

Article

Challenges and Opportunities of Mathematics in Digital Times: Preschool Teachers' Views

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Abstract: The COVID-19 pandemic has caused an unprecedented crisis. Worldwide, preschool teachers were invited to develop the students' learning experience in a new digital environment for mathematics. This research investigates preschool teachers' mathematics practices during remote teaching and the use of digital tools in teaching mathematics after their return to actual classes. Views from sixteen Greek preschool teachers were collected with semi-structured interviews and analyzed using thematic analysis. The results showed that mathematical activities such as Numbers and Operations, Geometry, and Measurement occurred during distance learning in digital preschool classrooms. They made little reference to activities related to Algebra, while they did not refer to Data Analysis and Probability. They also seemed to prefer mathematical activities based on Connections and Representation processes in their digital classrooms. Preschool teachers reported that parents supported this process by their presence, and digital learning communities supported learning activities by providing guidelines and innovative approaches to them in digital times. However, after returning to face-to-face schooling, preschool teachers seemed to use digital tools to a lesser degree. They also mention that in face-to-face schooling, they prefer to utilize the authentic communication frameworks emphasizing problem-solving activities to enhance all mathematical processes. Implications for preschool teacher professional development are discussed.

Keywords: mathematics; preschool education; COVID-19 pandemic; distance learning; content and process standards



Citation: Lavidas, K.; Apostolou, Z.; Papadakis, S. Challenges and Opportunities of Mathematics in Digital Times: Preschool Teachers' Views. *Educ. Sci.* **2022**, *12*, 459. <https://doi.org/10.3390/educsci12070459>

Academic Editor: Lieven Verschaffel

Received: 8 June 2022

Accepted: 29 June 2022

Published: 1 July 2022

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1. Introduction

In the spring of 2020, schools closed to avoid the spread of the COVID-19 pandemic. Indeed, even today, according to the official data (February 2022) of UNESCO [1], many countries' schools remain closed or partially opened. This lockdown led to a rapid shift to distance learning, placing more responsibility for learning on parents and guardians [2]. Distance learning is the absence of face-to-face contact between teachers and students in class. According to this policy, during distance learning, teachers from all levels of education should use digital tools and their infrastructures to carry out the learning process. Therefore, learning at home requires students and teachers to access the internet and technological and educational resources to engage in learning [2,3].

Concerning this situation, preschool teachers were forced to use digital tools in the educational process. Several teachers choose a blend of methods to meet the needs of their students with a hybrid of both synchronous and asynchronous teaching [3]. Therefore, teachers could follow communication with students by giving them proper homework and others that followed in some degree teaching interventions, utilizing online teaching and proposals from various Information and Communications Technology (ICT) scenarios [4,5]. However, the research indicated many barriers preschool teachers faced during school closures, such as technical skills for teachers and children, lack of infrastructure,

and lack of training for teachers in distance learning [3–7]. According to the previous research (e.g., [8,9]), preschool teachers stated that they taught mathematics during the school closure.

2. Teaching Mathematics in Preschool

Preschool mathematics is considered a crucial subject matter due to its role in promoting the development of the cognitive domain of young children [10]. Preschoolers use mathematical ideas in everyday life and develop mathematical knowledge that can be complex and sophisticated [11]. In the last few years, preschool education has offered an enriched learning environment that allows the involvement of preschoolers in mathematical activities. Specifically, preschoolers are not “taught” or “learned” mathematics in the traditional sense of the term. Preschoolers’ interests and everyday activities comprise natural vehicles for the first experience with mathematics and developing mathematical thinking [12]. Mathematical experiences challenge preschoolers to explore patterns, shapes, numbers, and spatial concepts. Game-oriented activities (spontaneous or organized in the classes’ math corners), routines (daily repetitive actions), utilizing situations from everyday life, occasional or current events, and investigations (work plans, little research, problems to be solved) support mathematical processes. These include Problem-solving, Reasoning and Proof, Communication, Connections, and Representation [12]. These standard processes are considered necessary for learning mathematics content, and along with children’s development, the usage of these processes is among the critical achievements of mathematics education [12]. The above five process standards and the utilization of Children’s curiosity, imagination, inventiveness, willingness to experiment, and sensitivity to patterns should be integrated into learning all mathematics content [13].

In this context, for students from prekindergarten through grade twelve mathematics education, the National Council of Teachers of Mathematics (NCTM) presented the mathematical content that students should know and be able to use as they progress through school [12]. This content knowledge about mathematics is called Content Standards and is summarized in five mathematical areas: (a) Numbers and operations, (b) Algebra, (c) Geometry, (d) Measurements, and (e) Data Analysis and Probability. According to the NCTM [12], each concept should be emphasized based on the child’s age.

In a study with Greek preschool teachers [14] before the pandemic, the favorite mathematics axes that they mainly teach are Numbers and Geometry. Moreover, the teachers use materials offered to develop play activities rather than those oriented to mathematics [14]. As mathematical concepts are not isolated, many actions from other subject areas (literature, language, etc.) or everyday situations enrich the actions proposed for the mathematical activities and the way of approaching the actions of other areas [14]. Thus, preschool teachers have an essential role in choosing the type of proposed activities and the way and the supporting tools (e.g., digital tools) in which they will support them in class, encouraging and promoting (as facilitators) the cultivation of children’s mathematics at this age.

Specifically, for digital tools, although many preschool teachers acknowledge the power of digital tools to motivate the children and encourage them to participate more in learning procedures, they do not use them in teaching practices [15,16]. Indeed, regarding the preschool teachers’ use of supporting digital tools for teaching mathematics before the pandemic, the researchers support is minimal (e.g., [15]). Some preschool teachers who use digital tools in teaching mathematics teach mathematical concepts, such as spatiotemporal, orientation, classification, matching, serializations, quantities, mathematical operations, patterns, comparisons, volume, shapes, and size. In addition, teachers use digital tools to teach mathematics more as a drill-and-practice tool and less as a tool for supporting discovery and exploratory activities. Finally, they highlight the lack of training on ICT integration and the preschool teachers’ role in mathematics teaching [15,16].

During the COVID-19 pandemic, the educational community tried to utilize digital tools that were neither familiar nor properly prepared [3]. Therefore, the transformation and adaptation of teaching practices to new conditions became a reality for preschool

classrooms [4]. Preschool teachers were invited to transform the objectives of the lessons to choose appropriate digital tools, teaching techniques, and mathematical activities. Thus, they try to promote interaction, creativity, and critical thinking and qualitatively develop the students' learning experience in a new digital environment for mathematics [17].

3. Previous Research

Several studies have been conducted on the pandemic school closures from various points of view regarding remote teaching in preschool settings during the COVID-19 outbreak. These studies have investigated the practices and barriers preschool teachers face concerning digital tool use [3,5–7,18]. Mainly, Gomes et al. [7], using web surveys, studied preschool teachers' practices and barriers across Australia, Bangladesh, Norway, Singapore, and India. Their findings revealed teachers' transformations to new teaching approaches and significant changes in their daily teaching practices. In addition, Ford, Kwon, and Tsotsoros [5], using a survey with a sample of 1434 teachers from the United States, investigated their teaching experiences and the challenges they face in maintaining educational continuity for the children. According to their findings, teachers revealed low levels of participation in children, limited social interaction and developmentally appropriate ways of engaging children in the virtual learning format, lack of knowledge and skills for virtual teaching, and limited technological support. Following a qualitative approach, Abdul-Majied et al. [6] investigated the experiences of Caribbean early preschool teachers at the start of the COVID-19 pandemic. According to their findings, teachers reported increased work with uncertain results. They had to respond to changes in teaching and new parental requirements without sufficient training and experience.

Similarly, Timmons et al. [3] conducted semi-structured interviews with 25 preschool teachers and 11 parents from Canada. Teachers and parents expressed concerns about the inequitable access to technology resources and the negative social and emotional impacts of distance learning on students. Finally, O'Keeffe, and McNally [18], using a survey with a sample of 310 preschool teachers during primary school closures in Ireland, investigated the teachers' practices about "play" strategies. About one-fifth of teachers said they advised their students' parents with play strategies during distance education. According to the research results, these strategies could play an essential role in teaching to support children's return to school.

In addition, there are limited studies about preschool teachers' practices for teaching mathematics (e.g., [8,9]). A sample of 25 Turkish preschool teachers was investigated to discover, among others, the activities performed. The teachers declared that they taught mathematics, and the most utilized learning activities were recognition of geometric shapes, counting, and adding/subtracting [9]. In a similar work in Greece, Nikolopoulou [8] investigated teacher practices with a mixed sample of eight preschool teachers and six primary education teachers during school closures. According to her findings, ten teachers declared that they taught mathematics. Their activities mainly consisted of Counting, Kinetic activities with numbers, enumeration, Counting and writing in worksheets, construction/formation of numbers with simple materials, and activities with dates.

Considering that there are not several studies in preschool education that investigate in-depth teaching mathematics during school closure, this research will cover this research gap. Regarding those children who do not have adequate opportunities to develop a cognitive foundation [11], in an educational equity environment [12], the investigation of preschool teachers' practices in teaching mathematics during school closures is essential and necessary for the educational community. This investigation will shed light on the issues and the conditions of the provided remote teaching in a childhood context for mathematics. Finally, this research would provide insights into the suitable training programs for teaching mathematics that should be conducted to prepare the teachers for similar cases in the future.

4. Research Aims

This research aimed to investigate:

- (1) The preschool teachers' practices for teaching mathematics during remote teaching;
- (2) The preschool teachers' usage of the digital tools in teaching mathematics after returning to the actual classes.

5. Methodology

5.1. Research Procedure and Research Instrument

This research was carried out from January to March 2022 and followed a qualitative methodology that allows researchers to analyze facts holistically and in-depth [19]. More specifically, we focused on 16 preschool teachers' practices of teaching mathematics before and after the pandemic. Semi-structured interviews with preschool teachers were carried out to identify their practices. The interviews were conducted individually and at a distance (web meetings), and each interview lasted about 20 min.

The research protocol conformed to the ethical guidelines of the European Union and was approved by the Research Ethics Board (REB) designated by the University of Patras and particularly by the Department of Educational Science and Early Childhood Education. Teachers gave permission prior to the research. Ethical considerations and guidelines concerning the privacy of individuals were carefully taken into account throughout the research process.

The interview protocol was based on the research objective. Before the primary survey, the interview protocol was tested with one teacher to review the interview and make corrections. This teacher is not included in the final sample. Table 1 presents the final interview questions that consisted of two parts. The first part was the demographic profile of preschool teachers (gender, studies, work experience, and any training about distance learning and teaching mathematics). The second part was about the digital tools teachers used to teach mathematics. Furthermore, it presents their practices, the barriers, and the transformations teachers applied to mathematics during remote teaching. Additionally, it presents the utilization of digital tools for mathematics after their return to the actual classes.

Table 1. Interview protocol.

First Part	Second Part
Preschool teacher's gender, studies, teaching experience	Describe the teaching approaches and the digital tools you utilized for mathematics in remote teaching
Training in distance learning	Describe the teaching objectives for mathematics in remote teaching
Teaching about teaching mathematics	

5.2. Participants

The purposive sample consisted of Greek preschool teachers from various Greece regions who were selected with the criterion of participating in both periods when the pandemic forced the closure of schools and distance learning. The initial selection for participating in the interviews included twenty voluntary preschool teachers. The sampling process took into account until theoretical saturation has been achieved [19]. Therefore, only 16 out of 20 teachers participated in the interviews, and therefore, the final sample consists of these 16 preschool teachers. All the preschool teachers declared that teaching experience varied from 5 to 30 years, 8 (50.0%) hold a postgraduate degree, and 14 (87.5%) have been trained in ICT integration in classroom practices. However, only 5 (31.3%) have been trained in distance education and 4 (25.0%) have been trained in teaching mathematics. Two of them have been trained in distance education and teaching mathematics.

5.3. Data Analysis Method

Initially, all interviews were recorded and transcribed verbatim. For the qualitative data analysis, a data-driven thematic analysis was conducted: relevant codes, categories, and themes emerged [19]. For process validation, a second coder was also employed.

Consistency between the two coders was high, about 90% and the discussion between them led to an impressive list of codes and the determined themes.

6. Results

The results analysis revealed themes such as using digital tools for mathematics and learning communities during remote teaching. Other aspects also emerged, such as the existence of learning communities that supported them in the educational process, the barriers they had faced while using them, the content and the process standards of mathematics during remote teaching, and the necessary transformations in these teaching approaches. The effectiveness and utilization of digital tools for mathematics were also of great importance after their return to actual classes.

6.1. Digital Tools for Mathematics and learning Communities during Remote Teaching

All preschool teachers had already participated in both periods of distance learning during the pandemic in the kindergarten. Even those who participated in some distance education training programs did not have previous experience with WebEx, e-me, and e-class platforms proposed and provided by the Ministry of Education. However, preschool teachers managed to use these platforms and familiarize themselves with them (Table 2). Furthermore, despite their relative embarrassment and difficulty, they seemed to have overcome the initial difficulties by adopting alternative practices and adapting to the new conditions. Some of them referred to the use of alternative digital tools (Table 2) for mathematics, such as “Photodentro”, “Wordwall”, “Quiziiiz”, “Google docs”, “Zoom”, “Learning apps”, “GCompris”, “Jigsaw planet”, and “Wheel of Luck”, that they knew from their personal uses and evaluated them as “easier”.

Table 2. Digital environments for mathematics during remote teaching ($N = 16$).

Digital Tools	Role of Learning Communities
WebEx (16), Zoom (4), e-me (2), e-class (11), Photodentro (3), Wordwall (4), Quiziiiz (2), Google docs (8), Learning apps (7), Gcompris (1), Jigsaw planet (1), Wheel of Luck (1)	Communication and exchange of material, teaching approaches, and good practices among teachers for several thematic areas (14)

Learning communities (Table 2) seem to have played an essential role in this, as many preschool teachers made a significant reference. They mainly referred to online learning communities that operated on social media (e.g., “Distance education for kindergarten”, “Support for teachers in distance learning and ICT”, etc.). These were either set up during the COVID-19 period, and distance education either pre-existed or emerged due to the vast need for communication and exchange of good practices of teachers among themselves for several thematic areas (e.g., mathematics, language, etc.).

6.2. Content Standards

Participants stated that they tried to conduct several mathematical activities during distance learning. They mainly used them (e.g., WebEx, e-class, e-Me, Word wall, Quiziiiz, Learning apps, GCompris, Jigsaw planet, Wheel of Luck) as a drill-and-practice tool. Preschool teachers referred to thematic areas such as Numbers and Operations (e.g., Counting, comparison, addition, abstraction) and Geometry (e.g., shape recognition and Measurements). To a lesser extent, they referenced activities related to Algebra (e.g., pattern recognition) and space and time, while they did not refer to its subject area of Data Analysis and Probability (Table 3). Four preschool teachers (PT) (PT6, PT8, PT11, PT1) stated:

Table 3. Content and process standards for mathematics ($N = 16$).

Content Standards	Examples of Mathematical Activities	Process Standards
Numbers and Operations (16), Geometry (12), Measurements (10), Algebra (5)	Counting and order of numbers (16)	Problem-solving (7), Connections (6), Representation (5), Reasoning and Proof (2)
	Addition (10), Abstraction (5)	
	Correspondence number with its symbol (14)	
	Describing positions (e.g., inside and outside, far from, close to, on top of, underneath, in front of, behind, above, top, middle and bottom) (6)	
	Describing movements (e.g., up and down, over and under, forwards and backwards) (8)	
	Sorting and grouping objects found in the house according to shape, color, texture, and size (11)	
	Routines (e.g., digital calendar) (14)	
	Shape recognition 2D and/or 3D (6)	
	Pattern recognition (5)	
	Measurement of the attributes of the various things with non-standard units (10)	
	Comparison objects and/or numbers (e.g., less and greater than) (10)	
	data	

“During the distance learning, we mainly focused on activities aimed at counting things, comparing and ordering numbers, addition, abstraction, classification, chronology, comparison, measurement, routines, utilizing situations from everyday life, etc.” PT6

“Counting and sorting objects found in the house according to shape, color, texture, and size while at the same time we asked our students to write down the numbers for what they found or counted. Our goal was for the preschoolers to be able to count things and to match the number of things with the numerical symbol.” PT8

“Although the main goal was not to lose touch with the school, we tried through organized activities for which it was tough and took an extremely long time to work on the correspondence things with shapes, groupings . . . but also mainly the counting.” PT11

“During e-learning, we tried to do many activities . . . I want to help children acquire mathematical knowledge skills through repetitive activities, drills, and practice. It was a classic in Word wall to match objects by their number. The goal was for the students to count the objects they saw in the pictures and match them with the correct number.” PT1

Additionally, teachers tried to stimulate children’s interest to ensure active participation in the remote teaching. They succeeded thanks to some experiential activities that mainly related to the thematic area of Geometry and less to Algebra. Specifically, using non-standard (arbitrary) units of measurement of various house objects, teachers simultaneously dealt with various concepts of Geometry, Algebra, Counting, and Measurement. Two teachers stated (PT7, PT5) that:

“Recognizing 2D or 3D shapes and classifying objects in the house according to the shape (circle, square, triangle), color, and size along with the writing of the number symbols. The aim was the sorting and to be able to correspond the number of objects with the numerical symbol.” PT7

“I asked the children to measure the length of their living room carpet with house tiles, [. . .], moreover, to classify three glasses according to their height, I encouraged children to use words such as taller and shorter.” PT5

6.3. Process Standards and Transformations

Although the participants' statements in the research showed that they made efforts to utilize the digital tools in mathematics, the activities carried out did not follow the processes of the mathematical activities as they take place in the face-to-face schooling. Preschool teachers referred that during remote teaching, they carried out problem-solving activities in which only some mathematical processes (Table 3), such as Connections, Representation, Reasoning and Proof, were mainly approached. Indicatively, three teachers stated (PT2, PT11, PT16) that:

"The material and activities we used in our real classes had to adapt to distance learning significantly. They mainly utilized non-standard units of measurement (house tiles, kitchen items, food, and home decoration items) for the activities we designed. With the help of their parents, we asked our young students to connect household items with mathematical concepts and to represent these concepts using their body, their hands, their face, etc. In this way, we approached these mathematical concepts as the children did not have in their homes the pedagogical material that exists in the mathematical corner." PT2

"During remote teaching, I think we lost a big experiential part, but the important is that we could move around the space to find objects, to measure distances, length, height, to compare them, calculate quantities and objects, to give reasonable explanations for any connections of objects with their ideas, to prove their explanations, to represent the numbers with many ways, etc." PT11

"During the holidays season, we dealt significantly with festive customs and mainly with recipes. I even asked the parents to cooperate, and we made recipes "live" from their kitchens by counting and measurement of ingredients and quantities (e.g., a spoon, a cup, etc.). During this activity, the children were invited to apply the concepts of quantity making connections and representations to observe the dosage of the recipe. They liked this process because the parents actively participated, even from home." PT16

Most teachers also referred to the barriers (Table 4) faced during distance learning, especially for mathematics. They referred to the lack of equipment or internet connection in schools. They also mentioned that children were unfamiliar with distance learning, which led to a continually reduced interest. They also highlighted the limited personalized teaching, the absence of pedagogical material related to mathematical concepts in face-to-face schooling, and the need to create and/or recreate digital material due to the lack of "real" material. Most children showed discomfort, indifference, and hostile behavior in this context, and the teachers struggled to improve the communication process standard in this limited context.

Table 4. Barriers and transformations for mathematics ($N = 16$).

Barriers	Transformations
Lack of equipment and/or problems with internet connections for teachers and students (12)	Create and/or recreate digital materials (12)
Teachers and students were unfamiliar with distance learning (13)	Combine their informal ideas with formal mathematical concepts by simplifying activities and goals (10)
Absence of pedagogical material for mathematics-related to remote teaching (10)	Utilize non-standard units of measurement (10)
Discomfort and damaging behavior of students (9)	Parents as facilitators (13)
The reduced interest of students (7)	Use of audiovisual material for the mobilization of students (8)
Difficulties in enacting the communication process standard (9)	Utilization of digital learning communities (14)
Limited personalized teaching methods (5)	

However, even within this context, preschool teachers, displaying the great flexibility that characterizes them, seemed to try using any difficulties as a trigger to find alternative

and valuable solutions. They referred to the transformations (Table 4) they had done to adapt those activities to the needs and conditions of distance education. They noticed that they used various alternative practices to encourage children to present their thoughts that combine their informal ideas with formal mathematical concepts by simplifying activities and goals. They also utilized non-standard units of measurement, the disposition of parents for active participation in the actions, adaptation of the teaching of mathematics and other cognitive objects, use of audiovisual material for the mobilization of learning, and active participation of students their dedication and concentration. Specifically, two teachers stated (PT1, PT10) that:

“The conditions were new, and the students struggled, although they adapted quickly. They had difficulty concentrating and lost interest more easily. Their participation in the process became smaller, although there was a great effort to include them and encourage them in discussion and participation by simplifying activities and mainly by using home material and non-standard units of measurement.” PT1

“Use of objects already in the children’s homes. Video and digital images were also used.” PT10

In this context, most preschool teachers reported that the presence of parents in the distance education process was a catalyst. Each parent contributed to this process in any way possible and seemed to have a facilitating role (as mediator) between the teacher, the student, the digital tools, and the learning processes (material, game, etc.). Specifically, two teachers (PT12 and PT14) stated about the presence of parents that:

“Children who found it difficult to perform in face-to-face schooling, in distance learning, with the support and active participation of their parents, which was a catalyst, felt comfortable and activated by participating significantly in several digital actions.” PT12

“Parents or older siblings of our students regularly participated actively by giving time and patience at a process they did not know and did not have to know. They were next to the children and tried to help them in many ways, taking advantage of the comfort of their home, often left their place, disappeared from the screen, and we were looking for them [. . .] they were important for us”. PT14

In the same context, most preschool teachers referred to the importance of the emergence of existing or the creation of new digital learning communities. They reported that they often turned to these communities to find good practices, material, and ideas and communicate problems encountered during distance learning to approach mathematical concepts and find online activities from peer suggestions. Two preschool teachers (PT14, PT13) characteristically stated:

“Fortunately, there were learning communities on Facebook or other personal pages. There, I found material and ideas. I asked at the forum about several problems I faced during distance education, especially mathematics, and I found amazing ideas and responses. Specifically, the wheels, the matching games, the classifications created by other preschool teachers using Twin Space tools, eTwinning tools, web2.0 tools were essential to all of us”. PT14

“The various communities that emerged during the pandemic helped me the most. I drew all the material, like video, digital images, digital tools, etc. I even found math worksheets in these communities.” PT13

6.4. The Utilization of Digital Environments for Mathematics in Face-to-Face Schooling

Regarding the digital environments they used during distance learning after returning to the actual classes, preschool teachers reported that they no longer use them because they have not been needed until now. Only four preschool teachers with postgraduate studies

trained in distance education and two trained in mathematics referred to the occasional use of some activities to remember them again or as an alternative approach for enriching the material they may need in the future. One of them (PT4) stated that:

“Now that we are back, at our real classrooms, I still use only Wordwall, some videos on YouTube, and some activities of Learning Apps as games and what we do in the classroom. The truth is that our students now in the classroom still ask for some activities we did during the distance education and attracted their interest”. PT4

A preschool teacher (PT16) with significant experience, postgraduate studies, and training in mathematics mentioned characteristically:

“At distance education, we mostly used the wheel of luck game, and we adapted some game elements to some mathematical activities in our real class. However, children like the distance wheel more because it was new for our students”. PT16

Nevertheless, most of them do not use digital environments. Preschool teachers typically mentioned that kindergarten means direct communication and active participation. For mathematics, they seem to think that although they could adapt several life-to-life math activities to digital classroom conditions, now that they have returned to their classes, they choose the school classroom materials. Furthermore, they prefer direct communication and engage their students with mathematics using tangible material and activities. Upon their return to the classroom, preschool teachers tried to approach all the concepts related to mathematics, but mainly those that were difficult to approach in the digital classrooms. In particular, the authentic communication frameworks and circumstances offered by the actual classroom enabled communication and problem-solving approaches, not only for processes such as Connections and Representation, which are dominant in digital classrooms. Two preschool teachers (PT3, PT10) characteristically stated that:

“Now that we are back in our classes, I try to use every opportunity, every occasion, to encourage my students to communicate mathematical concepts with each other, to solve problems, to give reasonable explanations, to interpret their mathematical concepts. I aim to give my students the chance to collaborate to understand mathematical concepts interactively, something that was not easy in the digital classroom”. PT3

“I do not use any of the practices and tools I used in distance education. Kindergarten means experiential learning, immediacy, contact, communication, active engagement, not digital tools and distance learning.” PT10

7. Discussion

This study aimed to investigate preschool teachers' practices in teaching mathematics during remote teaching and the utilization of the digital tools in teaching mathematics after their return to the actual classes. Concerning their practices during the pandemic, preschool teachers clearly stated that they did not know the platforms (WebEx, e-me, and e-class) indicated by the Ministry of Education. More specifically, they faced barriers such as lack of training for distance education, lack of equipment or internet connection in schools and students, and the children were unfamiliar with distance learning and limited personalized teaching. Moreover, they referred to continually reduced students' interest as they preferred direct contact and communication with their teacher and classmates [3,6]. In addition, the absence of pedagogical material related to mathematical concepts in face-to-face schooling led them to create and/or recreate digital material. Previous studies found similar findings [4,8,9].

Preschool teachers referred to content standards such as Numbers and Operations, Geometry and Measurement, and, to a lesser degree, Algebra. In contrast, they did not refer to the subject areas of Data Analysis and Probability. Specifically, they stated that they utilize activities to approach Counting, addition, classification, chronology, comparison,

recognizing 2D and 3D shapes, and measurement. Similarly, in previous studies, teachers focused on counting and shape recognition [8,9]. Moreover, preschool teachers referred to poor problem-solving activities, including process standards such as Connections, Representation, Reasoning, and Proof. This explicit reference of preschool teachers to processes such as Connections and Representation and not Communication and Problem Solving can be explained, as the last process is based on “authentic communication frameworks” that take place mainly within the face-to-face schooling and not the digital classrooms. The digital kindergarten classroom seems to weaken and significantly limit the communication process and the need to engage in solving problem processes that so often seem to arise in the context of a real preschool classroom [20].

Despite the initial difficulties that preschool teachers faced, they made many changes and transformations in approaching mathematical concepts, stimulating the students’ interest, and engaging them in the educational process. In this new situation, teachers had to plan and adapt the educational processes, including materials and means of communication and platforms. They also had to participate in activities to maintain the material safety of students, such as providing supplies, health products, and study materials [17,21]. In this way, teachers tried to use each child’s material in his house to approach mathematics through some experimental activities. Simultaneously, they encouraged the children to present their thoughts, combine informal ideas with formal mathematical concepts, and simplify activities. This frame utilized audiovisual material to mobilize students’ learning, active participation, dedication, and concentration. The benefits of digital tools on mathematics for preschoolers have been cited by many researchers [15,22–24].

In addition, some participants referred to the difficulty of applying individualized teaching methods according to the principles of differentiated teaching. However, preschool teachers reported that the presence of parents in the distance education process was a catalyst for this situation, too. Other studies have cited these findings (e.g., [3]), which referred to parents as facilitators between teachers and preschoolers. This process could be time-consuming for the parents, since they also have their work, they need to focus on. However, studies have shown that parents showed a natural protective attitude towards their children. They already considered that mathematics is essential for their life since they frequently used computation themselves [20,25].

It is worth mentioning that the emergence of existing or new digital learning communities contributed to supporting teachers to provide remote teaching [26]. These online learning communities that operated on social media (e.g., “Distance education for kindergarten”, “Support for teachers in distance learning and ICT”, etc.) emerged due to the need for communication and exchange of good practices of teachers among themselves for several thematic areas. They reported that online learning communities offered material and ideas, but also helped and supported the problems that teachers faced during distance learning, such as online activities for mathematical concepts.

Even though preschool teachers reported that during distance learning, they used digital tools for interdisciplinary activities [4], after returning to face-to-face schooling, they avoided using them. However, some teachers accept that this experience supplied them with technological skills that could be utilized in similar situations [4]. Almost all of the participants in our study prefer authentic communication frameworks and communication circumstances offered by the real classrooms to enhance all mathematical process standards and not only Connections and Representation, which were dominant in the digital classrooms. They prefer classroom materials to enhance communication skills, mainly tangible materials and collaborative activities [12]. According to teachers, a kindergarten classroom means communication and active participation. In conclusion, although distance education cannot replace traditional education, this new treaty can greatly benefit education, as targeted and well-designed teacher training can be adequate.

8. Implications

Our findings could provide a basis for distance education for all stakeholders. Policymakers should include online activities for solving problem processes approaching mathematical concepts in the preschool curricula for mathematics. More digital tools should be created and/or recreated in this context, providing enriched environments with suitable materials for learning mathematics. These environments should include activities for all content standards.

Regarding that the online learning community plays a vital role in remote teaching, policymakers should support an official online education community that will provide guidelines and organize online activities and innovative practices for confronting emergency crises.

The findings indicate the implementation of teacher professional development programs that should enhance teachers' digital competencies [4,8]. These training programs should indicate ways to utilize process standards for teaching mathematics that could be adopted in similar situations. The emphasis should be on utilizing the problem-solving process in remote and face-to-face teaching. Moreover, ways to engage parents and their good practices in the learning process should be suggested.

9. Limitations and Future Research

The small sample size is the main limitation of this study. Moreover, the findings were based on self-report, and this fact usually leads to biased responses [27]. Future research is suggested to include a more significant sample and investigate teachers' good practices during remote teaching, providing insights into which technology is more appropriate to reduce barriers and enhance students' interest. Finally, considering the catalyst role of parents during the remote teaching, it is suggested to triangulate the experiences of parents and teachers.

Author Contributions: Data curation, K.L.; formal analysis, K.L. and Z.A.; methodology, Z.A.; writing—original draft, K.L. and Z.A.; writing—review and editing, S.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The research protocol conforms to the ethical guidelines of the European Union. Permission was given by teachers prior to the research. Ethical considerations and guidelines concerning the privacy of individuals were carefully taken into account throughout the whole research process (<https://research.upatras.gr/portfolio/ehde/?lang=en>, accessed on 1 June 2022).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data are not publicly available as this is ongoing research.

Conflicts of Interest: The authors declare no conflict of interest.

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