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Teaching Mathematics in Early Childhood Classrooms: From Beginning to End

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This qualitative study explores the intentional mathematics teaching practices of early childhood educators in Türkiye, focusing on the planning, implementation, and assessment phases of math instruction in preschool settings. Employing a transcendental phenomenological design, the research involved focus group discussions with twenty early childhood teachers from public schools in the eastern region of Türkiye. Data analysis revealed significant insights into how teachers conceptualize and deliver mathematics education. Findings indicate that although educators prioritized number-related concepts, they displayed limited integration of diverse mathematical domains, including measurement and data analysis and probability. Additionally, they often preferred whole-group instruction over authentic small-group or individualized approaches. Early childhood teachers also recognized the importance of developmental appropriateness, gamification, and the use of concrete materials. Furthermore, while educators utilized various attention-grabbing and participatory strategies, including storytelling, humor, and technology, the majority relied heavily on teacher-centered methods. Assessment practices were also found to be inconsistent and predominantly summative, lacking the frequency and formative depth necessary for supporting differentiated instruction. The study emphasizes the need for robust professional development, curriculum alignment, and policy interventions that support holistic, inclusive, and developmentally responsive mathematics teaching in early childhood education. Ultimately, fostering intentional, child-centered approaches to mathematics may enhance young learners' cognitive engagement and long-term academic outcomes.

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Introduction

The first eight years of life are the early childhood period, during which the child's cognitive, linguistic, social, emotional, and motor development is the fastest and most critical. Early childhood lays the foundation for developing learning experiences, thinking, and questioning skills, which in turn increase productivity in the child's later years (Tunçeli & Zembat, 2017). Early childhood education, often viewed as a precursor to primary education, has a lasting impact on the later stages of life. In particular, the mathematical knowledge and skills that individuals need throughout their lives are based on early childhood education (Akman, 2002; Clements & Sarama, 2009; Papadakis et al., 2017; Watts et al., 2014). Moreover, previous studies revealed that early mathematical knowledge and skills are a strong contributor to academic achievement in later years (Aunio & Niemivirta, 2010; Aunio et al., 2008; Bailey et al., 2014; Claessens & Engel, 2013; Jordan et al., 2009; Nguyen et al., 2016; Ramani, 2017; Purpura et al., 2017; Ryoo, 2014; Ten Braak et al., 2022; Watts et al., 2014). Additionally, they enhance career prospects, leading to a more financially stable life (Platas, 2016). Thus, quality mathematics education in the early years is a crucial topic that should begin in the early years (Gasteiger & Benz, 2018).

Children have an intense interest in learning mathematics from an early age (Clements & Sarama, 2021) and possess the potential to develop mathematical thinking skills due to their natural and strong aptitude for mathematics (Greenes et al., 2004). Well-designed and developmentally appropriate mathematics activities can enhance children's existing mathematical understanding and address any misconceptions they may have (Baroody & Sarama, 2013; Clements & Sarama, 2009; Copple & Bredekamp, 2009; Deng et al., 2023; Lewis Presser et al., 2015; Zhu et al., 2021). Specifically, the National Association for the Education of Young Children (NAEYC) emphasizes the importance of intentional teaching in early childhood classrooms (Copple & Bredekamp, 2009).

For intentional teaching, teachers need to be aware of every aspect of the teaching process, including identifying objectives, planning, selecting appropriate and effective teaching strategies and materials, engaging with children throughout the activities, assessing children, and making adjustments based on the assessments (Epstein, 2007). Although some teachers reported a sense of competence in their ability to teach mathematics in an intentional teaching (Cerezci, 2019; Chen et al., 2014; MacDonald, 2020), others expressed feelings of inadequacy and a negative attitude towards teaching mathematics (Can & Gültekin Akduman, 2022; Johnston & Bull, 2022; Lee & Ginsburg, 2009; Karakuş & Akman, 2022; Kılıçkaya & Avcı, 2021; Takunyacı & Takunyacı, 2014; Varol, 2013). Furthermore, math activities in preschool classrooms are mainly teacher-centered, and worksheets are the primary material used in those activities (Alat, 2019; Aydoğan & Sağsöz Başyurt, 2013; Göl-Güven, 2009; Ransom & Manning, 2013), and large class sizes, inadequate physical conditions, and lack of materials were considered as challenges to implementing math activities (Alat, 2019; Baki & Hacısalihoğlu Karadeniz, 2013; Guven & Gok Colak, 2019).

Despite of some recent studies focusing on intentional mathematics teaching in early years (Akıncı Coşgun & Yılmaz, 2021; Can & Akduman, 2022; Grieshaber et al., 2021; Karakuş et al., 2019; Kılıç & Özcan, 2020; Lewis et al., 2019; Pekince & Avcı, 2016; Yazlık & Öngören, 2018; Yang et al., 2022), our understanding of preschool teachers' intentional mathematics teaching is still insufficient. This study sheds light on the perceptions of early childhood teachers regarding the implementation of intentional math activities in classrooms. Specifically, this study may provide a deeper understanding of the challenges in intentional mathematics teaching, which in turn contributes to the development of policies and programs

that support effective early mathematics education (Chen & McCray, 2014; Ginsburg, 2016). Furthermore, this study may yield findings that researchers can use to explore further the dynamics of early childhood pedagogy (Gasteiger & Benz, 2018; Kilderry, 2015). Ultimately, through inferences drawn from the study's results, improving teachers' early mathematics teaching practices can lead to enhanced cognitive, linguistic, social, and emotional development in children (Clements & Sarama, 2009; Papadakis et al., 2017; Watts et al., 2014). This study seeks explicit answers to the following research questions:

(1) How do preschool teachers plan mathematics activities?
(2) How do preschool teachers implement mathematics activities?
(3) How do preschool teachers assess children's mathematical skills?

Method

Research Design

This study is part of a broader investigation examining the incorporation of technology into kindergarten classes to support the mathematical development of young children. This portion of the investigation employed the transcendental phenomenological methodology, a qualitative research approach. The primary objective of phenomenological studies is to investigate a present occurrence within an authentic, real-world setting. This study focuses on "intentional teaching in early math education."

Study Group

The study's participants comprise 20 Turkish early childhood teachers, consisting of 18 females and two males. The participants were selected using a convenience sampling method, based on their willingness to participate. Volunteering is the exclusive selection criterion for this study. Each participant was employed at public schools in the eastern region of Türkiye. The participants represented a broad spectrum of teaching expertise, ranging from 1 to 15 years. All participants received their undergraduate degree from the Department of Early Childhood Education. Five participants possessed a master's degree in early childhood education. Their classroom size ranged between 6 to 30. Pseudonyms were used to protect the participants' privacy. While 13 teachers worked with five-year-old children, the remaining teachers worked with four-year-old children during the school year when the data was collected.

Context

In Türkiye, formal early childhood education, which is not mandatory, is offered to children between the ages of three and six. There are independent preschools for children aged 36 to 69 months, preschools within primary schools for children aged 57 to 69, and nursery schools for children aged 3 to 36 months. The Preschool Education Program, updated by the Ministry of National Education in 2024, aims to support children's cognitive, language, social-emotional, and motor development, help them develop good habits, prepare them for primary school, and provide a typical educational environment for disadvantaged children. The program is child-centered, flexible, eclectic, balanced, play-based, and dynamic, incorporating school-family and community involvement, family education, and guidance services (MoNE, 2024).

As part of the national early childhood curriculum, teachers are expected to conduct math-

related activities to contribute to children's cognitive development, support their interest in mathematics, help them connect newly learned knowledge with existing concepts, and make meaningful learning of mathematical concepts (MoNE, 2024). The program also requires teachers to plan activities that help children develop mathematical questioning and mental calculation skills, associate mathematics concepts with everyday life, and assess both the children and the activities conducted.

Data Collection Tool

The Focus Group Discussion (FGD) approach was employed for data collection in the summer of 2023. FGD is an appropriate methodology for this study as it seeks to examine preschool teachers' comprehensive perspectives on intentional teaching in math education in the early years (Eeuwijk & Angehrn, 2017; Nyumba et al., 2018). This approach enables researchers to elucidate, explicate, and provide a more comprehensive perspective (Mishra, 2016).

Procedures

Ethical approval from a university ethics committee was obtained (18.06.2022, 9102). After conducting an extensive literature review, the researchers compiled a set of questions related to the intentional teaching of mathematics in early childhood classrooms. Then, three experts from the Department of Early Childhood Education reviewed the question pool, which consisted of twelve questions. Two questions were removed from the pool after the revisions based on the expert views. Two preliminary interviews were conducted with kindergarten teachers to determine whether the responses to the questions provided substantial data regarding the research aim. After finalizing the questions, the researchers recruited five early childhood teachers to participate in the first FGD session. Subsequently, five FGD sessions were conducted with three kindergarten teachers in each session. Since the data obtained in the last session was similar to that in previous sessions, the researchers decided not to conduct further FGD sessions. A total of twenty kindergarten teachers participated in this particular study. Two sample questions are: "What type of materials do you use while conducting mathematics-related activities?" and "What do you pay attention to when teaching children mathematical skills?"

Contradictory recommendations on the number of participants in each focus group discussion session can be found in the literature (Cortini et al., 2019; Liamputtong, 2010). For this specific study, five kindergarten teachers were assembled in the first session. The interview lasted longer than one and a half hours, and the researcher who led the discussion noted that the participants either experienced a lapse in memory regarding their views or became disinterested due to the prolonged waiting period. Thereupon, the other sessions were conducted with three kindergarten teachers. The sessions took place in a virtual environment, and conversations were recorded with the participants' consent. The duration of the sessions ranged from 70 to 95 minutes.

Data Analysis

All recordings were converted into a written format before the data processing. Two researchers independently reviewed the data from one of the FGD sessions multiple times to become acquainted with its content. Subsequently, each researcher created their codes and categories, organizing the codes into broader groups (Elo & Kyngäs, 2008). Then, the same researchers reviewed the categories and codes and used a formula (Miles & Huberman, 1994)

to guarantee inter-rater reliability. The inter-rater reliability value was determined to be 92%. Researchers reached a consensus on disagreements. The third researcher analyzed the categories and codes based on their conceptual and linguistic aspects. A modification was made to only two themes and two codes, which were reworded.

Trustworthiness

Qualitative studies employ four key criteria to assess reliability: credibility, dependability, conformability, and transferability (Lincoln & Guba, 1985). Regarding credibility, two preliminary interviews were conducted. Furthermore, once all recordings were transcribed, these texts were thoroughly verified to confirm their alignment with the original recordings. Furthermore, the data collection and analysis processes were carried out concurrently to ascertain the necessity for supplementary data or clarification. Additionally, peer feedback was acquired throughout the data analysis procedure. In terms of dependability, the characteristics of the participants and the methods employed for data collection and analysis were provided. Two researchers independently analyzed the data to ensure conformability in this study, while a third researcher provided comments on the codes and themes. In addition, the findings section includes direct quotes to ensure conformability. The transferability of the study is enhanced by providing comprehensive details regarding the participants and the research methodology.

Findings

Regarding the planning phase of math activities, teachers' responses were categorized into three sub-themes: mathematical concepts and activity types, material selection, and aspects considered in planning math activities. Each theme is explained below.

Planning Phase

Regarding the planning phase of math activities, teachers' responses were divided into three sub-themes: mathematical concepts and activity type, material selection, and aspects taken into account in planning math activities. Each theme is explained below.

Mathematical Concepts and Activity Types

The teachers were asked to classify their mathematics activities according to the frequency of classroom practice. Considering the five main concepts - numbers, geometry, arithmetic, measurement, pattern, and data analysis, as well as graphs and probability, - while the numbers concept was the most preferred, data analysis, graphs, and probability were the least preferred mathematical concepts covered in their classrooms. In addition to their explanations, this situation was also observed in the examples they provided throughout the FGD sessions. They mainly provided examples of activities that focused on number recognition, counting, or shapes as they answered.

All teachers reported planning whole-group, small-group, or individual math activities depending on the concept they cover or the children's needs. Mine stated that

> *Individual work is more prominent as there are more differences and discrimination among children in cognitive achievements. If the classroom is crowded, it is more useful to work with children in small groups or individually. (Mine, FGD: 05.08.2023)*

However, the answers to the probe question regarding the small-group activities revealed that

only one teacher carried out planned small-group activities. The rest only had children sit around the tables in small groups, but conducted the same math-related activities, which does not accurately reflect the real meaning of small-group activity (MoNE, 2024; NAEYC, 2009). In addition to the activity type, the teachers reported that they followed a holistic approach to teaching mathematical concepts. In other words, they stated that mathematical concepts were also covered in music, science, language arts, and free time activities.

Material Selection

The teachers reported using manipulatives, educational materials, or other materials while conducting math activities (Fig. 1).

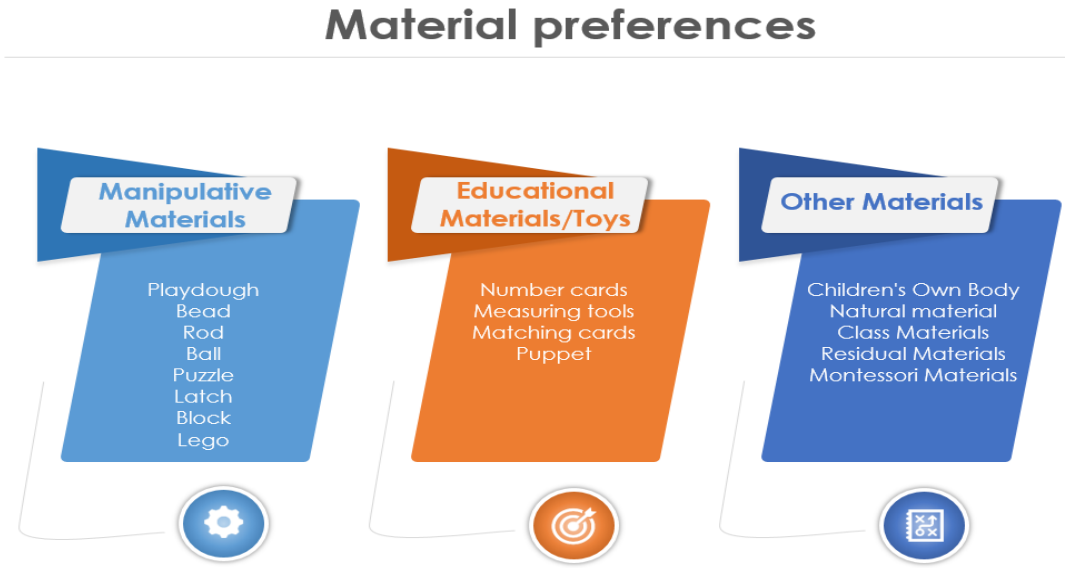

Figure 1. Material preferences in math activities

Direct quotes related to teachers' material preferences in math activities:

> *I have some Montessori materials. Pink towers, for example. And then red and blue sticks. We use these. And then there are these beads to use in counting by tens. Besides that, we made an adding machine ourselves, for example, together with the children in the classroom. We use it. Apart from that, we made scales again. We used scales. (Tuba, FGD: 26.08.2023)*

> *I use everything in the classroom, all the toys, even including the children themselves, I use everything as long as they learn, as long as they do something, puzzles, matching, then pencils, erasers, notebooks, their bodies, everything if necessary, everything is material for them. (Vahide, FGD: 12.08.2023)*

Aspects Taken into Account in Planning Math Activities

The teachers were asked to name the aspects they consider when planning math activities. Teachers mentioned two different aspects: objectives and factors (Fig. 2). In terms of objectives, they plan math activities that children enjoy and direct them towards problem-solving and observation. Teaching simple to complex concepts is another objective they considered. Children's readiness, age, developmental level, and individual differences, as well as the use of concrete materials, are the factors that teachers consider when planning math

activities. Additionally, teachers emphasize the importance of gamification, repetition, incorporating real-life situations, and parental involvement as key factors.

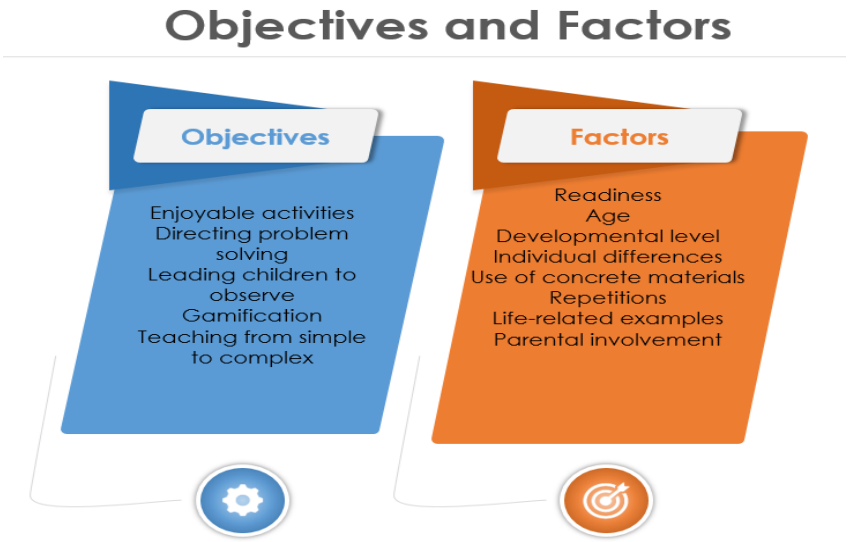

Figure 2. Objectives and factors taken into account in planning math activities

Direct quotes related to factors taken into account in planning math activities:

> *I focus on their [children] developmental levels and then readiness while planning math activities. I want them to use what they learn in terms of mathematics in their daily lives (Yavuz, FGD: 19.08.2023).*
>
> *I try to teach with games, so they do not get bored. Also, ımm, I mean age appropriateness is the key. Using different concrete materials, in a memorable way with stories (Ceyda, FGD: 05.08.2023).*

Implementation Phase

In terms of the implementation phase of math activities, teachers' responses were divided into three themes: methods and techniques, ways to attract children's attention, and ways for active participation. Each theme is explained below.

Methods and Techniques

The teachers reported they used teacher- and child-centered math activities in their classrooms (Fig. 3). While most participants mentioned teacher-centered math activities, only a few teachers referred to child-centered methods and techniques.

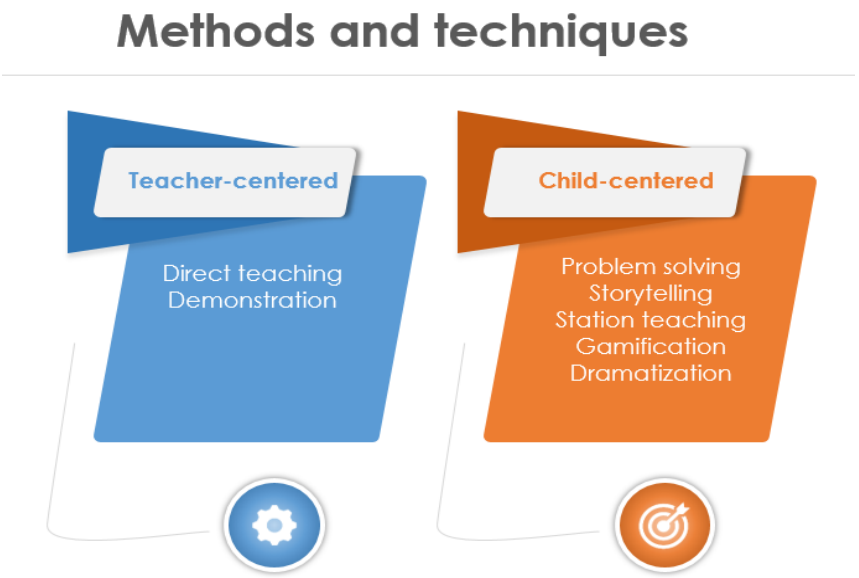

Figure 3. Methods and techniques used in math activities

Direct quotes related to techniques and methods in conducting math activities:

> *I use demonstrations in some cases. For example, in creating patterns, I first show how to create patterns. Then, I call the students one-on-one, and of course, ask them to create a pattern and if needed I provide help. (Hatice, FGD: 19.08.2023)*
>
> *Especially I use the station method. I put different materials on every table related to my mathematical concept. One table belongs to me. I work with those kids, and they all rotate. (Ayşe, FGD: 12.08.2023).*

Ways to attract children's attention

At the beginning of a math activity, teachers reported several ways to attract children's attention. Two teachers emphasized the importance of children's energy and suggested that they expend some of it through games, dancing, or other physical activities before the math sessions. In addition, while some teachers stated that introducing new materials to the classroom helps children pay more attention to the activity, others suggested that using technology, math-related books, nursery rhymes, and songs are also effective ways to attract children's attention (Fig. 4).

Fig.4. Ways to attract children's attention

Direct quotes related to ways to attract children's attention in math activities:

> *I ask many questions. I mean while reading a story, I ask how-many questions based on the main character or the flow of the story. This is how I get their attention (Yavuz, FGD: 19.08.2023).*
>
> *I am at the fun part of it! I make many jokes. Kids like contradictions. We discuss them and they laugh. Then, I draw their attention to the concept I want them to learn. I use the smartboard to show a picture or video (Beren, FGD: 12.08.2023).*

Ways for Active Participation

The teachers discussed four aspects of children's active participation during math-related activities: attracting children's attention, guiding, using stimulating materials, and persistence and transfer of knowledge (Fig. 5).

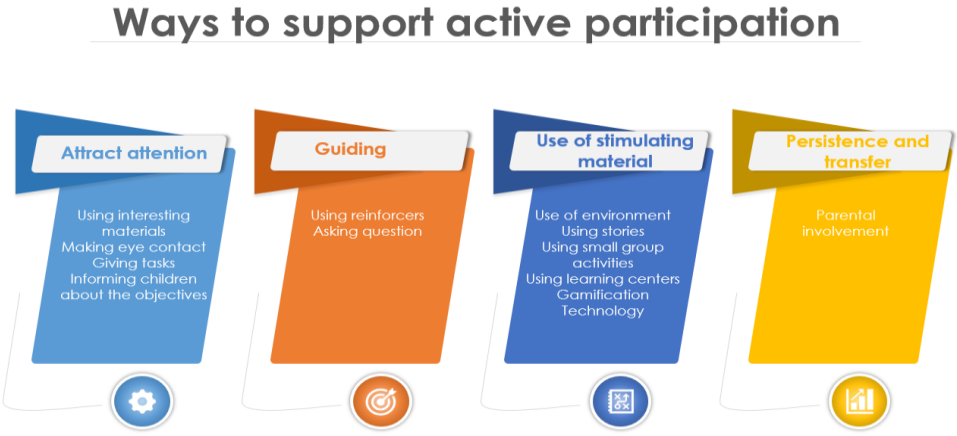

Figure 5. Active participation in math activities

Direct quotes related to ways for children's active participation in math activities:

> *I sometimes tell unfinished stories and ask children to complete it at home with their parents. I also inform parents, too. Imm, when I teach shapes, I ask them to search the classroom to find similar shapes (Nazlı, FGD: 02.09.2023).*

> *We have a smartboard in our classroom. For instance, I write a number and then delete it quickly. Then I ask children to remember the number I wrote. As Ms. Ceyda said, I use educational cartoons. And songs, like number songs. I always give them reinforces when they get the right answer (Pınar, FGD: 09.09.2023).*

Assessment Phase

When assessing children's learning of mathematical concepts, the teachers reported using checklists, progress report forms, online evaluation worksheets, and standardized tests. Individual talks with children and observations are also ways teachers use to assess children. The teachers were also asked when they do assessments. Responses ranged from during or at the end of each math activity to the end of the year (Fig. 6).

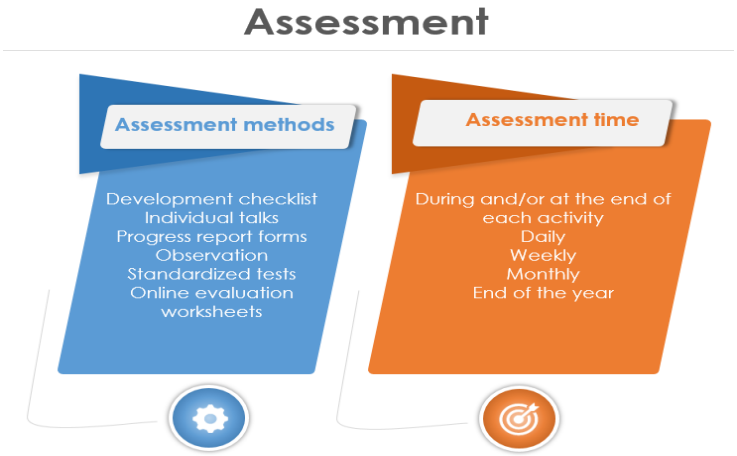

Figure 6. Assessment

Direct quotes related to evaluation in math activities:

> *After the activity, I give the children a worksheet about the concept I covered. But this is not daily. I give it to them for the weekend. Then I check them out. If there are children who have problems in their worksheets, I conduct small group activities with those children (Şule, FGD: 26.08.2023).*

> *During my master's education, I received training specifically related to standardized tests. I administer these tests at the beginning and end of the year to assess how much progress the child has made (Berrak, FGD: 05.08.2023).*

Discussion

This study examined the intentional mathematics teaching of early childhood teachers in terms of planning, implementation, and assessment procedures. The findings from the focus group discussions reveal significant patterns in the preferences and practices of teachers regarding mathematical activities in early childhood classrooms. The preference for number-

related activities over the other concepts reveals a considerable imbalance in the breadth of mathematical content. This aligns with previous research suggesting that early childhood teachers often prioritize foundational skills, such as number recognition and counting, over less familiar or more abstract mathematical concepts (Akıncı Coşgun & Yılmaz, 2021; Baki & Hacısalihoğlu-Karadeniz, 2013; Clements & Sarama, 2009; Orçan Kaçan & Halmatov, 2017). Therefore, despite the recognized importance of early number skills, the limited focus on a broader range of mathematical domains is concerning. Comprehensive mathematics education in early childhood should include all domains to foster children's problem-solving, critical thinking skills, and overall mathematical thinking (Clements & Sarama, 2009). To address these gaps, further research should explore the barriers to integrating diverse mathematical topics into preschool settings. Additionally, enhanced professional development opportunities for preschool teachers could promote more holistic and inclusive mathematics instruction from an early age.

Regarding instructional strategies, the reported use of whole-group, small-group, and individual activities highlights an adaptive approach based on children's needs and the complexity of the concept. However, a deeper examination through probing questions revealed a discrepancy in the implementation of small-group activities. While one teacher adhered to the principles of small-group instruction by planning differentiated activities tailored to the group's specific needs, most teachers merely organized children into small groups without altering the nature of the activity. This practice does not align with the definition of small-group instruction, which necessitates differentiated, interactive, and focused engagement (Büyüktaşkapu Soydan, 2019; Clements et al., 2023; Jacob et al., 2020; MoNE, 2024; NAEYC, 2009). In addition, this study observed teachers' tendency to conduct whole-group activities, a finding also reported in other studies (Büyüktaşkapu Soydan, 2019; Kurtulmuş & Şanlı, 2023). In light of these findings, professional development programs, as well as teacher education programs, should emphasize a balanced approach to planning activities that incorporate whole-group, small-group, and one-on-one interactions. This holistic approach enables the accommodation of diverse learning styles and supports the overall developmental outcomes of early mathematics instruction.

Teachers reported choosing manipulatives (such as playdough, blocks, and LEGO), educational materials (such as number and matching cards and puppets), or other materials (such as children's bodies and natural materials) while planning mathematics activities. According to research, teachers already utilize a variety of materials with diverse characteristics in mathematics activities, which not only support the development of mathematical skills but also encourage children's active participation in mathematical activities and deepen their conceptual understanding (Akıncı Coşkun & Yılmaz, 2021; Clements & Sarama, 2009; Epstein, 2014; NAEYC, 2009; Yazlık & Öngören, 2018). Although the teachers demonstrated awareness of using diverse materials, effectively integrating these resources depends heavily on their intentionality and alignment with learning objectives.

Mathematics education in early childhood settings requires well-structured and thoughtful planning to cater to diverse learners while fostering an enthusiasm for mathematical thinking. Based on the study's findings, teachers focus on specific objectives and factors when planning math activities. Enjoyable activities and gamification are particularly effective in fostering engagement, increasing motivation, and reducing negative attitudes toward mathematics (Boaler, 2019; Dicheva et al., 2015; Sailer et al., 2021). Boaler (2019) further argues that engaging students in enjoyable mathematical tasks cultivates a growth mindset, reducing math

anxiety and promoting resilience in problem-solving (Boaler, 2019). In addition, teachers mentioned children's developmental readiness, age, and individual differences, as well as the use of concrete materials and real-life examples, and parental involvement as factors they consider when planning math activities. These factors create a comprehensive framework for planning effective math activities (Boaler, 2019; Clements & Sarama, 2021; Siegler & Ramani, 2008; Sousa, 2017). By addressing these elements, educators can design instruction that meets the diverse needs of their students while fostering a deep and lasting understanding of mathematics. The interplay between these objectives and factors emphasizes the need for a holistic approach to math activity planning. Teachers must blend engagement strategies with developmental appropriateness while adapting to the unique needs of their learners. Although the teachers in this study reported considering the aforementioned objectives and factors while planning math activities, classroom observations are necessary to evaluate the extent to which teachers effectively implement these objectives and factors in mathematics education. Through direct observation, researchers can identify potential discrepancies between the planned and enacted activities, assess alignment with developmental appropriateness, and examine how these are tailored to meet individual learner needs (Clements & Sarama, 2021).

In early childhood education, mathematics instruction is foundational in shaping a child's cognitive development and future academic success. The study's findings indicate that teacher-centered methods predominate in early childhood classrooms, with fewer educators integrating child-centered approaches to teach mathematical concepts. This trend reflects longstanding instructional norms and highlights the need for a more balanced and developmentally appropriate approach to teaching mathematics to young children. In early childhood mathematics education, while teacher-centered methods such as direct teaching and demonstration have traditionally been favored for their clarity and structure, research increasingly highlights the superiority of child-centered approaches in fostering deeper engagement and conceptual understanding. Direct instruction often introduces foundational skills, such as counting, pattern recognition, and basic arithmetic (Rosenshine, 2012). However, these methods tend to position students as passive recipients of knowledge, limiting opportunities for active exploration and critical thinking (Freeman et al., 2014). In contrast, child-centered methods, grounded in constructivist theories, emphasize active engagement, inquiry, and collaboration – essential elements for young learners. Specifically, child-centered approaches, including problem-solving activities, dramatization, gamification, or storytelling, enable children to explore mathematical concepts through open-ended challenges, thereby fostering critical thinking, enhancing creativity, and promoting cognitive flexibility (Boaler, 2016; Clements & Sarama, 2021; Dicheva et al., 2015; Sailer et al., 2021). Although teacher-centered methods can provide structure and clarity in specific contexts, their limitations in fostering active learning, creativity, and higher-order thinking make them less effective in early childhood education. By prioritizing child-centered approaches, educators can create dynamic and engaging environments that support holistic development and foster a lifelong love for mathematics.

Capturing attention is essential in early childhood mathematics education, where young learners' natural curiosity and energy must be effectively harnessed. Teachers reported that they employ body movements (Ratey & Hagerman, 2008), novel materials (Clements & Sarama, 2021; Dolan & Dayan, 2013), storytelling (van den Heuvel-Panhuizen & Elia, 2012), and humor (Amran & Bakar, 2022; McGhee, 2019; Quemba Plazas, 2023) to create engaging environments that promote cognitive readiness and emotional connection as suggested in the literature. These strategies align with experiential and constructivist learning principles, emphasizing that meaningful experiences deepen understanding and build connections to new

knowledge (Kolb, 1984). The teachers also mentioned other techniques, including gamification (Dicheva et al., 2015; Sailer et al., 2021) and questioning (Chouinard et al., 2007; Mercer et al., 2019), to foster sustained engagement and excitement for mathematics. Although technology, such as tablets, smartboards, and interactive apps, provides personalized and multisensory learning experiences that cater to diverse developmental needs (Hwang et al., 2020; Hirsh-Pasek et al., 2015), the teachers reported that they use technology to play songs or watch videos with children, which is already discussed in another article (Elmalı et al., 2025).

Active participation among young children during mathematics activities is pivotal for effective learning, and the strategies highlighted by early childhood teachers reflect a multifaceted approach to achieving this goal. The four aspects discussed — attracting attention, guiding, using stimulating materials, and fostering persistence and transfer — align closely with research-based practices in early childhood education (Clements & Sarama, 2021; Dicheva et al., 2015; Dolan & Dayan, 2013; Hirsh-Pasek et al., 2015; Sailer et al., 2021; van den Heuvel-Panhuizen & Elia, 2012). The abovementioned interconnected strategies form a comprehensive framework for supporting active participation in early childhood mathematics. Based on teachers' reports, it appears that teachers create engaging, meaningful, and enduring learning experiences that nurture mathematical curiosity and foundational understanding if they effectively combine attention-grabbing techniques, guided interaction, stimulating materials, and family reinforcement.

Assessment in early childhood education is a crucial process for understanding children's development, identifying their learning needs, and tailoring instruction to support their growth and development. However, the study's findings reveal gaps in teachers' understanding and implementation of effective assessment practices. The reported reliance on infrequent assessment, such as evaluating children only at the end of the school year, indicates a limited appreciation for the ongoing nature of assessment and its potential to inform instructional strategies. Effective assessment in early childhood should be continuous and formative, focusing on observing and supporting children's learning throughout the academic year. Observation, a widely recognized method, enables educators to identify children's strengths, misconceptions, and areas of difficulty in real-time, allowing for timely intervention (Ginsburg, 2016; Pyle & Deluca, 2017; Shepard et al., 2018). Development checklists and progress report forms offer structured ways to monitor growth across various developmental domains, including cognitive, social, and motor skills (NAEYC, 2020; Wortham & Hardin, 2015). Individual talks provide educators with opportunities to engage with children one-on-one, enabling them to assess understanding and address individual needs (McAfee et al., 2016). Standardized tests, although sometimes criticized for their lack of flexibility, can serve as benchmarks when complemented by more dynamic tools, such as online evaluations and observation (Snow & Van Hemel, 2008).

Assessment timing is equally critical. Frequent assessments, such as those conducted daily, weekly, or at the end of activities, enable teachers to track ongoing progress and adjust teaching methods accordingly (Black & Wiliam, 2009; Brookhart, 2011). Formative assessments, those carried out during the learning process, are particularly valuable in promoting a responsive teaching approach. Research highlights that regular, low-stakes assessments foster active learning by providing immediate feedback to both students and teachers, creating opportunities for reflection and growth (Andrade & Heritage, 2017). Conversely, end-of-year assessments alone fail to capture the nuances of a child's learning journey and often overlook opportunities to address misunderstandings or knowledge gaps

during the school year (Wiliam, 2011). Early identification of challenges, supported by regular assessments, is crucial for scaffolding learning and preventing the accumulation of knowledge gaps (Alexander, 2010). In conclusion, assessment is not merely a tool for measuring outcomes but a continuous process integral to effective teaching and learning. To ensure meaningful learning experiences, educators must adopt frequent, diverse, and formative assessment strategies that capture the dynamic nature of early childhood development. Professional development opportunities for teachers should emphasize the importance of ongoing assessment and equip them with the skills to implement it effectively.

Conclusion

The results highlight several implications for policy and practice. Policies should require the integration of formative and summative assessments, along with clear guidelines on diverse methods, including observation and digital tools. To this end, governments must fund tools and training to ensure effective assessments while ensuring practices are inclusive and equitable, addressing diverse cultural, linguistic, and developmental needs. In addition, pre-service teacher programs should include training on assessment literacy, and accountability systems should monitor the consistent application of best practices.

In terms of practices, teachers should design small group activities to provide personalized attention, addressing the diverse learning needs of children. Groups can be organized by ability or interest, allowing for differentiated instruction that supports all learners, including those with special needs. This approach ensures that children receive the targeted support they need to succeed, encouraging cooperation and communication while fostering social-emotional skills alongside cognitive development. Early childhood teachers should prioritize ongoing assessments, such as observations, checklists, and progress reports, rather than relying solely on end-of-year evaluations. This approach enables the real-time identification of learning gaps and the delivery of tailored instructional responses. Also, there is a clear need for professional development programs to equip teachers with strategies for effectively incorporating underutilized mathematical concepts, such as data analysis and probability, into their curricula.

In conclusion, effective early childhood education relies on a multifaceted approach that integrates formative assessment, engaging teaching strategies, and inclusive practices to support children's development. Key methods, including small-group activities, play-based learning, and continuous observation, enable educators to address diverse needs, foster collaboration, and promote active participation. Additionally, involving parents and utilizing technology enhances continuity and personalization of learning. To ensure success, policies must prioritize professional development, equitable access to resources, and the integration of frequent, meaningful assessments. By combining these strategies, educators can create dynamic and supportive environments that nurture curiosity, foster growth, and develop foundational skills for lifelong learning.

Declarations

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