

# Mathematics in Early Childhood Education: Awareness, Perspectives, Knowledge

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## Research Article

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# Abstract

This qualitative study investigates the awareness of preschool teachers regarding the importance of mathematics education. The study also examines their knowledge and perspectives on an effective early years math curriculum and pedagogy using a qualitative case study approach. The study sample included 27 teachers at preschools located in the southeast region of Turkey. Semi-structured interviews were conducted to obtain the required data. The interviews were audio-recorded and subsequently transcribed into full text in Turkish, with selected quotes being translated into English. The collated data were analyzed using an emergent coding approach. The teachers believed that providing a solid mathematical foundation in early childhood increases students' engagement in future mathematics courses. However, in the absence of a formal early years mathematics curriculum, the findings indicate that early years teachers require pedagogical knowledge and a relevant curriculum to teach young children mathematics. This is necessary for the development of children's mathematical thinking and to broaden children's understanding as to how they can improve their strategies for using math knowledge to solve problems.

## Introduction

Early childhood is a highly formative period in a child's life and mathematics education is crucial for enabling a child's later academic attainment to reflect their creative, critical, and analytical skills in school. Mathematics has historically been considered inappropriate for early years education. Preschoolers have been viewed as cognitively inept in relation to mathematical thinking and in their ability to learn mathematics purposefully in pre-school (Ginsburg, 2009). Thus, formal mathematics instruction has typically been postponed until first grade (Starkey et al., 2004). However, with the onset of the 21st century, there has been a shift towards generating persuasive proof that children have a significant level of mathematical competence from birth, and the cognitive development of children in early childhood education determines their capacity for abstraction (Alsina & Salgado, 2021). The focus of developmental psychologists has dramatically moved from what young children cannot do to what they can do (Hachey, 2013). Accordingly, contemporary research on early childhood mathematics tends to center on children from birth until they begin primary school (Björklund et al., 2020). Psychologists' attitudes toward teaching children mathematics have changed and they have started to design new pathways specifically for the improvement of mathematical knowledge from birth (Sarama & Clements, 2009).

International attention in early childhood mathematics education has increased progressively in recent years (Tsamir et al., 2011) and it is now described as being important for overcoming mathematical illiteracy (Clements & Sarama, 2013) and for meeting the requirements of a knowledge-based society. This consensus on the significance of mathematics education emphasizes that teaching math in early childhood has comprehensive advantages for children in both the short- and long-term at school. A quality mathematics education is important for early years children because it is the strongest predictor of mathematics achievement later in life (Simoncini et al., 2020; Watts et al., 2018). Arguably, one of the

key determinants of children's achievement is early math skills and mathematical literacy. Obtaining mathematical skills at an early age can increase the level of school accomplishment (Anders & Rossbach, 2015) and enhance career opportunities in adulthood (Lee, 2017). Thus, developing children's mathematical abilities at an early age is crucial for building long-term success in school (Watts et al., 2014). Furthermore, it has been discovered that children who experience quality education throughout the early years period acquire significantly better outcomes in international tests, such as PISA and PIRLS (Alsina & Berciano, 2020).

Mathematics education in preschools requires teachers' awareness, pedagogies, and approaches to enhance their teaching (Murphy et al., 2019; MacDonald et al., 2018). Sound pedagogical content knowledge (Aldemir & Kermani, 2017) is one of the key foundations of effective mathematics teaching in preschool. Teachers are required to possess a perspective on early childhood mathematics, an awareness of young children's needs, curiosity, ability, creativity, critical thinking, problem-solving skills and understanding, and an in-depth knowledge to align daily activities with curriculum objectives and contemporary teaching methods (Wood & Hedges, 2016). Pedagogical knowledge includes up-to-date information on math content, concepts, pedagogy, and the instructional strategies and methods used to teach the subject in the classroom. Accordingly, pedagogical content knowledge is vital for helping a child to develop an interest in the learning process and for turning high-level instructional strategies into learner comprehension (Bose & Bäckman, 2020).

Considering preschool teachers' awareness and approaches alongside their knowledge of pedagogy regarding mathematics are crucial because they influence the learning acquisition process. Teachers need to be aware of the learning possibilities, curriculum, and limitations of the environment so that they can provide appropriate activities and materials to their students and accommodate the diversity of ways to convey understanding. (Björklund & Barendregt, 2016). Herein, recognizing the surrounding learning situation help preschool teachers analyze it so that children can explore and interact to acquire knowledge and skills (Costa, 2021). Hence, the knowledge of teachers on the curriculum, their backgrounds, approaches and perspectives all contribute to the mathematics activities in practice and the building of a foundation for young children's learning experiences (Piasta et al., 2014).

Although there are a number of recent studies relating to preschool educators' pedagogical knowledge, perceptions, attitudes, perspectives, and awareness of teaching mathematics in the international literature (Gasteiger et al. 2020; Björklund et al., 2020; Sumpter, 2020), no studies have been conducted in Turkey (Ata-Akaturk & Demircan 2021; Yildirim 2021; Karademir, et al., 2020) in this area. Significantly, Turkey has considerably low mathematics outcomes in national exams, including the high school exam (LGS), the university entrance exam (TYT-AYT), and in international tests such as the PISA and PIRLS. The average number of accurate answers in the 20-question math test of the students in the LGS is 4.20 out of 20; the average number of accurate answers in the 40-question math test of students in the TYT, and the AYT is 5.54 and 5.20 out of 40, respectively (OSYM, 2021). Turkey is below the OECD average in mathematics outcomes, and PISA results show that Turkey was ranked 42nd in mathematics out of 79 OECD countries (PISA, 2018). Since mathematics achievement in the early years is the strongest indicator

of later success in mathematics, and early math skills facilitate children's future mathematical skills acquisition, this research can be used to support preschool teachers' knowledge and awareness in order to create a more effective learning process for young children. Additionally, it can shed light on the underlying causes of failure in mathematics in underdeveloped and developing countries, such as Turkey, where there is a low level of mathematics achievement in international tests, including PISA and TIMMS, and it can contribute to the body of research on early childhood mathematics by identifying any shortcomings in the literature. Therefore, the purpose of this study is to scrutinize the perspectives of preschool teachers in Turkey, to manifest their awareness of mathematics education and its importance, and to identify their mathematical pedagogical knowledge and their knowledge of the current math curriculum. The key research questions that were addressed in this study are:

1. What are the perceptions and level of awareness of early childhood teachers regarding mathematics education in a preschool setting?
2. What are the teachers' current approaches to mathematics instruction for preschoolers?
3. What are the perspectives of preschool teachers on the extant curriculum and pedagogical knowledge concerning mathematics schooling?

## Method

### Research Design

A qualitative case study approach was used in this study. The case study method is naturalistic, richly descriptive, exploratory, reflective, interpretive, and inductive (Rossman & Rallis, 2017). This approach suited this study because of its focus on a single unit, its restricted milieu and discipline, and because it seeks to understand the phenomena through the interpretation of the experiences and realities from the subject's perspective (Meriam & Tisdell, 2016).

#### Participants

Participants were recruited using maximal variation sampling, which is a purposeful sampling method. When using maximal sampling, a researcher selects a small number of units sample that differs in one characteristic of a qualitative research (e.g., socioeconomic status) (Creswell, 2017). Accordingly, this study was conducted in six state preschools located in the southeast region of Turkey. The study group consisted of 42 teachers working at the preschools. The sampling process included four stages: (a) the researcher was only allowed by the city council department of education to collect data from teachers in 12 schools, of which only two schools were located in low income areas; (b) the 42 teachers were asked if they were willing to voluntarily participate in the research; (c) 34 agreed to participate in the study, and (d) seven withdrew before the start of the study for personal reasons. 27 (22 females and 5 male) participants were included in the sample, and they were then categorized into groups based on their school's socio-economic mix of students: high, medium, and low socio-economic status on the basis of the council definitions for high, medium, and low. The teachers' responses were then manually coded based on high (Teacher 1 [T1] through T9), medium (T10 through T18), and low (T19 through T27)

student socio-economic status. Six of the 12 schools had to be selected from diverse environments because there were only two low-income schools in the sample of 12, meaning only two could be included from high-mid-low-income schools. The aim of selecting such a sample was to maximize the diversity relevant to the research question to provide in-depth and detailed information on how a phenomenon is comprehended by different people in different settings. It was not permissible to request teachers' demographic information, but all participants were of a majority (Turkish) ethnic background.

## **Data Sources and Collection**

A review of the literature was conducted to generate the initial set of questions for the semi-structured interview schedule to determine the perspectives, perceptions, awareness, and approaches of preschool teachers on mathematics education. Relevant early childhood mathematics study results were then analyzed to inform useful points of enquiry for the interview. An original 15-question pool was thus composed according to the findings of the previous studies. The views of qualitative interview experts in educational studies from a state university in Turkey and the U.S. were sought to assess the draft interview schedule in terms of content, clarity, and suitability for sampling prior to the onset of data collection. Furthermore, the semi-structured interview questions were evaluated for grammatical structure and clarity by three teachers who specialize in the Turkish language to ensure that the questions would be clearly understood by the potential respondents. The questions were piloted with volunteer teachers in a school to improve the clarity and usability and were then adjusted accordingly. A total of 10 questions comprised the final interview schedule.

The semi-structured interviews were conducted with the participants to reveal their perspectives, perceptions and awareness of mathematics education, pedagogical knowledge, and the significance of familiarizing young children with mathematics at an early age as a foundation for future success. The researcher allowed for adjustments to be made to the questions during the discussion to provide flexibility for interviewees. The interviews were conducted by the researcher in 35 to 45 min sessions, all of which were audio recorded and later transcribed.

## **Data Analysis and Coding Procedure**

Teachers' responses were anonymised to ensure the confidentiality of the participants. The data collected from the interviews were analyzed and coded, resulting in the development of recurring categories. This approach allows the codes to emerge from the data analysis because it assumes that coding and recognising concepts and themes are parts of one integrated process. It is also beneficial in designing detailed descriptions for this case study.

Three completed interview documents from the set of data were selected at random and coded inductively by each of the three researchers to develop, revise, and refine an initial qualitative codebook. The creation of the codebook provides inter-coder agreement between coders to compare their work to the established valid codes and sub-codes so that the researcher is able consistently analyze the remaining semi-structured documents for consistency and validity in the analysis. Hence, I applied then these codes

to all remaining interviews, while still observing for any additional emerging codes. I clustered the codes by common ideas to create categories after the initial coding. Then, I represented the case data using narrative descriptions, including “detailed discussion of several themes with subthemes, specific illustrations, and multiple perspectives from individuals, and quotations that provided a more profound understanding of the previously collected inquiry data” (Creswell & Creswell 2017, p. 194).

## Results

The participants of the semi-structured interviews were asked several questions to determine their awareness, perspectives, and knowledge of mathematics education for preschoolers. They were also asked additional questions which probed more deeply into the following topics: the activities they use to simplify and support young students' math learning and for conducting effective mathematics instruction; the adequacy of the curriculum and how to reach a decision on what they teach; the quality of training they received and its impact on their practice; and their views on how the acquisition of mathematics skills at kindergarten age affects children's future lives. The responses were coded into multiple categories falling under the general heading of teacher awareness and approaches to appropriate mathematics education, and to curriculum and pedagogy. Within these major categories, multiple subcategories emerged, including the appropriate age for mathematics teaching, the necessity of mathematics training, influence on students' future success, effective approaches to mathematics education, novelties implemented in relation to existing approaches, the adequacy of the curriculum, and the quality of mathematics teacher training in early childhood departments.

### Teacher Awareness of the Importance of Early Mathematics Education

Each semi-structured interview participant was asked to share their perceptions of their awareness of preschool mathematics. Responses were coded as “appropriate age range,” “necessity of mathematics training,” “influence on student's future success,” and “effective mathematics education.”

#### Appropriate Age Range

Regarding the appropriate age range, the majority of participants indicated that mathematics education should begin from birth, when a child begins to become independent and recognizes their milieu. Many things in their environment, such as shapes, objects, and concepts have mathematical features. In this way, a child already starts learning mathematics as soon as they notice and perceive their surroundings. One interviewee reflected these perceptions indicating:

A child gets into mathematics viewing her/his mum's face, shapes around as soon as s/he is born... Mathematics is already in their life with money, numbers, shapes, and objects. In the simplest way, you say to your daughter, ‘My darling, bring me a fork’. You have one fork, two napkins. It's been there since she is little. Mathematics is in our life, whether we want it or not. For example, when you go to a grocery store, and you see your parent exchanging money, there is a concept of quantity, grouping, matching, in a way. It is not limited to a certain age; it has already existed since a child was born. (T27)

Some of the interviewees stated that they had positive reactions to teaching children mathematics at kindergarten age, considering their understanding of the children and the level of the children's readiness. A few of the interviewees claimed that it is appropriate to teach children math before preschool to help them to explore the world and to understand their life. They also highlighted that child become conscious, aware of objects, comprehend and count numbers at the ages of two and three. Mathematics appears in all realms of their life, and therefore math skills can be strengthened at that age. However, only one of the interviewees was skeptical about the appropriate age range for mathematics schooling. The following quote articulates this point:

Some research is needed to determine the age range. I would like to say 5 years old is a proper age, but I don't have any data. How can I come to such a conclusion? This needs research and I can say something accordingly. Research says age 0, right? (T1)

### **The Need for Mathematics Training**

Nearly all of the participants stated that mathematics education is required to help young children to develop their mathematical thinking, to improve their practical intelligence and problem-solving, and to support them for learning in their daily life. Early mathematics teaching enables them to think actively, to be ready for primary school, and ensures success in many parts of their life. Mathematics is in all aspects of our lives, and it is therefore crucial to expose children to it at early age because it gives meaning to their lives. The following one quote exemplifies the opinion shared on this matter:

I like math, so I strongly champion math for preschoolers as I am thinking of making children's lives easier. We can prepare them seriously for the future by developing a positive attitude towards math, by questioning the causes of an event, by correlating between reasons and results, by synthesizing, in particular, by improving problem-solving skills. We can do all of them with math. Math means neither teaching shapes, concepts nor adding, subtraction with numeric things. Math is embedded in all parts of a child's world. (T18)

Of course, not all participants shared these values. The remaining participants were concerned about the need for mathematics at preschool due to a lack of information and feelings of inadequacy. They suggested that they should be adequately supported for implementing math education. One of the participants felt that he did not know how to teach math, because

There is no clear instruction about what to teach and how to teach math. I do not feel educated enough to teach young students math. I am confused because there is nothing to support us, and so we cannot teach students math properly. We therefore do not feel qualified to teach mathematics. (T1)

### **Influence on Students' Future Success**

Nearly all of the participants had positive views about teaching math at an early age due to its contribution to children's attainment in later academic life. They also reported that mathematics directly improves preschoolers' problem-solving abilities, as well as the fact that it enables them think logically.

Some participants reported that children experienced an increase in their mental skills and acquired distinct ideas. Views of one participant about the impact of mathematics on students' future success included:

Math affects students' future lives in school. Math is life itself. When a child learns math, she learns about life. A child who is successful in mathematics is successful in Turkish, science subjects, and she also comprehends well what she reads. Therefore, if we can properly educate our students on math and make students love math, get a child to grasp it, in particular, to grasp the object-quantity relationship and put it in practice, I believe a child can be successful in all phases of their academic life. (T11)

In the same vein, another participant emphasized a significant difference between a child obtaining a mathematics education and one not obtaining it:

One who has a solid foundation in math can solve problems, think logically, and understand more easily. However, another child who does not have a math foundation cannot easily respond and has a limited problem-solving ability. If math is ably founded, it could be an interaction between logical thinking and mathematical intelligence. (T3)

Other comments included that learning math at an early age helps students to gain a new perspective, familiarizes them with math, enhances their sense of curiosity, creates awareness, teaches them life skills and increases students' engagement in future math courses. However, not all participants shared similar sentiments. A few stated that their teaching of math in kindergarten may affect children negatively because they did not feel competent in teaching math and did not have the correct skills for math schooling. The reason for this was they were professionally educated only for preschool activities, but not educated in mathematics. One participant, who did not feel efficiently equipped, commented:

Not sure how I could teach kids math? The math curriculum of early childhood and primary school is substantially different. If I teach kids math, then a primary school teacher will teach them math in a different way. Herein the kids may stumble. My teaching style may harm their learning due to my lack of knowledge and not using effective methods. The kids may become stuck because of my methods of teaching mathematics schooling in primary school. (T17)

## **Effective Teaching Mathematics**

In order to provide effective math teaching in kindergarten, the majority of participants indicated that student preschool teachers should be skillfully educated at universities. Preschool teachers also should be supported with current knowledge in the field, provided with new knowledge through supportive courses and seminars, and provided with continuing professional development. In addition, a mathematics curriculum may help teachers to develop their self-confidence, to gain a new perspective, to create original ideas for teaching, and to focus on their work positively. Moreover, learning about the results of relevant research can be beneficial for implementing effective mathematics schooling. The following quote exemplifies some of the opinions shared on this matter:



Starting to handle the issue at universities is crucial for teaching preschoolers' math properly. There are math lectures at universities, but they are not effective on leading us how to teach kids math. The responsibilities of the professors are to educate student teachers according to expectations and the curriculum. If this is not realized, some math experts should organize seminars or courses to support current teachers about how kids can be taught math in an effective way according to their level. This should not be difficult, but it is not performed in reality (T12)

Another participant indicated that the advantages of receiving expert guidance on mathematics is to gain a better understanding of the teaching process, new perspectives on the teaching methods, and consistency in teaching. This interviewee declared:

Knowing what to do requires guiding us about what and when we can teach. How much can we teach? We need to be guided in a timely way to progress professionally. The guidance is essential because every teacher educates kids using different methods, which does not work at all. Teaching math is likely to be effective only if it is conducted with a certain organization and system. This can be great for both us and the kids. (T15)

Participants' further comments also indicate that this kind of math curriculum may work efficiently if it opportunities are given for improving materials, for creating an environment for learning through experience, and for creating activity materials to develop children's mathematical thinking. In addition to this, teachers' self-development can only be realized by designing a mathematics curriculum in collaboration with teachers and if good teaching conditions are ensured.

### **Approaches to Proper Mathematics Training**

The interview participants were asked several questions relating to their approaches to what they considered to be proper mathematics training for preschoolers. They were also asked additional questions which probed more deeply into additional mathematics schooling practices. The data were coded under the general heading of teacher approaches to proper mathematics as "Proper Mathematics Schooling Practices", and "Novelties in Teaching Mathematics".

### **Proper Mathematics Schooling Practice**

In terms of age-appropriate mathematics teaching, most of the participants reported that they teach counting using concrete objects and then figures. They then teach additional numbers and connections between the numbers and objects. This is followed by math signs, including addition and subtraction. They also employ suitable materials for teaching appropriate math. One of the participants commented:

I use a variety of materials for teaching math. First, number recognition and showing the connection between objects and quantity of numbers. Then, I do activities. For that, there are various materials, such as clothespins, straws, blocks, dough. The use of materials is truly advantageous for learning math because young children enjoy doing math while studying. When they find out this is math, their affection for math increases. (T9)

In reference to conducting age-appropriate math schooling, some participants concluded that teaching math concretely involved playing games, counting numbers with concepts whilst considering the students' needs, and familiarizing them with math at an early age to help to build their readiness levels. Play in particular increases students' self-confidence so that they feel prepared to move into elementary mathematics education. One of the participants shared the following:

An effective way of learning at preschool is playing a game. That is, it is the foundation of teaching. All instruction is realized via playing... The reason is to recognize students to teach them in an appropriate way. Everything starts with getting to know children. (T13)

A minority of participants also expressed the importance of learning math through multiple experiences, such as listing numbers in order, teaching through singing a song, and establishing a connection with numbers.

### **Novelties in Teaching Mathematics**

The majority of the interviewees reported that mathematics helps learners to use their knowledge to think independently, to establish new connections between concepts and ideas, and to build related strategies in their own unique way. Hence, the use of relevant novelties such as materials, websites, and cartoons on the internet should be pursued for teaching math. Children are now raised with digital technologies, meaning teachers are expected to use any apps related to math activities for improving children's math skills because young children can easily learn math at a remarkable rate using online applications. One of the participants declared the significance of using digital media for teaching math:

Media and internet appeals to five senses, and I benefit from the use of media. The digital tools provide great facilities for schooling, and it makes teaching math not complicated. The tools are influential if they are used for math. We have to dispose of old-fashioned teaching methods in this digital age. We can teach children in the way of cartoons, sing a song, etc. A teacher consistently should improve himself, and explore the new innovative methods and materials in teaching math to prepare young students for the 21st century. If teachers want to be satisfied with their profession, they also should be receptive and follow the innovations. (T24)

The findings highlighted that some of the participants make use of relevant research on math, and some use effective overseas math websites; similarly, a few of them pursue the method of teaching through drama-style play, brainstorming, and utilizing computer games for teaching math. Multi-sensory, fun activities embed visual, auditory material into the learning process, appeal to all the senses and enable teaching at the highest level to attain students' math goals. Notably, one of the participants who follows innovations closely highlighted the importance of p-smart training which helps children to find an object in space.

### **Curriculum and Pedagogy**

Participants' perspectives on the curriculum and preschool teacher education regarding mathematics were categorized in the data analysis in relation to the "adequacy of the curriculum", and the "quality of the training received". They were also asked additional questions which probed more deeply into the existing curriculum and teacher education at their university to explore the impacts of these on mathematics practices in preschools.

### **Adequacy of the Curriculum**

Nearly all of the interviewees complained they did not have an adequate curriculum. They indicated that a leading curriculum is significant for increasing children's math success in later life, because high-quality preschool curriculums could assist children's achievement and ready them for their future academic life. However, they stated that they taught math according to their experience, instead of taking advantage of the curriculum. Thus, they felt alone in teaching children. Perceptions of one participant about the disadvantages of lacking an adequate curriculum included:

The curriculum has suitable content for teaching, but not for teaching mathematics. It is not useful, so we do not teach students math according to any criteria based on a proper curriculum. Instead, we reveal teaching math enabling the students to live in a certain way based on our experience. Sometimes, math instruction appears accidentally; sometimes systematically as a training opportunity as planned and structured within the day. Curriculum standards are only given to us; however, it does not provide any planned activities, it is only instructive. Thus, I am planning all teaching activities myself relying on my background. (T10)

In opposition to the majority, a few participants claimed that a detailed curriculum does not exist, however, curriculum standards, including ranking, matching, connecting between objects and amounts are used. These enable them to specify students' needs and expectations in an age-appropriate way, meaning that maths pedagogy is entirely dependent on the teacher. One of the participants shared their opinion on this matter:

The acquisition standard leads us to conduct teaching math properly. Reaching the standard is under the control of the teacher because things to be conducted are given in general terms. It helps us to arrange teaching and relevant activities in the best order. Herein, it has a significant foundation because it is a main part of the curriculum. It can be improved according to your perspective and children's readiness, although it is not planned like primary schools' curriculum. (T14)

The interviewees were also asked why they thought the curriculum was inadequate. Nearly all of the participants who considered the curriculum insufficient made it clear why it was inadequate when they elaborated on their own experiences; there was no appropriate material available in it, there was no instructive information to learn, and no instruction on how to use teaching methods in the curriculum. In contrast to the majority, the very few participants who thought the curriculum was sufficient claimed that the curriculum expectations were clear, the content was provided, and the school facilities were useful.

## Quality of Professional Training Received

Conspicuously, both educated and non-educated teachers of math emphasized that they feel ill-prepared to engage preschoolers with math. While some participants who had received an adequate education expressed that they were educated by instructors whose expertise was neither in early childhood mathematics nor school more generally, most of participants receiving math instruction at the faculty highlighted that the math education they received is inadequate because it was focused on abstract mathematics. It was not practice-oriented, meaning it did not include any teaching methods, practice, or material. In other words, it was not related to early childhood, and was focused on memorizing terminology, taking an exam, and graduating. For example, one of the participants stated:

I did not acquire any math training, namely, no math education at the department, so no lecture was suitable for learning about teaching math. Therefore, it put me in trouble about teaching math practically in my classroom. We are not able to implement math education and do not know how to teach kids math although it is an element of the school program. The title of the content is in the curriculum, however, teachers have no pedagogy about how much of it should be transmitted. To be honest, they are not aware of math. That is the topic which needs to be focused on, but no one does anything although the willingness of teachers is remarkable. (T1)

Regarding the impacts of mathematics training practices in the classroom, all of the participants were unsure whether their maths education affected their teaching positively or negatively. Few participants reported that they had been positively impressed by their math education or that they never encountered challenges during teaching their students math because of their math education being well organized at the university. One of the participants appreciated obtaining a math lecture at their university, and they described their happiness at demonstrating their teaching abilities in the classroom. One of the participants shared her opinion on this matter:

I took a sufficient math lecture at the university, and I was really satisfied with it. I was doing an internship at one of the schools at that time, and I also could perform everything that I learned in math in the internship at the same time. The lecture had an impact on the activities I taught in school. Thus, I am able to use my knowledge in teaching math in my classroom. (T23)

When discussing the negative effect of a lack of math teacher education at universities, the other participants articulated concerns about their practice. They felt they were not supported regarding what can be taught, how can it be transmitted, and how students can be instructed according to their level, and that 'fish rot from the head down'.

In the context of the participants' views and comments regarding math curriculum and the knowledge gained on mathematics at universities, it can be ascertained that preschool mathematics teaching may be improved if mathematics education were better organized at universities, if a sufficient curriculum were to be provided, and if teachers were better supported.

## Discussion

This research provided insights into a sample of Turkish preschool teachers' pedagogical knowledge, awareness of mathematics education, and views on the adequacy of the curriculum. This basis was used to discuss directions for Turkish teacher education and ways to increase teachers' skills for teaching young children mathematics, according to 21st century requirements.

Participants felt that early ages are a productive and appropriate time to educate children in math. Most of the participants argued that the best time for young children to learn mathematics begins from birth because children are capable of engaging in mathematical thinking. Consistent with these views, Björklund et al. (2020) have outlined that the current early mathematics research has centered on children from birth until they start primary school. Clements and Srama (2013) highlighted that international curricula reflect the understanding that children gain mathematic knowledge from birth. While one participant had concerns about the age range for teaching math, all other participants stated that young children have a good deal of mathematical competence for math schooling, with one stating: "mathematics education definitely must be given from an early age because math is all around us. If we start to teach children math at age 4, we can contribute to their life" (T22). Indeed, children at early years have substantial skills and remarkable capacities for learning mathematics (Presser et al., 2015).

In terms of the need for mathematics education and implementing it according to the level of the children in question, the participants suggested that mathematics constitutes a significant part of young children's daily life in thought and action alongside buying, selling, describing, and asking. Children start understanding and describing shapes and spaces and using such mathematical concepts before they even learn how to sit and speak. Thus, mathematics education is fundamental for early years children to improve their mathematical thinking, to gain essential abilities, and to engage them with social life. Children can only be prepared to move into their later academic life by learning simple skills. These include numbers and the connections between them, symbols, concepts, and math signs, such as adding and subtracting, through creating learning environments using play because "the way of learning at early childhood is to play. Play is fundamental and it means everything for children, and we can only teach preschoolers through play" (T13). Generally speaking, play is a common way of creating learning situations in preschools, meaning that teaching in early childhood is generally realized in the form of play (Vogt et al., 2018; Fleeer, 2015). Researchers have shown that preschoolers in general become interested in mathematical thinking and problem solving when they are taught with play (Brandt, 2013; Vogel, 2013). Herein, it is important to note that preschool teachers play a critical role in providing appropriate learning opportunities through play to explore mathematics (MacDonald & Murphy, 2021). In addition, Lee (2017) found that the more the teacher is acquainted with math activities through children's play, the more opportunities can be provided to induce children's mathematical thinking. Therefore, the use of a play-based approach in the learning process is a crucial way in which young children can be prepared for their future education (Cui, et. al., 2021; Campbell et al., 2018).

This study indicates that preschool teachers need a detailed curriculum to support and guide children in their math learning using various strategies. An effective curriculum may facilitate teachers to create a learning environment, demonstrate their innovative ideas, improve their insights, and develop their self-confidence, as well as to positively enhance their teaching. These points are corroborated by Bose and Backman (2020), who found that math curriculum is important for supporting teachers to gain knowledge and skills to create rich and relevant math teaching content. Campbell et al. (2018), Vogt et al. (2018), and Fleeer (2015) found that a sufficient curriculum is required to provide a learning environment for improving young children's mathematics competencies, for helping them to discover their learning capabilities and to understand how they learn. Similarly, Wood and Hedges (2016) argued that a curriculum enables a milieu to facilitate and extend children's learning. However, a few participants in this study noted that, although an adequate curriculum helps children to have a greater readiness and increases their success in future education, they still teach mathematics by using their own experience because "training at universities is not enough and the curriculum does not overlap with math" T (12).

All participants agreed that their competence and pedagogical knowledge in teaching mathematics and implementing relevant activities is rather low due to shortcomings in high-quality education at universities, curricula, and expert support. Preschool math teaching requires an in-depth pedagogical knowledge, an awareness of mathematics on a daily basis, and the creation of learning opportunities to promote children's mathematical thinking and conceptual development. Bjorklund and Barendregt (2016) revealed that teachers' mathematical pedagogical knowledge and their mathematical awareness are prerequisites for effectively encouraging children to explore mathematical phenomena in everyday situations and to enhance their conceptual development. Keuch and Brandt (2020), and Bruns et al. (2020) have also discovered that teachers' pedagogical knowledge of mathematics affects their readiness to use the content to facilitate children's mathematical learning. Mathematics instruction requires teachers with proficiencies and knowledge that differ from abilities needed in other subjects (Gasteiger et al., 2020). In other words, strong teacher mathematical pedagogical knowledge ensures high-quality education for children during the early ages period (Macdonald et al., 2018), considering the need for improvement regarding quality and differentiation. Hence, pedagogical content knowledge is critical for providing high-quality mathematics teaching, for sustaining children's thinking on maths in their daily activities, for building children's academic trajectories, and for creating potent strategies for solving problems themselves during their lives.

All teachers were unanimous in the beliefs that the acquisition of math skills during early years establishes an infrastructure for their later school years. Educators should focus on teaching math skills in early childhood because "math education is crucial for advancing the capacities of a child at an early age, and so the more that children are taught math at that age, the more likely they will be successful in school and the learning can be permanent" (T26). Teachers' views here echo the research which has revealed that early mathematics skills are the strongest predictor of later achievement in school (Simoncini et al., 2020; Watts et al., 2018; Bjorklund & Barendregt, 2016), and that acquiring early abilities forms part of math learning much later on (Bjorklund et al., 2020). Similarly, Anders and Rossbach (2015) highlighted the significance of quality mathematics training being given in early childhood as it lays the

foundations of accomplished math experiences through school. In addition, (Department of Education, Employment and Workplace Relations (DEEWR), 2009) indicated that positive attitudes and competencies in mathematics are essential for children's successful learning. The foundations for these competencies are built in early childhood (p. 38). Siraj-Blatchford (2019) also found that the quality of pedagogical experiences during a child's early years has a lasting influence on preschoolers' later success. Accordingly, Moss et al. (2016) reported that "high-quality maths learning opportunities before formal schooling are crucial" (p. 153). Shortcomings in mathematical knowledge and skills in the early years cause weak mathematics performance in children's future accomplishments in school (Salomonsen & Reikerås, 2019).

The scope of this study is to qualitatively investigate preschool teachers' awareness of early years mathematical education acquisition and to explore the teachers' pedagogical knowledge on mathematic schooling and curriculum practices. Similar studies could be conducted in different regions in Turkey to support the generalization of the results, and studies of student teachers which explore the quality of mathematics instruction they received at their universities could also be conducted. I, therefore, recommend that future research on the improvement of math schooling pays attention to these matters to develop a strong knowledge base in this field. I also suggest examining preschool teachers' perceptions of self-efficacy related to teaching young children math in school. Naturally, this research is not worldwide, but these attempts would broaden the scope of the present study and would illuminate more potential studies for the development of mathematics education in early childhood around the globe.

## **Study Limitations**

This paper presents a descriptive and reflective qualitative case study, and therefore the findings should be considered with these limitations in mind. Additionally, the study was limited to 27 preschool teachers that were included in the study samples on a voluntary basis in Turkey. Nevertheless, the findings give a flavour of the current views and needs of Turkish preschool educators regarding early years mathematics education. The rich descriptions of the mathematics context in preschools may enable readers to relate the findings of this research to their specific cases, even though the generalization of the results may not be possible due to the nature of the exploratory study. Researchers who undertake similar research in the future can perhaps conduct research with teachers in distinct territories of Turkey or their countries to further contribute positively to improving early childhood mathematics education.

## **Declarations**

Competing interests: "No potential conflicts of interest were reported by the author"

A statement on participant consent: Verbal informed consent was obtained from the participants prior to the interview.

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