in stronger average literacy-related skills but more fragile mathematical competencies. The clustering of our participants in the "average" band may therefore reflect a curriculum and home environment that provides consistent but not enriched opportunities for literacy and numeracy learning.

In sum, the frequency distribution confirms that most children are at a transitional stage: they demonstrate emerging skills but have not yet achieved mastery across domains. This finding underscores the importance of targeted interventions to support children at both ends of the distribution, strengthening competencies for low performers and providing enrichment opportunities for the small number of high performers.

An independent samples *t*-test was conducted to assess whether there were statistically significant differences in total performance scores between boys and girls. As shown in **Table 3**, boys (n = 20) had a mean score of 11.20 (SD = 2.78), while girls (n = 30) had a mean score of 11.10 (SD = 2.72). The difference between the two groups was not statistically significant, $t(48) = 0.13$, $p = 0.90$, indicating no meaningful gender-related variation in overall performance on the tasks related to print awareness and early mathematical concepts.

Table 3. Gender Differences.

Gender	N	Mean	Std. Deviation	Std. Error Mean
Boys	20	11.20	2.783	0.622
Girls	30	11.10	2.721	0.497

The absence of gender differences in this sample aligns with international research showing that, at the preschool stage, boys and girls generally perform comparably in emergent literacy and numeracy, with differences only becoming more pronounced in later schooling and often depending on cultural or curricular factors [52,54]. However, it is important to note that the homogeneous socio-economic composition of the sample may have minimized variability. In more diverse populations, small but systematic gender-related differences sometimes emerge, particularly in literacy, where girls may

show a slight advantage, or in numeracy, where boys occasionally outperform in tasks involving spatial reasoning [64].

In the context of Greek early childhood education, the finding of no gender differences suggests that both boys and girls are developing foundational skills at similar rates when exposed to the same instructional practices. This underscores the potential of preschool curricula to provide equitable learning opportunities across genders, provided that classroom activities are inclusive and balanced in their emphasis on literacy and numeracy.

The mean performance of boys (M = 11.20, SD = 2.78) and girls (M = 11.10, SD = 2.72) did not differ significantly, $t(48) = 0.13$, $p = 0.90$ (**Table 4**). This finding confirms the absence of gender-based variation across the assessed skills, consistent with prior research showing that preschool-aged boys and girls generally demonstrate similar levels of emergent literacy and numeracy when exposed to the same instructional practices [52,54]. The homogeneity of the sample may also have minimized variability, as subtle differences sometimes emerge in larger and more diverse populations [64].

Table 4. Group Statistics and Independent Samples *t*-Test by Gender.

Assumption	F	Sig.	*t*	df	Sig. (2-tailed)	Mean Difference	Std. Error	95% CI Lower	95% CI Upper
Equal variances assumed	0.149	0.702	0.126	48	0.900	0.100	0.793	−1.494	1.694
Equal variances not assumed.			0.126	40.224	0.901	0.100	0.796	−1.509	1.709

Turning to print awareness, many children struggled with fundamental book concepts. Over half were unable to identify the front cover (58%) or point to the title (56%), and only 24% could name words related to the title. This indicates that several children are still developing core print awareness skills, aligning with evidence that explicit adult modeling of book-handling conventions is critical for fostering emergent literacy [5,13]. These findings underscore the need for preschool teachers to adopt deliberate "print-referencing" strategies during shared reading to scaffold children's awareness of how print functions.

In the domain of early mathematical concepts, children also encountered difficulties. Only 38% could correctly enumerate the number of pigs in the story, and many struggled with ordering tasks. These results mirror international findings that enumeration and ordering require more structured practice and are highly sensitive to the amount of numerical language children encounter in classrooms and at home [21,41]. By contrast, performance was comparatively stronger in tasks involving symbol recognition (52% correctly identified numbers on a page) and relative magnitude (56% identified the number closest to three). This suggests that children are beginning to associate numerals with quantities but still require support in applying these skills in more abstract problem-solving contexts.

Importantly, the use of a familiar fairy tale proved an engaging medium for eliciting responses. Story contexts may provide a natural bridge between emergent literacy and numeracy, offering opportunities for integrative instruction. As recent research has shown, embedding mathematical questions in narrative formats can make abstract concepts more meaningful for children and strengthen cross-domain learning [57]. While the present study highlights the potential of this approach, it also indicates the need for further refinement, particularly in ensuring that both literacy and numeracy dimensions are systematically targeted within story-based interventions.

5. Discussion

This study tested young children's knowledge of print awareness and emergent mathematics with storytelling interventions. Results showed that children scored relatively well on features of print awareness, whereas their knowledge and use of early numeracy content remained less developed. While these results are consistent with certain previous studies, they are not without qualification and should be interpreted with regard for the methodological limitations of the study as well as the overall teaching and policy environments.

One of the most stable findings was that children evidenced significant proficiency at identifying book and print conventions, letters, and at understanding how print works. This result aligns with international literature, which indicates that print-related knowledge tends to appear more prominently at preschool compared with early numeracy knowledge, at least partly because of the greater salience

of print as part of young children's natural environs[5,51]. Shared book reading practices, whether household or class, typically place text features, title, illustrations, and print concepts center-stage, which hastens young children's knowledge of print as a symbolic system[13].

This strength, however, must also be viewed in context. Studies have found that young children's print awareness has strong roots coming from the home literacy environment[40], such as books available at home, parental reference to writing and print, and reading behavior modeling. Since our sample represented only one kindergarten with quite similar backgrounds, the observed strength of print awareness might represent group-specific culture and socio-economic factors. For instance, reading practices at bed or alphabet play might receive higher priority from parents living in medium-level socio-economic status Greek homes compared with numeracy practices. That would mean that observed universal development might actually reflect, at least partially, context-specificity.

In contrast, children's responses to numeracy-related tasks, such as counting objects, recognizing set cardinality, or demonstrating one-to-one correspondence, were less consistent. This pattern is not surprising, given extensive research showing that numeracy often lags behind literacy in early childhood curricula and teaching practices[21,23]. Teachers tend to devote more time to storybook reading and language activities than to structured number-related tasks, and families are more likely to encourage verbal play with letters than mathematical concepts[41].

Multiple confounding factors might account for this gap. One is that whereas print is ever-present in the environment (street signs, logos, food labels), numeracy ideas are less prominent unless parents or teachers actively bring them to the forefront. A second one is the role of language: the structure of the system of number words and of the count might help or hinder knowledge of cardinality[43]. In Greek, the system of number words is quite transparent, but children might have less exposure to it in daily practices than to letters and words. A third one concerns data collection at a point at which there has historically been an emphasis on developing literacy skills at the expense of mathematics education at the level of national preschool curricula[63]. Children's numeracy performance might therefore reflect systemic imbalances of curricula instead of an intrinsic lag of development.

A key innovation of this study is the focus on print awareness and numeracy together in the same narrative context. Whereas previous studies almost always treat literacy and numeracy as distinct and isolated entities, new evidence suggests that these areas are more connected than has been thought previously[47]. Literacy and numeracy both draw on knowledge of symbolic systems: letters for sounds and words; numerals for quantity. Children's knowledge of knowing that symbols hold meaning might transfer between areas. For example, children who know that there is a written word that stands for an object or idea are also likely to more quickly understand that the numeral "3" stands for three objects.

In our study, however, the relative gap between literacy and numeracy suggests that while the symbolic nature of print was familiar, the symbolic nature of numbers remained less internalized. This highlights a potential pedagogical opportunity: integrating numeracy into literacy-rich storytelling experiences could leverage children's stronger grasp of print to scaffold their developing number sense. International research supports this approach. For example, Rosas and Sarama (2022)[57] found that narrative-based mathematics interventions improve both vocabulary and quantitative reasoning by embedding numbers within meaningful story contexts.

As with any study, the findings must be understood in relation to possible confounding factors. The most significant limitation is the homogeneity of the sample: all participants came from a single public kindergarten in Edessa, which reduces socio-economic, linguistic, and cultural variation. Children from different SES backgrounds or multilingual households may demonstrate different developmental trajectories. Research consistently shows that children from lower-SES backgrounds tend to have reduced exposure to both print and numeracy activities at home, which affects their school readiness[62,65]. Similarly, children in multilingual environments may acquire print awareness differently, as exposure to multiple orthographies can either accelerate or complicate symbol learning[66].

Another confounding variable might be the home learning environment. Parents who stress reading books together might tend to enhance children's print knowledge without necessarily exposing them to numeracy talk, which has been found specifically to predict young knowledge of numbers[40]. Teacher routine also exerts strong effects: our

kindergarten teachers spent time on storytelling and referring to print, but less on weaving mathematical talk into class routine. This skew probably reinforced the literacy–numeracy gap seen.

Placing these findings in an international context further illuminates their significance. Studies in North America and Europe show similar patterns: children often enter school with stronger literacy-related skills than numeracy skills[52,54]. However, findings from multilingual contexts provide nuance. In Singapore, for example, children's print awareness varies depending on whether instruction occurs in English or the mother tongue, while numeracy tends to be less affected by the language of instruction[43]. In Canada, home numeracy practices predict math outcomes even after controlling for literacy activities, underscoring the distinctiveness of numeracy development[41].

In adding data from Greece, this effort joins a growing volume of cross-cultural work that documents the universality as well as the context-specificity of precocious development of skills. While the symbolic nature of numeracy and literacy is ubiquitous, comparative weighting of each domain represented in the curriculum and pedagogy has the potential for very large variations between children's readiness profiles.

The findings carry important implications for both pedagogy and policy. From a pedagogical perspective, the study underscores the value of integrative, story-based approaches that foster literacy and numeracy simultaneously. Teachers can be trained to highlight both print and quantitative concepts during storytelling, for instance, by drawing attention not only to letters and words but also to numbers, quantities, and patterns embedded in the narrative. International interventions such as dialogic reading with embedded numeracy questions[47] provide models for how such integration can be achieved effectively.

At the level of policy, the findings point towards curricular rebalancing. In Greece, as well as other nations, literacy usually gets undue focus at the level of early childhood education. Policy-makers would do well to enhance the mathematical aspect of the preschool curriculum as part of infusing numeracy objectives into prevailing literacy-strong practices and not as discrete areas. This might help correct the kinds of initial inequities, particularly for disadvantaged children who might not get much exposure at home.

6. Conclusions

In total, this study presents evidence that while preschool children from Edessa, Greece, had greater capacities for print knowledge beyond that of early numeracy, such patterns are informative only when interpreted from a critical frame that considers curricular focus, home environment, and culture. In juxtaposing the results next to international evidence, the study contributes its share to the international debate on how numeracy and literacy are best integrated for young children. It's context-specific and exploratory work, but it has valuable reflective questions: In culturally diverse classrooms, how can educators achieve a more equitable balancing of teaching literacy and numeracy? In multilingual environments where children have different experiences with symbols from one language to another, how can story-like methods be adapted? How can policy levers see that both areas have equal emphasis at the level of national curricula?

Finally, the results challenge us to view literacy and numeracy not as distinct silos but as related symbolic systems that, if taught together, can give young children a stronger start for learning for life.

Author Contributions

Conceptualization, A.M. and I.P.; methodology, A.M.; validation, A.M. and I.P.; formal analysis, A.M.; investigation, A.M.; resources, I.P.; data curation, A.M.; writing—original draft preparation, A.M.; writing—review and editing, I.P.; visualization, A.M.; supervision, I.P.; project administration, I.P. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

This study was conducted in line with accepted ethical standards for research in early childhood educational settings. Prior to the commencement of data collection, permission to carry out the study was granted by the kindergarten director and teaching staff. The study adhered to the principles of the Declaration of Helsinki (2013) and followed ethical

guidelines for educational research with young children.

Informed Consent Statement

Written informed consent was obtained from all parents/guardians of the participating children, and children's assent was sought in age-appropriate ways. Participation was entirely voluntary, and parents were informed that they could withdraw their child at any stage without consequence. No personal identifying information was recorded, and all data were treated with strict confidentiality.

Data Availability Statement

The data supporting the findings of this study are not publicly available due to ethical restrictions concerning the confidentiality of participating children. Anonymized datasets may be made available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Ellis, K., Hickle, K., Warrington, C., 2023. Researching sensitive topics with children and young people: Ethical practice and blurry boundaries. International Journal of Qualitative Methods. 22, 1–13. DOI: https://doi.org/10.1177/16094069231207011

[2] Clay, M.M., 1991. Becoming literate: The construction of inner control. Heinemann: Portsmouth, NH, USA.

[3] Mouratoglou, A., Papadopoulos, I., 2025. Print awareness in early childhood: An application of the PWPA tool in Greece. Journal of Language and Culture in Education. 2(2), 41–55. DOI: https://doi.org/10.5281/vfw14568

[4] Duke, N.K., Cartwright, K.B., 2021. The science of reading progresses: Communicating advances beyond the Simple View of Reading. Reading Research Quarterly. 56(S1), S25–S44. DOI: https://doi.org/10.1002/rrq.411

[5] Logan, J.A.R., Piasta, S.B., Zettler-Greeley, C.M., et al., 2023. Small-group, emergent literacy intervention under two implementation models: Intent-to-treat and dosage effects for preschoolers at-risk for reading difficulties. Journal of Learning Disabilities. 56(3), 225–240. DOI: https://doi.org/10.1177/00222194221079355

[6] DeBaryshe, B.D., 2023. Supporting emergent writing in preschool classrooms: Results of a professional development program. Education Sciences. 13(9), 961. DOI: https://doi.org/10.3390/educsci13090961

[7] Paris, S.G., Turner, J.C., 2022. Engagement matters: Supporting meaning, identity, and agency in literacy learning. Reading Research Quarterly. 57(1), 5–15.

[8] Ünal Gezer, M., 2021. Storybooks, songs, and games: Tools to boost early literacy development in primary English classrooms. International Online Journal of Education and Teaching. 8(4), 2683–2700. Available from: https://eric.ed.gov/?id=EJ1318841

[9] Taylor, R.R., Paris, S.G., 2023. Socioeconomic status and reading development: Moving beyond the first snapshot. Mind, Brain, and Education. 17(3), 293–301. DOI: https://doi.org/10.1111/mbe.12351

[10] Snow, C.E., Burns, M.S., Griffin, P., 1998. Preventing reading difficulties in young children. National Academy Press: Washington, DC, USA.

[11] Alatalo, T., Westlund, B., 2021. Preschool teachers' perceptions about read-alouds as a means to support children's early literacy and language development. Journal of Early Childhood Literacy. 21(3), 413–435. DOI: https://doi.org/10.1177/1468798419852136

[12] Turan, Z., Küçük, S., Çilligöl Karabey, S., 2022. The university students' self-regulated effort, flexibility and satisfaction in distance education. International Journal of Educational Technology in Higher Education. 19, 35. DOI: https://doi.org/10.1186/s41239-022-00342-w

[13] Zucker, T.A., Justice, L.M., Piasta, S.B., et al., 2010. Preschool teachers' literal and inferential questions and children's responses during whole-class shared reading. Early Childhood Research Quarterly. 25(1), 65–83. DOI: https://doi.org/10.1016/j.ecresq.2009.07.001

[14] Strauss, M.S., Curtis, L.E., 1981. Infant perception of numerosity. Child Development. 52, 1146–1152.

[15] Purpura, D.J., Napoli, A.R., Wehrspann, E.A., et al., 2017. Causal connections between mathematical language and mathematical knowledge: A dialogic reading intervention. Journal of Research on Educational Effectiveness. 10(1), 116–137. DOI: https://doi.org/10.1080/19345747.2016.1204639

[16] Frye, D., Baroody, A.J., Burchinal, M., et al., 2013. Teaching math to young children: A practice guide. National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences: Washington, DC, USA.

[17] Gersten, R., Jordan, N.C., Flojo, J.R., 2005. Early identification and interventions for students with mathematics difficulties. Journal of Learning Disabilities. 38(4), 293–304.

[18] Halpern, D.F., 2012. Sex differences in cognitive abilities. Psychology Press: New York, NY, USA.

[19] Van den Heuvel-Panhuizen, M., Elia, I., 2011. Kindergartners' performance in two types of fantasy situations:

Mathematical versus non-mathematical story contexts. Educational Studies in Mathematics. 76(1), 65–85.

[20] Van den Heuvel-Panhuizen, M., Elia, I., 2012. The role of picture books in young children's development of mathematical understanding. Educational Studies in Mathematics. 79(1), 65–83.

[21] Pittalis, M., 2025. An empirically validated rational number sense framework. Mathematics Education Research Journal. 37, 125–160. DOI: https://doi.org/10.1007/s13394-024-00484-2

[22] Braak, D., Lenes, R., Purpura, D.J., et al., 2022. Why do early mathematics skills predict later mathematics and reading achievement? The role of executive function. Journal of Experimental Child Psychology. 214, 105306. DOI: https://doi.org/10.1016/j.jecp.2021.105306

[23] Outhwaite, L.A., Aunio, P., Leung, J.K.Y., et al., 2024. Measuring mathematical skills in early childhood: A systematic review of the psychometric properties of early maths assessments and screeners. Educational Psychology Review. 36, 110. DOI: https://doi.org/10.1007/s10648-024-09950-6

[24] Turan, E., De Smedt, B., 2022. Mathematical language and mathematical abilities in preschool: A systematic literature review. Educational Research Review. 100457. DOI: https://doi.org/10.1016/j.edurev.2022.100457

[25] Connor, D.O., 2024. Conceptually distinct measures of the cardinality principle. Journal of Experimental Child Psychology. 66, 61–74. DOI: https://doi.org/10.1016/j.ecresq.2023.08.010

[26] Litkowski, E.C., Duncan, R.J., Logan, J.A., et al., 2020. When do preschoolers learn specific mathematics skills? Mapping the development of early numeracy knowledge. Journal of Experimental Child Psychology. 195, 104846. DOI: https://doi.org/10.1016/j.jecp.2020.104846

[27] Clements, D.H., Sarama, J., 2020. Learning and Teaching Early Math: The Learning Trajectories Approach, 3rd ed. Routledge: New York, NY, USA. DOI: https://doi.org/10.4324/9781003083528

[28] Membrive, A., Ros, I., García-Pellicer, A., 2022. Advancing the conceptualization of learning trajectories. Trends in Neuroscience and Education. 28, 100180. DOI: https://doi.org/10.1016/j.lcsi.2022.100658

[29] Clements, D.H., Sarama, J., 2007. Early childhood mathematics learning. In: Lester, F.K. (ed.). Second handbook of research on mathematics teaching and learning. Information Age Publishing: New York, NY, USA. pp. 461–555.

[30] Fritz, A., Ehlert, A., Balzer, L., 2023. The role of small number ranges in early arithmetic development. Frontiers in Psychology. 14, 1116492. DOI: https://doi.org/10.3389/fpsyg.2023.1116492

[31] Clements, D.H., Sarama, J., 2009. Learning and teaching early math: The learning trajectories approach. Routledge: New York, NY, USA.

[32] Gelman, R., Gallistel, C.R., 1978. The child's understanding of numbers. Harvard University Press: Cambridge, MA, USA.

[33] Splinter, S.E., Depaepe, F., Verschaffel, L., et al., 2024. Perceptual subitizing performance in 3- and 4-year-olds: The impact of visual features of sets. Journal of Experimental Child Psychology. 244, 105946. DOI: https://doi.org/10.1016/j.jecp.2024.105946

[34] Fuson, K.C., 1988. Children's counting and concepts of number. Springer-Verlag: New York, NY, USA.

[35] Fischer, J.P., 1992. Digital learning: The procedural – declarative distinction. Presses Universitaires de Nancy: Nancy, France. (in French)

[36] Starr, A., Libertus, M., Brannon, E., 2013. Number sense in infancy predicts mathematical abilities in childhood. Proceedings of the National Academy of Sciences. 110(45), 18116–18120. DOI: https://doi.org/10.1073/pnas.1302751110

[37] Libertus, M.E., Brannon, E.M., 2009. Behavioral and neural basis of number sense in infancy. Current Directions in Psychological Science. 18(6), 346–351. DOI: https://doi.org/10.1111/j.1467-8721.2009.01665.x

[38] Lemonidis, C., 1994. A walk through the learning of elementary arithmetic. Kyriakidis Brothers Publications: Thessaloniki, Greece.

[39] Butterworth, B., 2005. The development of arithmetical abilities. Journal of Child Psychology and Psychiatry. 46(1), 3–18.

[40] Napoli, A.R., Purpura, D.J., 2018. The home literacy and numeracy environment in preschool: Cross-domain relations of parent–child practices and child outcomes. Journal of Experimental Child Psychology. 166, 581–603. DOI: https://doi.org/10.1016/j.jecp.2017.10.002

[41] Mutaf-Yıldız, B., Sasanguie, D., De Smedt, B., et al., 2020. Probing the relationship between home numeracy and children's mathematical skills: A systematic review. Frontiers in Psychology. 11, 2074. DOI: https://doi.org/10.3389/fpsyg.2020.02074

[42] Mazzocco, M.M.M., 2005. Challenges in identifying target skills for math disability screening and intervention. Journal of Learning Disabilities. 38(4), 318–323. DOI: https://doi.org/10.1177/00222194050380040701

[43] Cheung, P., Ansari, D., 2023. A million is more than a thousand: Children's acquisition of very large number words. Developmental Science. 26(1), e13246. DOI: https://doi.org/10.1111/desc.13246

[44] Sarnecka, B.W., Carey, S., 2008. How counting represents number: What children must learn and when they learn it. Cognition. 108(3), 662–674. DOI: https://doi.org/10.1016/j.cognition.2008.05.007

[45] Clements, D.H., Sarama, J., 2011. Early childhood mathematics intervention. Science. 333(6045),

968–970.

[46] Mol, S.E., Bus, A.G., 2011. To read or not to read: A meta-analysis of print exposure from infancy to early adulthood. Psychological Bulletin. 137(2), 267–296. DOI: https://doi.org/10.1037/a0021890

[47] Whitehurst, G.J., Lonigan, C.J., 1998. Child development and emergent literacy. Child Development. 69(3), 848–872. DOI: https://doi.org/10.1111/j.1467-8624.1998.tb06247.x

[48] Piasta, S.B., Petscher, Y., Justice, L.M., et al., 2021. How preschool print knowledge and phonological awareness jointly predict kindergarten literacy. Journal of Educational Psychology. 113(1), 133–147.

[49] Neumann, M.M., Hood, M., Ford, R.M., 2013. Mother–child referencing of environmental print and its relationship with emergent literacy skills. Early Education and Development. 24(8), 1175–1193.

[50] Neumann, M.M., Hood, M., Ford, R.M., 2013. Using environmental print to enhance emergent literacy and print motivation. Reading and Writing. 26(5), 771–793. DOI: https://doi.org/10.1007/s11145-012-9390-7

[51] Schaughency, E., Linney, K., Carroll, J., et al., 2023. Tender shoots: A parent-mediated randomized controlled trial with preschool children benefits beginning reading 1 year later. Reading Research Quarterly. 58, 450–470. DOI: https://doi.org/10.1002/rrq.500

[52] Duncan, G.J., Dowsett, C.J., Claessens, A., et al., 2007. School readiness and later achievement. Developmental Psychology. 43(6), 1428–1446. DOI: https://doi.org/10.1037/0012-1649.43.6.1428

[53] Hassinger-Das, B., Hirsh-Pasek, K., Golinkoff, R.M., 2017. The case of brain science and guided play: A developing story. Young Children. 72(3), 44–52.

[54] LeFevre, J.A., Fast, L., Skwarchuk, S.L., et al., 2010. Pathways to mathematics: Longitudinal predictors of performance. Child Development. 81(6), 1753–1767.

[55] Van Marle, K., Chu, F.W., Geary, D.C., 2014. Acuity of the approximate number system and preschoolers' quantitative development. Developmental Science. 17(4), 492–505.

[56] Feigenson, L., Libertus, M.E., Halberda, J., 2013. Links between the intuitive sense of number and formal mathematics ability. Child Development Perspectives. 7(2), 74–79. DOI: https://doi.org/10.1111/cdep.12019

[57] Rosas, D., Sarama, J., 2022. The role of story contexts in early mathematics instruction. Early Childhood Research Quarterly. 62, 33–44.

[58] Justice, L.M., Ezell, H.K., 2000. Enhancing children's print and word awareness through home-based parent intervention. American Journal of Speech-Language Pathology. 9(3), 257–269. DOI: https://doi.org/10.1044/1058-0360.0903.257

[59] Justice, L.M., Ezell, H.K., 2004. Print referencing: An emergent literacy enhancement strategy and its clinical applications. Language, Speech, and Hearing Services in Schools. 35(2), 185–193. DOI: https://doi.org/10.1044/0161-1461(2004/018)

[60] Justice, L.M., McGinty, A.S., Piasta, S.B., et al., 2005. Print-focused read-alouds in preschool classrooms: Intervention effectiveness and maintenance of effects. Early Education and Development. 21(4), 467–488.

[61] Landis, J.R., Koch, G.G., 1977. The measurement of observer agreement for categorical data. Biometrics. 33(1), 159–174. DOI: https://doi.org/10.2307/2529310

[62] Niklas, F., Schneider, W., 2017. Home learning environment and development of child competencies from kindergarten until the end of elementary school. Contemporary Educational Psychology. 49, 263–274. DOI: https://doi.org/10.1016/j.cedpsych.2017.03.006

[63] Eurydice, 2019. Key data on early childhood education and care in Europe – 2019 edition. Publications Office of the European Union: Luxembourg.

[64] Gunderson, E.A., Ramirez, G., Levine, S.C., et al., 2012. The role of parents and teachers in the development of gender-related math attitudes. Sex Roles. 66(3–4), 153–166. DOI: https://doi.org/10.1007/s11199-011-9996-2

[65] Hart, B., Risley, T.R., 1995. Meaningful differences in the everyday experience of young American children. Paul H. Brookes: Baltimore, MD, USA.

[66] Verhoeven, L., Perfetti, C., 2021. Universals in learning to read across languages and writing systems. Scientific Studies of Reading. 26(2), 1–15. DOI: https://doi.org/10.1080/10888438.2021.1938575