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A Mathematics Intervention in Kindergarten Using Shel Silverstein's "The Missing Piece Meets the Big O": Early Childhood Educators' Perceptions on a Teaching Framework Integrating Literature in Mathematics-Related Concepts

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Abstract

Teaching mathematics in kindergarten necessitates interdisciplinary methods. By merging different disciplines, educators should create an environment conducive to learning, equipped with diverse materials, which allows children to engage with mathematical concepts through play, observation, and read-aloud stories. The aim of the present study is to explore early childhood educators' perceptions of a teaching framework integrating literature in mathematics-related concepts. The hypothesis is that a mathematics intervention using Shel Silverstein's "The missing piece meets the big O" could affect the teaching of mathematics in kindergarten. In this action research, twenty-four (n=24) early childhood educators participated by implementing the intervention and completing a semi-structured questionnaire. Data analysis included descriptive and inferential statistical analysis that was used to compare the mean scores of the two parts of the questionnaire before and after the intervention. Results show that educators were more positively inclined to use picturebooks as a stimulus for approaching mathematics-related concepts and creating a demarcated and inviting space for learning mathematics. Their answers lead to the assumption that a clear and concise framework, which integrates literature in mathematics and offers specific phases with activities would facilitate their teaching process. The notable deviation in their answers before and after the intervention demonstrates the extent to which the intervention affected their perceptions. Discussion of findings highlights the need for the Greek curriculum for preschool education to offer methodological recommendations for the integration of picturebooks in the teaching of mathematics.

Keywords: mathematics, literature, picturebooks, integration, teaching framework, intervention, early childhood educators, perceptions

1. Introduction

The primary goal of mathematical education in modern Greek kindergarten has shifted away from rote memorization of concepts and procedures towards fostering a thinking approach that leverages mathematical principles. The aim is for children to adopt a mathematical mindset, recognizing the practical applications of mathematics in everyday life (Papadakis, Kalogiannakis & Zaranis, 2016). Through daily activities and interaction with their surroundings, children progressively explore various mathematical dimensions outlined in the curriculum, including numbers and operations, space and geometry, measurements, stochastic mathematics and introduction to algebraic thinking (Curriculum for preschool education, 2022). Integrating these mathematical concepts into kindergarten education necessitates interdisciplinary methods. By merging different disciplines, educators can bridge the gap between classroom learning and children's real-life experiences, tapping into their interests and ideas (Helm & Katz, 2011). To achieve this goal, teachers create an environment conducive to learning, equipped with diverse materials, which allows children to engage with mathematical concepts through play, observation, and read-aloud stories.

Pedagogical stories are generally used for introducing children to moral or ethical questions, problem-solving, developing an understanding and appreciation of the diversity of cultures, or with the aim of enhancing children's literacy and language skills. However, Casey, Kersh and Young (2004) pointed out that there are also 'math-stories', which are used in early childhood education for the purpose of introducing specific aspects of mathematics, such as a new concept or a problem for the children to solve. The integration of children's literature in mathematics-related concepts has proved to be a positive contribution to the mathematics course, making this learning area more interesting as well as motivating, and

arousing curiosity amongst students (Can, Özer & Durmaz, 2020). It has also been suggested that teachers who included literature books in the mathematics teaching process consider the mathematical activities much more stimulating and exciting (Prendergast, Harbison, Miller & Trakulphadetkrai, 2019). The key to this type of teaching, according to Björklund and Samuelsson's (2013), is for the teacher to be able to recognize the mathematics that is embedded within a specific context or story, to have the skill to bring out these features and to enable the children to discern them.

There are numerous earlier studies, which examine the integration of literature in mathematics teaching in kindergarten. The uniqueness of this study is the testing of the hypothesis that early childhood educators need a specific methodological framework for their interdisciplinary teaching approaches of mathematics and literature to be based on. Hence, this research aims to evaluate the influence of an interdisciplinary intervention on educators' perceptions on mathematics teaching. The specific intervention integrates non-mathematics-oriented picturebooks into mathematics-related concepts.

2. Literature Review

2.1 Mathematical Education According to Greek Curriculum for Preschool Education

Active engagement of children in solving mathematical problems is considered a crucial element in creating an educational environment conducive to grasping fundamental mathematical concepts, as outlined in the Greek curriculum for preschool education (Curriculum for preschool education, 2022). International studies (Bowman, Donovan & Burns, 2001; Clements, 2001; Sarama & Clements, 2004) have highlighted the active involvement of children in the learning process as pivotal in designing effective teaching interventions aimed at enhancing children's mathematical competency. When mathematical activities within a school setting are meaningful and enable children to approach mathematical knowledge and explore mathematical concepts through various stimuli, they can significantly contribute to their mathematical development (Balfanz, Ginsburg & Greenes, 2003; Clements, Sarama & DiBiase, 2003; Clements & Sarama, 2009; Clements & Sarama, 2013).

Kindergarten children typically possess informal numeracy knowledge upon entering school, which can be expanded, enriched, and refined through appropriately designed learning activities. Therefore, it is pertinent for kindergarten educators to emphasize the creation of a distinct learning environment during mathematics instruction. Specifically, this entails developing learning approaches that are grounded in children's experiences, capture their interest, and gradually guide them towards constructing mathematical concepts (Papadakis et al., 2016).

2.2 The Use of Picturebooks in Kindergarten as an Impetus for the Learning of Mathematics

Shapiro, Anderson and Anderson (1997) observed mathematical talk in shared book reading of parents and children without mathematics being the focus in the research. Similarly, studies by Ginsburg and Seo (1999) and Ginsburg, Lin, Ness and Seo (2003) indicated that when children are in an inspiring environment with elements that can be mathematized, they inevitably come up with mathematics-related thinking.

Van den Heuvel-Panhuizen and Van den Boogaard (2008) investigated whether mathematics-related thinking would evolve when young children were read a picturebook that was not written with the intention of teaching mathematics. Their findings revealed that children show cognitive engagement when they are read a picturebook, resulting in the incorporation of general utterances and in specific mathematics-related utterances. These utterances are child-initiated and come up spontaneously without probing by the reader, a fact that leads to the assumption that the picturebook has the potential to elicit mathematical thinking. Another idea supported by this study is that children can be mathematically engaged by being read a picturebook even when the reading session does not have an instructional purpose, the book is not mathematics-oriented and it does not explicitly display mathematics.

Elia, Van den Heuvel-Panhuizen and Georgiou (2010) explored the characteristics that picturebooks -with either a representational or an informational function- should have to contribute to 5-year-old children children's learning of mathematics. Their findings showed that the picturebook has the potential for cognitively engaging children. However, the pictures with a representational function were found to elicit mathematical thinking to a greater extent than the pictures with an informational function. Ompok, Teng, Pang, Mun, Abdullah and Sapirai (2018) documented that educators provided favorable responses regarding the incorporation of picturebooks to teach mathematics-related concepts. According to their research, teachers endorse the idea that picturebooks could capture children's attention, foster their cognitive abilities, stimulate creativity, and contribute to improved early mathematics performance. Earlier research has also indicated that children's literature should afford them the chance to apply mathematical concepts in real-world scenarios (Whitin & Whitin, 2004; Van den Heuvel-Panhuizen & Elia, 2012). Moreover, given that different books can generate different amounts of mathematical talk and different kinds of mathematics (Anderson, Anderson & Shapiro, 2005), the literary works should empower children to connect mathematics with their personal experiences, other areas of learning, and additional mathematical concepts (Hunsader, 2004; Cotti & Schiro, 2004; Marston, 2010; Van den Heuvel-Panhuizen & Elia, 2012).

Based on all the aforementioned studies, this discerned power of the picturebook sheds a new light on the theoretical positions that support the use of picturebooks to learn mathematics.

2.3 Interventions on the Integration of Children's Literature in Approaching Mathematics-Related Concepts

Jennings, Jennings, Richey and Dixon-Krauss (1992) designed a study with the aim of examining whether the utilization of children's literature in teaching mathematical concepts to kindergarten children would lead to enhanced math achievement test scores, increased interest in mathematics, and greater utilization of mathematical vocabulary during free play. An intervention was conducted to 61 kindergarten children who were randomly assigned to experimental and control groups. The findings, derived from assessments such as the Test of Early Mathematics Ability and the Metropolitan Readiness Test, as well as observations of vocabulary usage during free play, supported the notion that the intervention contributed to improvements in children's math achievement and an augmented use of mathematical vocabulary. Feedback from teachers, parents, significant adults, and the children themselves indicated a heightened interest in mathematics. Students' increased interest in mathematics resulted in self-initiated activities, allowing the children to establish connections between mathematical concepts beyond those introduced by the teacher, communicate about mathematics with others, perceive mathematics as relevant to their daily lives, and recreate the logical aspects of mathematics. The integration of children's literature into the mathematics curriculum not only encouraged the use of mathematical language, skills, and concepts in various curriculum areas but also facilitated the application of mathematical knowledge in new situations.

Welchman-Tischler (1992) explored methods of incorporating literature into the mathematics classroom to enrich students' learning encounters. These methods include utilizing literature to offer a context or model for activities with mathematical content, introducing manipulatives for diverse applications (not strictly adhering to the story), sparking creative mathematical experiences for children, presenting intriguing problems, laying the groundwork for a mathematics concept or skill, and elucidating or reviewing a mathematics concept or skill. In Björklund and Samuelsson's (2013) empirical study the case of a teaching situation was examined with an intended mathematical object of learning and the mathematical notions of half and whole, which were introduced with a story. Specific contributing features, such as shared attention, reasoning about meaning and creating a demarcated space for learning a specific content, were clearly discerned regarding the use of a story while teaching mathematical-related concepts. Can et al. (2020) also showed in their research that the implementation of such types of intervention had a determinative impact on teachers who reported that books can be a tool for associating mathematics to real-life situations.

In a more recent study, however, Farrugia and Trakulphadetkrai (2020) showed that the integration of mathematics and stories is not a common practice for teachers. The identified obstacles are classified as constraints in resources and time, a lack of pedagogical framework and confidence, uncertainties regarding expected outcomes, and societal norms that hinder progress. On the other hand, the recognized facilitators include pedagogical advantages, a passion for storytelling, and supportive social norms. Considering that most participating teachers recognize the potential advantages of this approach and express a desire for training, it indicates a positive inclination toward the integration of picturebooks in approaching mathematics-related concepts in kindergarten.

2.4 Rational, Aim and Objectives

The aim of the present study is to explore early childhood educators' perceptions on a teaching framework integrating literature in mathematics-related concepts. There were numerous previous relevant studies studying the views from either pre-service primary teachers or kindergarten teachers regarding the incorporation of literature, mostly referring to math-oriented picturebooks, into the teaching of mathematics (Jennings et al., 1992; Ompok et al., 2018; Can et al., 2020; Farrugia & Trakulphadetkrai, 2020). However, there is no specific study exploring the impact that an intervention on the integration of a non-mathematics-oriented picturebook has on early childhood educators in their approach of mathematic-related concepts. Hence, this study sets the hypothesis that a mathematics intervention in kindergarten using Shel Silverstein's "The missing piece meets the big O" (2006) could affect early childhood educators' perceptions on a teaching framework integrating literature in mathematics-related concepts. More specifically, the objectives of the study are outlined in the following research questions:

RQ 1. To what extent do early childhood educators follow methodological recommendations by using different kinds of means and tools in their teaching of mathematics-related concepts in kindergarten?

RQ 2. To what extent does the integration of picturebooks affect early childhood educators' approach to mathematics-related concepts in kindergarten?

RQ 3. To what extent does the intervention affect early childhood educators in their integration of literature in the mathematics teaching process?

3. Research Design

3.1 Research Approach

This study aims to explore early childhood educators' perceptions on a teaching framework integrating literature in mathematics-related concepts. The action research approach used, through the implementation of an intervention, restrained the sample so that it could be better monitored. Although a qualitative approach would be more suitable to analyze perceptions, considering pure statistical results to assess the intervention's functionality, the approach utilized for this research is quantitative (Sells, Smith & Sprenkle, 1995; Bloom & Quint, 1999; Sanders & Sullins, 2005).

3.2 Data Collection Tool

3.2.1 Intervention Design

The intervention was based on prior action research endeavors (Jennings et al., 1992; Van den Heuvel-Panhuizen & Elia, 2012; Farrugia & Trakulphadetkrai, 2020; Kalaitzi & Panos, 2023). The intervention was conducted within a two-week period with an average of six class hours per week (3 days/week, 2 hours/day). When devising the activities, objectives, concepts, and methodological recommendations regarding the mathematics learning area, the Greek curriculum for preschool education (Curriculum for preschool education, 2022) was considered. The procedural practices were divided into four phases, each phase including activities aiming at the integration of a picturebook in a specific mathematics-related concept, that of the shape transformation. Table 1 below outlines the content of all four intervention phases.

Table 1. Mathematics intervention phases

INTERVENTION LAYOUT			
PHASE 1:	PHASE 2:	PHASE 3:	PHASE 4:
Picturebook read-aloud, accumulating information & setting the problem	Experimenting on divergent ideas – hypotheses & testing the verification of ideas	Recording solutions/ideas on board	Reusing set techniques & preserving the already known
Read-aloud of Shel Silverstein's picturebook "The Missing Piece Meets the Big O"	Shape match/synthesis: matching the triangular pieces to complete the circular shapes (activity sheet/ digital or pc paint of two-dimensional shapes)	Record all possible solutions/ideas to the spine board	Draw *still-shot animation* using movie magic app to create animated picturebooks with shape transformations
Use of a story sack with paper shapes (circles and triangles) to accumulate information – Start scripted questioning and discussions	Shape transformation part A: transform triangles and circles (separately) into something else (using two-dimensional paper shapes or three-dimensional construction objects)	Produce short narratives to alter the picturebook ending according to each solution/idea	Discover shapes in the environment - Find triangular and circular shapes in toys, paintings, objects, food, nature, etc.
Problem solving histogram: *how can the missing piece (triangle) feel complete and be able to roll?* - divergent thinking (mapping the hypotheses/ideas in a board)	Shape transformation part B: combine triangles and circles to transform them into something else (using two-dimensional paper shapes or three-dimensional construction objects)	Illustrate the new short narratives with transformed shapes drawings	Apply shape transformation skill into a new situation - transform objects with diverse shapes to solve a problem

3.2.2 Questionnaire

For the data collection, a semi-structured questionnaire was developed by the author for the purposes of this research. The framework that the questionnaire's elements were based on was Can et al. (2020) & Farrugia and Trakulphadetkrai's (2020) previous research. Certain questions were based on the questionnaires applied in these two studies, both regarding teachers' views and beliefs about the integration of children's literature in mathematics teaching and learning. The questionnaire included (excluding the demographic questions) twelve (n=12) 5-point Likert scale questions, ranging as follows: 1=Never, 2=Rarely, 3=Sometimes, 4=Often, 5=Always. The questions were grouped into

two (n=2) parts. Part A of the questionnaire, administered before the intervention, included six (n=6) questions regarding the approach of mathematical concepts in early childhood education. Part B of the questionnaire, administered after the intervention, also included six (n=6) questions regarding the methodological framework integrating picturebooks in teaching of mathematics-related concepts.

The data obtained in the study was entered into SPSS and the necessary coding followed. Data analysis included descriptive and inferential statistical analysis, with which, as stated by Sells et al. (1995), the data are summarized and interpreted based on the predetermined themes and could be presented by considering the questions or dimensions used in the questionnaire. Beyond the mean score tables, paired samples t-test was used to compare the difference between mean scores, before and after the intervention.

3.3 Sample

Twenty-four (n=24) early childhood educators participated in the research by implementing the intervention and by fully completing the questionnaire. This small-scale sample of professionals in the field of Early Years Education was chosen as a preliminary pilot sample to ensure a wider sample result reliability for a future big-scale research design (Sells et al., 1995). All participants worked in three Greek kindergartens of the public sector (eight educators per kindergarten). The inclusion criteria used to select the sample were, the academic qualifications (range from bachelor to PhD) and the working experience (range from 1 to 30+ years).

Firstly, the participants were asked to complete part A of the questionnaire. Subsequently, they were asked to implement the intervention. Early childhood educators were given the necessary amount of time, that of two weeks (3 days/week) to conduct the intervention. They were provided with a detailed outline of the intervention phases and with the translated version in the Greek language of the picturebook “The missing part meets the big O” (Silverstein, 2006). Subsequently, the participants were asked to complete part B of the questionnaire. The questionnaire was distributed through the Directorate of Preschool and Primary School of Eastern Thessaloniki (Greece) where the permanent and substitute teachers of early childhood education are registered. Early childhood educators were reached through their professional email addresses of the Hellenic social school network. Prior to the distribution of the electronic version of the questionnaire, an electronic version of consent form was acquired from all the early childhood educators. The consent form was accompanied by an information sheet describing the tool. Consent forms were also acquired from the headmaster of each school and students’ parents/ legal guardians. An information sheet describing the context, aim, methodology and the intervention of this study was also distributed to the participants-educators, school headmasters and students’ parents/ legal guardians. After the completion of the study, debriefing letters were distributed to educators, school headmasters and students’ parents/ legal guardians to inform them about the study’s process and the results. This research was approved by the Greek Institute of Education Policy (IEP).

4. Results

An exploration of early childhood educators’ perceptions on a teaching framework integrating literature in mathematics-related concepts was attempted, using a semi-structured questionnaire administered in two parts, one before and one after a mathematics intervention in kindergarten using Silverstein’s picturebook. The results below provide answers to all three research questions which were set especially for the purposes of this study. At this point it should be mentioned that neither the working years (Table 2 shows that 50% of the early childhood educators have 1-15 years of working experience and another 50% over 15 years), nor the academic qualifications (Table 3 shows that 54.2% of early childhood educators hold a master’s or a PhD degree, while 45.8% hold a bachelor’s degree) significantly affected the participants in their answers.

Table 2. Participants’ working experience

	Frequency	Percent	Valid Percent	Cumulative Percent
1-15 years	12	50.0	50.0	50.0
15-30+ years	12	50.0	50.0	100.0
Total	24	100.0	100.0	

Table 3. Participants' academic qualifications

	Frequency	Percent	Valid Percent	Cumulative Percent
Bachelor	11	45.8	45.8	45.8
Master / PhD	13	54.2	54.2	100.0
Total	24	100.0	100.0	

4.1 RQ 1. To What Extent Do Early Childhood Educators Follow Methodological Recommendations by Using Different Kinds of Means and Tools in Their Teaching of Mathematics-Related Concepts in Kindergarten?

Results showed that before the intervention (Table 4) early childhood educators stated to a greater extent that they follow Greek curriculum for preschool education methodological recommendations in the teaching of mathematics-related concepts (M = 3.29, SD = 1.082) and that they use different kinds of means as a stimulation to introduce mathematics -related concepts (M = 3.20, SD = .931). However, the lowest mean (M = 2.66) reveals that the level of their confidence in approaching mathematics-related concepts in their teaching is not very high. Furthermore, two more of the lowest means (M = 3.04 & M = 3.08) refer to early childhood educators' intention of integrating mathematics with other learning areas and their eagerness to use picturebooks in their approach of mathematics-related concepts. The latter observation contradicts the notable percentage of participants (M = 3.16) who believe that picturebooks can contribute to the development of mathematics-related concepts suggesting that there is a distance between what early childhood educators support in theory and what they apply in their active teaching.

Table 4. Approaching mathematical-related concepts in early childhood education (Before intervention)

		Mean	SD
1.	Early childhood educators feel confident in approaching mathematics-related concepts in their teaching.	2.66	1.049
2.	Do you follow Greek curriculum for preschool education methodological recommendations in the teaching of mathematics-related concepts?	3.29	1.082
3.	Do you use different kinds of means as a stimulation to introduce mathematics-related concepts?	3.20	0.931
4.	Do you integrate mathematics with other learning areas?	3.08	0.928
5.	In what frequency do you use picturebooks when you approach mathematics-related concepts?	3.04	0.750
6.	Picturebooks can contribute to the development of mathematics-related concepts?	3.16	0.637

4.2 RQ 2. To What Extent Does the Integration of Picturebooks Affect Early Childhood Educators' Approach to Mathematics-Related Concepts in Kindergarten?

After the intervention, as shown by the results (Table 5), early childhood educators stated to an even greater extent that picturebooks should be used as a stimulus to introduce the mathematics-related concepts (M = 5.00) and that the approach of mathematics-related concepts through picturebooks engages preschoolers' attention (M = 5.00). What can also be observed by the mean scores (M = 4.83 & M= 4.87) is that the participants, after implementing the intervention, had a greater intention of integrating mathematics with other learning areas, and particularly with literature by using the multimodal type of a picturebook which enhances reasoning about meaning and creates a demarcated space for learning. The need for a methodological framework that integrates picturebooks in the teaching of mathematics and facilitates educators in following discreet steps in approaching mathematics-related concepts was also expressed by large percentages (M = 4.87 & M = 4.66).

Table 5. Approaching mathematical-related concepts through the integration of picturebooks in early childhood education (After intervention)

		Mean	SD
1.	The integration of other learning areas supports the understanding of mathematics-related concepts.	4.83	0.380
2.	The integration of picturebooks assists the educator in following discreet steps in teaching mathematics-related concepts.	4.66	0.481
3.	Picturebooks should be used as a stimulus to introduce the mathematics-related concepts.	5.00	0.000
4.	The multimodal type of a picturebook (text & picture) enhances reasoning about meaning and creates a demarcated space for learning mathematics-related concepts.	4.87	0.337
5.	The approach of mathematics-related concepts through picturebooks engages preschoolers' attention.	5.00	0.000
6.	Early years curriculum should offer methodological recommendations that integrate picturebooks in the teaching of mathematics.	4.87	0.337

4.3 RQ 3. To What Extent Does the Intervention Affect Early Childhood Educators in Their Integration of Literature in the Mathematics Teaching Process?

As shown in Figure 1 after the intervention all variables have higher mean scores. It is observed that all the participants enhanced their perceptions regarding the use of picturebooks as a stimulus to approach mathematics-related concepts, engage children in the teaching process, and create a demarcated and inviting space for learning mathematics. Their answers lead to the assumption that a clear and concise framework which integrates literature in mathematics and offers specific phases with activities would facilitate their teaching process. The notable deviation in their answers before and after the intervention shows the extent to which the mathematics intervention in kindergarten, using Silverstein's picturebook, affected early childhood educators in their perceptions regarding the contribution of a teaching framework integrating literature in mathematics-related concepts.

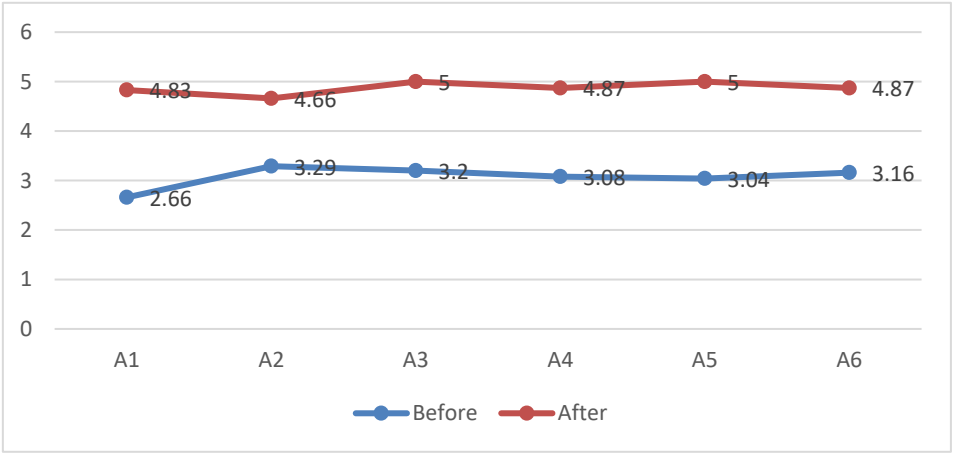

Figure 1. Before and After intervention

Table 6 indicates that educator ability in approaching mathematical-related concepts before the intervention shows lower levels (M = 3.07, T.A. = 0.750) compared to their ability in approaching mathematical-related concepts through the integration of picturebooks after the intervention (M = 4.87, T.A. = 0.185).

Table 6. Mean scores before and after intervention

		M	N	SD	SEM
Pair 1	Before intervention	3.07	24	0.750	0.153
	After intervention	4.87	24	0.185	0.037

Furthermore, as Paired samples t-test revealed (Table 7), the difference between mean scores, before and after the intervention, was found to be statistically significant ($t(23) = -14.044$, $p < 0.001$).

Table 7. Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		M	SD	SEM	Lower	Upper	t	df	p
Pair 1	Before intervention - After intervention	-1.79861	0.62743	0.12807	-2.06355	-1.53367	-14.044	23	0.000

5. Discussion

The findings confirmed what was already known from previous research about the determining role of the interdisciplinary approach of mathematics in early childhood education (Helm & Katz, 2011). The merging of different disciplines, tools, and modes, enables children to adopt a mathematical mindset, recognizing the practical applications of mathematics in everyday life (Papadakis et al., 2016). By using a non-mathematics-oriented picturebook, without following the typical mathematics learning instruction, but a read-aloud story accompanied with playful and interactive construction activities instead, educators can tap into children's interests and ideas. The intervention showed that when educators create an environment conducive to learning, equipped with diverse materials -such as a picturebook-, they allow children to engage with mathematical concepts through read-aloud stories. Earlier research findings (Balfanz et al., 2003; Clements et al., 2003; Clements & Sarama, 2009; Clements & Sarama, 2013) corroborate the results showing that when mathematical activities within a school setting are meaningful and enable children to approach mathematical knowledge and explore mathematical concepts through various stimuli, they can significantly contribute to their mathematical development.

This study also provided some new insights. Undeniably, according to all previous research, the use of children's literature and particularly the use of picturebooks enhances, enriches, and strengthens the approach of mathematics in early childhood education (Jennings et al., 1992; Ompok et al., 2018; Can et al., 2020; Farrugia & Trakulphadetkrai, 2020). Several methods of incorporating literature into the mathematics classroom to enrich students' learning encounters have been studied (Welchman-Tischler, 1992), nevertheless no specific framework has been created to be incorporated into the Greek curriculum for preschool education. Taking that into consideration, the intervention, designed especially for the purposes of this study, was based on this assumption, and focused mainly on the hypothesis that a set of constructed activities which incorporate a picturebook into the approach of specific mathematics-related concepts would function as a methodological framework for early childhood educators. The findings showed that professionals are affected in their perceptions in favor of integrating picturebooks in mathematics when they are offered to follow discrete steps in their teaching of mathematics-related concepts.

One of the findings that needs further consideration is that early childhood educators' perceptions regarding the approach to mathematics-related concepts and the contribution of picturebooks to it, showed significant deviations before and after the intervention. Previous research by Can et al. (2020) has suggested that pre-service educators should be introduced to children's books that incorporate mathematical themes as part of their teacher training. Similarly, most of the participants in this study stated that Greek curriculum for preschool education should offer methodological recommendations and concise steps with activities to demarcate the framework for the integration of picturebooks in the teaching of mathematics, a need analogous with the need for a framework for the selection of picturebooks to promote early mathematical development, which has been previously highlighted by Marston (2010). This finding is also consistent with the findings reported in the study by Prendergast et al. (2019) that practical examples should be presented to pre-service teachers so that they can relate to real-life situations while teaching mathematics and use the book as a tool for it.

Van den Heuvel-Panhuizen and Van den Boogaard's (2008) findings showed that children can be mathematically engaged by being read a picturebook even when the book is not mathematics-oriented and does not explicitly display mathematics. Also, Elia et al.'s study (2010) showed that picturebooks with a representational function -compared to picturebooks with an informational function- elicit mathematical thinking to a greater extent. According to all these researchers, picturebooks just narrate a compelling story, and by doing so, they unintentionally provide children with a

rich context for mathematical thinking. The selection of Silverstein' s "The missing piece meets the big O", the picturebook on which this study's mathematics intervention was based, relied on the latter findings. The significant different mean scores between the two parts of the questionnaire, before and after the intervention, show that early childhood educators use of a non-mathematics-oriented picturebook affected positively their perception regarding the use of picturebooks when approaching a mathematics-related concept, in this case the shape transformation. The latter observation also argues with Anderson et al.'s (2005) findings that different types and contexts of books may stimulate varying levels of mathematical discourse and diverse types of mathematical concepts.

In addition to all of the above, analogous to Hunsader (2004), Cotti and Schiro (2004), Marston (2010) and Van den Heuvel-Panhuizen and Elia (2012) who supported that the literary works should empower children to connect mathematics with their personal experiences, other areas of learning, and additional mathematical concepts, the results of the current study support that the shift in educators' perception was not observed only regarding the use of picturebooks, but also, the integration of mathematics with other learning areas and the use of different kinds of means as a stimulation to introduce mathematics-related concepts.

6. Research Implications

As reported by Leder (1992), given that children acquire mathematical knowledge before starting formal schooling, many of them can count meaningfully, can use appropriate quantitative terms, and understand addition and subtraction of small numbers. It should be mentioned at this point that preschoolers' level of mathematical knowledge at the time before the intervention was not evaluated. For further research, evaluations of mathematical knowledge and understanding of mathematics-related concepts should be implemented before and after the intervention. An experimental pretest-posttest process, according to previous suggestions by Van den Heuvel-Panhuizen and Van den Boogaard (2008), would lead to safer assumptions regarding the impact of the integration of picturebooks in the teaching of mathematics by evaluating what part of the mathematical understanding was brought in by the picturebook experience. Furthermore, different means and tools, other than literature, should be used within the teaching process of mathematical terms to test the significance and functionality of picturebooks as a means for teaching mathematics in early years education.

In accordance with Can et al.'s (2020) implications, this study also underlines the importance of offering early childhood educators the chance to explore picturebooks, especially those which are not mathematics-oriented, to explore the mathematical subjects and concepts they cover and to discern the tool's suitability for different age groups. Seminars, applied courses and continuous life-long education would introduce professionals into lists of suitable books, outlining the mathematics topics and the relevant learning domains. Such knowledge would increase early childhood educator awareness about the pedagogical effects of children's literature and furnish them with valuable resources to elevate their teaching by integrating any type of literature in other learning areas, such as mathematics.

7. Conclusion

This study suggests that improving how mathematics is taught at the preschool stage requires broader studies spanning different sectors. Understanding how children engage in mathematics in different contexts expands our understanding of their learning processes. Utilizing literature that resonates with children's interests and experiences and letting their responses shape teaching through questions and materials, builds on their current understanding. Reflecting on mathematical concepts in varied contexts, while integrating different domains and modes, enriches children's mathematical thinking. Reading picturebooks to children and observing their responses unveils a learning environment for the mathematics subject that differs from traditional didactic methods. This highlights picturebooks as an intriguing area for research and a source of fresh insights into mathematics learning.

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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