

ERD 2021

9th International Conference Education, Reflection, Development

**WHO WILL TEACH ME MATH? PROMOTING KINDERGARTEN
MATHEMATICS BY PRESCHOOL PARA EDUCATORS**

Sofia Ben Yair (a)* Olga Chiş (b)
*Corresponding author

(a) Kaye College- Early Educational Department, Azriel Nitsani St 6, Beer Sheva, Israel, sofiby16@gmail.com
(b) Department of Educational Sciences, Faculty of Psychology and Educational Sciences, Babes-Bolyai University,
7 Sindicatelor Street, Cluj-Napoca, Romania, olgachis76@gmail.com

Abstract

Over the past decade, there has been a change in the perception towards kindergartens in Israel as well as in the training of its educational staff. While the kindergarten teacher is required to have an academic education, the preschool para-educator (PPE) is only required to complete 12 years of schooling education and to undergo a designated training course. The contents of the PPE course, which does not cover the field of early childhood mathematics, do not correlate with the role of the PPE, who is required to promote mathematical abilities among kindergarteners. In light of this discrepancy, the need for appropriate training to PPEs, arises. This study describes current literature on the contemporary pedagogies in Israeli kindergartens, the role of the educational staff in the kindergarten, including the PPE, the development of early childhood mathematical thinking, and the different ways for teaching mathematics in kindergarten. The current study raises the need for a new training program, focuses on training PPEs in arithmetic for kindergarten with the ultimate goal of improving the teaching of arithmetic in kindergarten. Due to its importance as a basis for studying mathematics and adapting to the student's abilities, this training program can be extended to other mathematical disciplines, such as early geometry, and may be proposed to PPEs in general as well as special education kindergartens in Israel.

2672-815X © 2022 Published by European Publisher.

Keywords: Kindergarten, math teaching knowledge, number concept, preschool para-educator, professional training



1. Introduction

The current study discusses the importance of early childhood arithmetic training for kindergarten staff. Previous studies have shown that opportunities given to children in their first eight years of life, have a significant contribution to their development (Omidyar Network, 2019). As a result, high-quality and meaningful early childhood education positively predicts well-being and prosperity in a variety of indices in adulthood (Omidyar Network, 2019). Education during the kindergarten years largely focuses on experiences in diverse activities and on the combination of various knowledge field, with one of the main disciplines taught is early childhood mathematics. There are two main reasons for engaging in early childhood mathematics (Markovich, 2019): the integral role that mathematics plays in the children's daily lives; and the understanding that an optimal practice of mathematics at this age lays the foundations for the development and advancement of children's mathematical thinking in school. Practicing mathematics during early childhood seems natural and simple, however, in order to cultivate a meaningful mathematical environment and to ensure the proper development of arithmetic thinking, it is necessary that the kindergarten educational staff undergoes an intelligent mediation process which will allow them to gain a mathematical and pedagogical knowledge base and acquire the tools required to combine between them and successfully transmit them to kindergarteners (Shulman, 1986). Young learners do not stand on their own but are rather supported by people and environments with the mutual goal of helping them learn (Institute of Educational Technology, 2017). At kindergarten, the educational staff is the supporter and the teacher. Early mathematic skills have great predictive power for academic success and socioeconomic status in adulthood. As such, early mathematical intervention can also generate a long-term impact on the underlying learning process (Clements et al., 2017).

1.1. Preschool Mathematics Education

The children's mathematical knowledge base begins formulating at an early age. A joint statement by the National Council of Teachers of Mathematics (NCTM, 2000) and the National Association for the Education of Young Children (NAEYC, adopted 2002, updated in 2010) highlights that “a high-quality, challenging, and accessible mathematics education for three- to six years old children is a vital foundation for future mathematics learning”. Various researchers (Ginsburg et al., 2008; Uscianowski et al., 2020) have pointed to the challenge in early childhood mathematics education and the importance of the abstraction factor, in balancing spontaneous play with adult guidance. As per Vygotsky's (1978) study, adult guidance means that the teacher can help the child acquire new knowledge that is in the “zone of proximal development” by providing them with new information that can be assimilated in their existing knowledge, thus adding to the child's knowledge base and leading them from the familiar to the unfamiliar (Vygotsky, 1994). Preschoolers possess the ability to learn mathematical and arithmetic concepts. According to Ginsburg and Baroody (2003), the promotion of mathematical thinking, as well as the enrichment of mathematical language while ensuring accuracy in mathematical concepts, should be one of the cornerstones of kindergarten learning.

1.1.1. Number Concept Development

Early childhood mathematics encompasses a range of contents including pre-number skills (e.g., matching, sorting, or sequencing), number and operations, geometry, measurement and pattern, and algebra (Council of Chief State School Officers, 2010). The themes in the Israeli mathematics curriculum for preschool (INPMC, 2010), are divided to three major chapters: the number concept; spatial sense and geometry; and quantitative concepts in daily life. The Common Core State Standards, which set clear shared goals for knowledge and skills students are required to have in both English language and mathematics (Council of Chief State School Officers, 2010), recommended number concepts as the primary focus during early years. Arithmetic concepts are based on understanding the concept of numbers and its various components: size concepts, quantity concepts, space concepts, terms of operation, sorting, adjustment and control, regularization, quantity conservation, reversibility, understanding the concept of a group, the ability to understand the integer and its parts (Ilani, 2003). The ability to count objects is the basis for the development of the understanding of the number concept. Gelman and Gallistel (1978) point to five principles for counting objects: the permanent order principle; the one-to-one correspondence principle; the cardinal principle; the irrelevance principle of the counting objects order; and the abstraction principle that allows each group to be counted. The number concept was created as result of repeated experience with oral counting and objects counting. By introducing mathematics in early childhood education, children can acquire basic arithmetical concepts that they can use in their daily lives and enhance their thinking abilities and problem-solving skills (Hassan et al., 2019). As such, more weight should be placed on installing mathematical concepts in younger children to support the early development of numerical skills. For example, early informal cultivation of the meaning of numbers during kindergarten (Shane, 1999); the design of learning environments to include situations familiar to children; the use of manipulative materials and small numbers, later introducing larger numbers and encouraging generalizations and the inclusion of the use of letters to represent them (Uclés et al., 2020).

1.1.2. Preschool Teachers' Math Teaching Knowledge

Prior studies have shown that teachers' knowledge matters are an important factor in teaching (Ball et al., 2008; Shulman, 1986). To promote a meaningful mathematical environment and to ensure the proper development of arithmetic thinking, mediation is required between the kindergarten staff, mathematical-content knowledge, pedagogical knowledge, and the ability to combine them (Shulman, 1986). Teachers should be well familiar with the content, the levels of thinking, and the manner in which to use activities adapted to their children's thinking level (National Research Council, 2009, 2011; Sarama & Clements, 2009b). An additional factor that contributes to developing children's mathematical knowledge is the use of precise mathematical language by teachers (Ginsburg et al., 2008; Purpura & Reid, 2016; Uscianowski et al., 2020). According to Shulman and Ball (Ball et al., 2008; Shulman, 1986, 1987), teachers' knowledge is centralized around two main domains: Content Knowledge (CK) and Pedagogical Content Knowledge (PCK). Content Knowledge (CK) includes an in-depth knowledge of the curriculum, concepts, processes, principles, how they are organized and the connections between them. Pedagogical Content Knowledge (PCK) includes specific knowledge on teaching mathematics. PCK is a unique

knowledge for teachers, includes knowing students' typical ways of thinking, common mistakes made on specific topics, knowledge of how students understand topics, principles, and processes (Ball et al., 2008). A lack thereof of understanding of the level of difficulty of concepts and procedures in the specific topics studied and of the manner in which to properly present ideas in the specific content field, can lead teachers of young children to offer tasks that are either too easy or too hard for them, without identifying the mismatch (Clements, et al., 2021). When teachers understand the progression of levels of mathematical thinking along these paths, and able to sequence and individualize activities based on them, they can build effective mathematics learning environments and trajectories for all children (Clements, et al., 2021). While any typically developed adults can count and ask "how much" to unofficially evaluate a child's knowledge, the knowledgebase of the counting subskills is often uniquely required among preschool teachers for the purpose of diagnosing a child's counting difficulty (Ball et al., 2008), or alternatively to advance the child to a higher level of studies (Li, 2020).

1.2. The kindergarten system

The kindergarten is the first public educational system in Israel, suitable for children between the ages 3-6 (Israeli Ministry of Education, department of Preschool Education, 2010). The educational process focuses on developing the unique personality of each child from the moment they enter the kindergarten framework, and on providing for their physical, emotional, social, and intellectual needs and enabling the realization of their abilities (Israeli Ministry of Education, department of Preschool Education, 2010).

1.2.1. contemporary pedagogies at Israeli preschool education

Today's kindergarten children, born during the 21st century, are defined as the alpha generation. They are technological, independent, educated, and have access to knowledge, information, and resources from an early age (Fell, 2018). In 2018, the OECD (2018) defined the knowledge, skills and values required of children in the 21st century, to constitute the Future Kindergarten model, which focuses on learning the trends that are expected to bring about changes in the future reality over a period of up to ten years (Israeli Ministry of Education, 2018). The Future Kindergarten model is based on the ecological approach (Bronfenbrenner, 1979), according to which human learning and knowledge develop in social, cultural, and physical contexts and in cooperation between people with different backgrounds or between people with different abilities or points of view. The model presents four centers: learning in living spaces, community, entrepreneurship and productivity, and personal expression. It provides a pedagogical response and allows educational staff to create their unique kindergarten and to develop knowledge, skills and values tailored to the needs of alpha generation children (Israeli Ministry of Education, 2018). The Future Kindergarten model also focuses on the importance of the interaction between all of the partners in the kindergarten staff, as well as the environmental and cultural context. In positive teamwork, each member of the kindergarten staff expresses his or her uniqueness and strengths and is a partner of the joint creation in the kindergarten (Israeli Ministry of Education, 2020).

1.2.2. The Israeli kindergartens Preschool Para-Educator

The kindergarten educational staff consists of a kindergarten teacher and one or two PPEs. The kindergarten teacher has an academic education: a bachelor's degree and a teaching certificate. However, the PPE has a 12-year schooling education only and is an assistant to the teacher, while playing an organizational and pedagogical role determined by the kindergarten teacher according to the Israeli Ministry of Education policy (Israeli Ministry of Education, 2015). As part of a reform of the education system, a law was proposed in the Knesset of Israel (Knesset, Research and Information Center, 2017) intended to regulate the conditions of eligibility and training required for the PPE profession and the definition of its functions. The rationale for the proposal explains that the PPE employed in the Israeli education system plays a vital role and has a direct and profound impact on young children. In the past, the PPE was mainly responsible for the cleanliness of the kindergarten, however, nowadays the role of the PPE includes pedagogical activities as the PPE acts as a full partner in the educational activities (Knesset, Research and Information Center, 2017). The existing Israeli law regarding the PPE profession defines that only those who graduated 12 years of schooling, were not convicted in a criminal or disciplinary offence and graduated a designated training by the Minister of Education (Knesset, Research and Information Center, 2017) can be qualified as a PPE.

1.2.3. Preschool Para-Educators professional training

The needs for the PPE professional training is based on several sources: (a) the children's needs. To the children, the PPE is an adult at the kindergarten, therefore, the PPE must have the skills to meet the needs of children in a way that encourages their growth (Essa, 2002); (b) the kindergarten teacher's needs. The PPE is the only adult in the kindergarten with whom the kindergarten teacher can consult. The more professional the PPE is, the more productive the consultation will be (Gantz Aloni, 2003); (c) the Ministry of Education's needs. The kindergarten teacher works with a group of 35 children. When the kindergarten teacher is busy with part of the group, the PPE stays with the other children, and should be able to liaise them in the best possible way as per the educational rationale of the kindergarten; (d) the PPE's needs. The unprofessional performance required of the PPE in the past, has placed them in the margins of society (Tight, 2003).

2. Problem Statement

Professional education is a tool for achieving social recognition and personal development (Tight, 2003).

- According to the Israeli Ministry of Education's outline (2016), the PPE training program focuses on the following subjects: lifestyle, development and life skills, language and literacy, environmental education, art, music, computer-integration in preschool, digital photography, psychology theories, organizing an educational environment, interpersonal communication, communication with parents, computer skills, acquiring habits, and ways to deal with behav-

ioral, safety and health problems in the Kindergarten. Despite this broad scope of training, to date, there is no training on preschool mathematics (S.B.Y).

- As can be seen, the role of early childhood teaching is to provide the child with the appropriate experience to reach an overall understanding of the presented materials and to develop flexible ways of working with numbers, first with an intuitive and informal encounter with the numbers, followed by a formal and symbolic encounter with the various representations of the number as required in school (Baroody et al., 2006; NCTM, 2002).
- Prior studies have indicated that Public Capital Investments in preschool are economically profitable in the short and long term (Barnett & Masse, 2006). Moreover, PPE training in early childhood arithmetic is perceived as having significant contribution to predicting the children's continuing mathematical education and their future success in the field (Clements et al., 2017).

3. Research Questions

The research question that is aimed to be answered in this theoretical paper is whether the mathematics education is achieved between PPE and kindergarten children..

4. Purpose of the Study

The importance of this paper resides in the fact that it analyzes several conceptualizations of the early childhood mathematics education and its ability to promote children's continuing study at the school. Moreover, it provides theoretical evidence that kindergarten staff, including PPE, can be effective in promoting mathematical thinking at this age.

5. Research Methods

This theoretical study used a methodology of analysis and comparison between research literature and official governmental documents. The literature enabled the researcher to conclude that there is a gap in knowledge on the topics of Training Preschool Arithmetic for PPE. The conclusions of this study were derived from this literature review.

6. Findings

As per the existing literature in the field, PPE training programs in Israel lack the field of early childhood mathematics. Due the fact that PPEs are part of the kindergarten staff and are required to work with children in all areas, including mathematics, appropriate training is required.

The uniqueness of such training resides in the fact that it will be implemented with Preschool Para-Educators who have never undergone training on early childhood mathematical topics. The proposed intervention program provides the necessary tools for the proper implementation and promotion of mathematics at kindergarten ages. Hence, due to its goal of promoting children's mathematical education by introducing mathematics to the kindergarten staff, the proposed intervention program constitutes a breakthrough in Israeli preschool mathematics education.

7. Conclusion

The literature review shows that while early childhood mathematics is perceived as simple, it lacks basic knowledge among early childhood educators, which can lead to the assimilation of mistakes in the teaching of preschool children. The literature review justifies that PPE require intensive math-teaching focused training, to promote and refine their mathematics knowledge and teaching ability. This study has an important contribution to the Israeli PPE as it advances the knowledge - base in the field of developing children's arithmetic thinking. This type of training may promote the PPE, who in turn will promote kindergarten children optimally. From the point of view of local contribution in Israel, this study will enhance both theoretical and applied knowledge of mathematics in kindergartens. Due, to its importance as a basis for studying mathematics and adapting to the student's abilities, the intervention program presented in the study can be extended to other mathematical disciplines such as geometry, in a manner that will allow the PPE to be trained on early childhood geometry as well. The intervention program may also be offered to PPE in general in kindergartens younger than age 3, as well as special education kindergartens in Israel.

References

- Ball, D., Thames, M., & Phelps, G. (2008). Content knowledge for teaching. *Journal of Teacher Education*, 59(5), 389-407.
- Barnett, W. S., & Masse, L. (2006). Early childhood education. In: A. Molnar (Eds.), *School reform proposal: The research evidence*. Greenwich, CN: Information Age Publishing.
- Baroody, A. J., Lai, M., & Mix, K. S. (2006). The development of young children's early number and operation sense and its implications for early childhood education. In B. Spodek, & O. Saracho (Eds.), *Handbook of research on the education of young children*, 2, 187-221. Mahwah, NJ: Erlbaum.
- Bronfenbrenner, Y. (1979). *The ecology of human development*. Harvard University.
- Clements, D. H., Fuson, K. C., & Sarama, J. (2017). The research-based balance in early childhood mathematics: A response to Common Core criticisms. *Early Childhood Research Quarterly*, 40(3), 150-162.
- Clements, D. H., Vinh, M., Lim, C. I., & Sarama, J. (2021). STEM for inclusive excellence and equity. *Early Education and Development*, 32(1), 148-171.
- Council of Chief State School Officers. (2010). *Common Core State Standards for Mathematics*. National Governors Association Center for Best Practices.
- Essa, E. (2002). *Introduction to Early Childhood Education* (4 ed.) New York: Thomson Delmar Learning.
- Fell, A. (2018). *Generation Alpha: Q&A with Ashley Fell*. <https://mccrindle.com.au/insights/blogarchive/generation-alpha-qanda-withashley-fell/> [Hebrew]
- Gantz Aloni, R. (2003). *The kindergarten teachers world, needs and interactions*. Tel Aviv University, School of Education. Master's thesis. [Hebrew]
- Gelman, R., & Gallistel, C. R. (1978). *The child's understanding of number*. Harvard University Press.
- Ginsburg, H. P., Lee, J. S., & Boyd, J. S. (2008). Mathematics education for young children: What it is and how to promote it. *Social Policy Report*, 12(1), 1-22.
- Ginsburg, H., & Baroody, A. (2003). TEMA-3 examiners manual. *Austin, TX: Pro-Ed*.
- Hassan, M. N., Abdullah, A. H., Ismail, N., Suhud, S. N. A., & Hamzah, M. H. (2019). Mathematics Curriculum Framework for Early Childhood Education Based on Science, Technology, Engineering and Mathematics (STEM). *International electronic journal of mathematics education*, 14(1), 15-31.

- Ilani, B. S. (2003). Towards learning the concept of number. *Strong number 2000*, 5. http://ymath.haifa.ac.il/images/stories/mispar_chazak_2000/issue5/bat_sheva_ilani.pdf [Hebrew]
- Institute of Educational Technology (2017). *Innovating Pedagogy, exploring new forms of teaching, learning and assessment, to guide educators and policy makers*. The Open University, Walton Hall, Milton Keynes, MK7 6AA, United Kingdom.
- Israeli Ministry of Education (2010). *The Israel National Preschool Mathematics Curriculum (INPMC)*. Jerusalem, Israel. Retrieved from: http://meyda.education.gov.il/files/Mazkirut_Pedagogit/Matematika/TochnitKdamYesodiHeb.pdf [Hebrew]
- Israeli Ministry of Education (2015). *The Israeli Second aid reform in kindergartens*. Jerusalem, Israel. <http://meyda.education.gov.il/files/PreSchool/HearcutAvodatTsevet.pdf> [Hebrew]
- Israeli Ministry of Education (2016). *The Israeli Outline for the professional development of Preschool para-educators*. Jerusalem, Israel. <http://meyda.education.gov.il/files/PreSchool/professional-development-outline2.pdf> [Hebrew]
- Israeli Ministry of Education and Culture, Pedagogical Director, Research and Development Division. (2018). *Future-oriented pedagogy 2- Trends, principles, implications and applications*. Jerusalem: Ministry of Education. https://meyda.education.gov.il/files/Nisuyim/eng_fop2summary.pdf [Hebrew]
- Israeli Ministry of Education, department of Preschool Education (2010). Educational activities in the kindergarten, guidelines for the educational staff. Jerusalem, Israel. [Hebrew]
- Israeli Ministry of Education. (2020). *Future-Oriented Pedagogy, Running Tracks*. Pedagogical Director, Research and Development Division, Experiments and Initiatives, Israel. [Hebrew]
- Knesset, Research and Information Center (2017). *Basic requirements in the training of staff engaged in early childhood education in Israel*. Jerusalem, Israel. <https://main.knesset.gov.il/Activity/Info/mmm/Pages/default.aspx> [Hebrew]
- Li, X. (2020). Investigating US Preschool Teachers' Math Teaching Knowledge in Counting and Numbers. *Early Education and Development*, 1-19.
- Markovich, Z. (2019). *Early Childhood Mathematical Thinking: A book for educational practitioners and parents*. Tel Aviv: Mofet Institute. [Hebrew]
- National Council of Teachers of Mathematics (2000). *Principles and standards for school mathematics*. Reston, VA: Author.
- National Research Council. (2009). *Mathematics learning in early childhood: Paths toward excellence and equity*. National Academy Press.
- National Research Council. (2011). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. National Academies Press.
- NCTM (2002, updated in 2010). Position Statement: Early childhood mathematics: Promoting good beginnings. *A joint position statement of the National Association for the Education of Young Children (NAEYC) and the National Council for Teachers of Mathematics (NCTM)*.
- OECD. (2018). *The Future of Education and Skills, education 2030*. Retrieved from: [https://www.oecd.org/education/2030/E2030%20Position%20Paper%20\(05.04.2018\).pdf](https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf)
- Omidyar Network. (2019). *Big Ideas, Little Learners: Early Childhood Trends Report*. Retrieved from: <https://omidyar.com/big-ideas-little-learners-early-childhood-trends-report/>
- Purpura, D. J., & Reid, E. E. (2016). Mathematics and language: Individual and group differences in mathematical language skills in young children. *Early Childhood Research Quarterly*, 36, 259-268.
- Sarama, J., & Clements, D. H. (2009b). *Early childhood mathematics education research: Learning trajectories for young children*. Routledge.
- Shane, R. (1999). Making Connections: A Number Curriculum for Preschoolers. In NCTM (Eds.), *Mathematics in the Early Years*, (pp. 129-135). NCTM.
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4-14.

- Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57, 1-22.
- Tight, M. (2003). *Key Concepts in Adult Education and Training*. Routledge.
- Uclés, R. R., Brizuela, B. M., & Blanton, M. (2020). Kindergarten and First-Grade Students' Understandings and Representations of Arithmetic Properties. *Early Childhood Education Journal*, 1-12.
- Uscianowski, C., Almeda, M. V., & Ginsburg, H. P. (2020). Differences in the complexity of math and literacy questions parents pose during storybook reading. *Early Childhood Research Quarterly*, 50(3), 40-50.
- Vygotsky, L. S. (1978). *Mind in Society – The Development of Higher Psychological Processes*. Harvard University Press.
- Vygotsky, L. S. (1994). *Thought and Language*. M.I.T. Press.