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ABSTRACT
This study was conducted to examine the effect of the program designed with the flipped learning education model on preschool children's early mathematics skills. The study group consisted of children attending the official kindergarten affiliated with the Ministry of National Education in the Karatay district of the Konya province in the 2022-2023 academic year. There were 50 children in the study. The number of girls was 12 (48%) in the experimental group and 10 (40%) in the control group. A quasi-experimental model was used in the study. The "General Information Form" and the "Early Mathematics Aptitude Test-3 (TEMA-3)" were used to collect the research data. The education program designed with the flipped learning education model was implemented for 12 weeks with the children in the experimental group. The 12-week training program focuses on reinforcing each topic with children through daily activities. The program covers the fundamental topics of mathematics. As a result of the analysis of the research data, it was evident that the children in the study group had equivalent early math skills before the implementation. After the implementation of the program designed with the flipped learning model in the experimental group, it was determined that a significant difference existed between the experimental and control groups in the "TEMA 3" post-test application. It was determined that the children in the experimental group were more successful than the children in the control group in terms of math skills.

Keywords: Flipped Learning Method, mathematics skills, preschool education.

Introduction

In today's rapidly changing educational environment, studies on mathematics, research into effective teaching methods continue (Ernest, 2018; Hamami & Morris, 2020; Izmirli, 2020; Sriraman, 2021). Mathematics teaching is important in every level of education and, importantly, also, mathematics teaching gains importance in the preschool period. In this period, children's relationships with mathematics play a fundamental role in the mathematical skills they will acquire later in life. The preschool period is an important time for children to develop their relationship with mathematics. In this period, children begin to explore mathematical concepts, and this discovery process determines the mathematical skills they will acquire later in life (NCTM, 2007; Susperreguy, et al., 2022). In this context, the concept of "flipped learning" as an innovative educational model that goes beyond traditional learning methods is attracting more and more attention. Traditional learning methods have been used in education systems for many years. However, with the rapid development of technology and easy access to information, new educational models are emerging. Flipped learning stands out as one of these new educational models (Baker, 2000; Ünsal, 2018).

Flipped learning allows students to experience the learning process in a different way from traditional approaches. Instead of transferring knowledge to students, this method encourages students to explore, question, and apply knowledge. Using this model can help students develop mathematical skills by connecting abstract mathematical concepts with concrete experiences and developing a deeper understanding (Kates, Byrd, & Haider, 2015; Larcara, 2015).

The flipped learning educational model aims to make classroom time productive. In this model, learners perform tasks, such as acquiring knowledge outside of school, that require basic skills. Tasks that require higher-level skills such as application, problem-solving, and creativity are performed in the classroom under the guidance of the teacher (Aydın & Demirer, 2016). This education system is a teaching-learning method that enables students to engage more in subject-related activities on their own in the classroom environment and enables the teacher to deal with the learner one-on-one. In contrast to traditional education, the flipped classroom system is defined as a method that offers students the opportunity to learn theoretical knowledge at home on their own and apply what they have learned at school (Zownorega, 2013).Especially considering the development of technology and instructional technologies, it is believed that the limitations of learning environments can be minimized with these technologies (Torun & Dargut, 2015).

Flipped Learning offers a different perspective compared to traditional educational methods (Ihamaki & Heljakka, 2019) and can help children better understand and learn mathematical concepts. Mathematical skills are critical in modern society. These skills play an important role in the development of basic competencies such as problem-solving ability, logical thinking, and analytical thinking (Gürgah Oğul & Aktaş Arnas, 2020). Therefore, it is of great importance to provide a solid foundation for preschool children to establish a positive relationship with mathematics and develop these skills at an early age (Huntsinger, Jose, & Luo, 2016; NAEYC, 2002; NCTM, 2007).

Traditional mathematics teaching methods can reduce children's interest and motivation in this area. Students often struggle to understand abstract mathematical concepts and become bored with mathematics. This is where the flipped learning model comes in. This model can make learning mathematics more enjoyable and meaningful by increasing students' interaction with mathematics through games, applications, and concrete experiences (Cevikbas & Kaiser, 2020; Lessani et al., 2017; Lo & Hew, 2020).

Teaching in online environments can take place at different times with electronic materials such as text, video, audio recordings, or activities such as forum discussions; or it can take place simultaneously with applications such as instant messaging, audio, or video distance education platforms (Hayırsever & Orhan, 2018). To raise individuals with 21st-century skills, educational practices need to be adapted accordingly. In this context, with the developments in teaching-learning theories and approaches today, technology-supported and student-centered approaches are

being addressed rather than the teacher-oriented methods and techniques of traditional education. With the advances in information and communication technologies , differences in teaching approaches have become inevitable (Kozikoğlu et al., 2021).

The other positive aspect of the method is that it allows active learning activities in the classroom to be carried out in cooperation. In this context, group-based, interactive learning activities are included in various studies in the literature. Collaborative activities increase the communication skills of learners and help develop them into stronger individuals in the sociocultural context (Demirer & Aydın, 2017).

The flipped learning model has gained attention in recent years as an innovative approach in education. However, there are a limited number of studies on the effects of this model in early childhood education, particularly in mathematics instruction, where foundational skills are developed. At the preschool level, children tend to learn through concrete experiences, and traditional teaching methods are more commonly used. Therefore, it is important to examine how student-centered, digitally-supported approaches like flipped learning function with this age group and how they contribute to the development of mathematical skills (Nong & Cao, 2023; Rahman et al., 2020; Zownorega, 2013).

Existing literature has shown that the flipped learning model increases student engagement, personalizes the learning process, and supports deeper learning. However, these studies typically focus on middle school, high school, and university students (Bārdule , 2021;Hossein-Mohand et al., 2021; Sein-Echaluce et al., 2024; Tekin & Karakaya, 2020) . There is a lack of sufficient evidence regarding the applicability and effectiveness of this model in early childhood education. Additionally, it is well known that the development of mathematical thinking skills at an early age is critical for future academic success. Aiming to fill this gap in the literature, researching how the flipped learning model impacts preschool children's learning processes, in the context of mathematics education .

In summary, this study aims to investigate the effectiveness of the flipped learning model in early childhood mathematics education in order to address gaps in the existing literature and provide more insights into the applicability of this innovative approach within early childhood educationThis study will examine the effectiveness of the flipped learning model in preschool mathematics education. As a result, this research is planned to offer a perspective that goes beyond traditional approaches to developing mathematical skills in preschool. The flipped learning model will be tested to see whether it can help children develop mathematical skills. Furthermore, the aim is to make preschool mathematics education more effective by providing educators with practical suggestions on how to apply this model to make preschool mathematics education more effective.

Methods and Materials

Research Design

This study was conducted using a pre-test, post-test control group experimental model in which both the experimental and control groups were tested before and after the application. The dependent variable of the study is the early math skills of preschool children. The independent variable of the study is the program designed with the flipped learning model, which is carried out at school and at home. The method involving an experimental group, in which the application will be made, and a control group, in which only the tests will be conducted is called the quasi-experimental model with the pretest-posttest control group. The method is called quasi-experimental because the study group is determined by the purposive sampling method (Karasar, 1986).

Study Group

The study group of this research consists of children attending kindergartens affiliated with the Ministry of National Education in the Karatay district of Konya province. In the 2022-2023 academic year, two kindergartens in the district center were selected using the purposive sampling

method. Twenty-five children in one of these kindergartens constituted the experimental group, while 25 children in the other constituted the control group. Demographic information of the children and their parents, who participated in the study, is given in Table 1. The principle of volunteerism was observed in the study. A pre-test and post-test control group experimental design was used. Before the study started, a meeting was held with the families; the purpose, subject, and content of the study were explained, and information about the program was given. Permission was requested from the parents for their children's participation in the study, and the parents who agreed signed the "Consent Form for Participation in the Study." The demographic characteristics of the children and parents included in the program are given in Table 1.

Table 1. *Comparison of Descriptive Characteristics of Participants According to Groups*

	Group		Test (p)
	Experiment n=25	Control n=25	
Gender, n (%)			
Female	12 (%48)	10 (%40)	$\chi2$=0.325 p=0.569
Male	13 (%52)	15 (%60)	
Age (month)			
X ± SD	61.44 ± 2.40	61.96 ± 2.39	t=-0.768 p=0.446
M (min-max)	62 (56-65)	62 (57-66)	
Number of siblings (person)			
X ± SD	1.12 ± 0.83	0.96 ± 0.45	t=0.843 p=0.403
M (min-max)	1 (0-4)	1 (0-2)	
Mother's Education Level, n (%)			
Primary/Secondary Education	8 (%32)	4 (%16)	
High School	4 (%16)	5 (%20)	$\chi2$=1.873 p=0.599
Associate Degree/Bachelor's Degree	4 (%16)	4 (%16)	
Postgraduate	9 (%36)	12 (%48)	
Father's Education Level, n (%)			
Primary/Secondary Education	7 (%28)	2 (%8)	
High School	4 (%16)	3 (%12)	$\chi2$=3.987 p=0.263
Associate Degree/Bachelor's Degree	4 (%16)	6 (%24)	
Postgraduate	10 (%40)	14 (%56)	
Economic Status, n (%)			
Military pay	5 (%20)	3 (%12)	$\chi2$=0.595 p=0.440
Above military wage	20 (%80)	22 (%88)	

Independent Sample t Test (t); Chi-Square Test ($\chi2$); Descriptive statistics are given as mean (X), standard deviation (SD), Median (M), minimum (min), maximum (max), number (n), percentage (%).

Table 1 shows the distribution of the descriptive characteristics of the participants according to the groups. There were a total of 50 children in the study, 25 in the experimental group and 25 in the control group. The number of girls was 12 (48%) in the experimental group and 10 (40%) in the control group. The median age of the children was 62 months in the experimental group and 62 months in the control group. The median number of siblings in the experimental and control groups was one. The descriptive characteristics of the children and their parents in the control and experimental groups had a homogeneous distribution ($p>0.05$).

Research Instruments and Processes

Within the scope of the study, TEMA 3 Math Ability Test was used to evaluate the mathematics skills of the study group, and the General Information Form was used for demographic information.

General information form: In the General Information Form, information about the child and the family was obtained, including the date of birth, gender, number of siblings, parents' education level, and income level. This form was filled in by the parents of the children and submitted to the researcher.

Test of Early Mathematics Ability (TEMA-3): The Test of Early Mathematics Ability (TEMA), developed by Ginsburg and Baroody in 1983, assesses the mathematical abilities of children between the ages of three years and eight years and eleven months. The same test was revised in 1990 and updated as TEMA-2. After 3 years, the TEMA-2 test was revised updated and finalized as TEMA-3. In this test, the A and B forms of TEMA-3, children's mathematical skills are evaluated with applications using various materials, pictures, mathematical symbols, and countable small objects. Before starting the questions, the chronological age of the child is calculated. The test question appropriate for the child's chronological age is asked of the child. Each item is evaluated as 0-point or 1-point. To finalize the test, the child must score 0 on five consecutive questions. The children's correct answers are summed to obtain a raw score (Ginsburg & Baroody, 2003, p. 12). The standardization, adaptation, validity, and reliability studies of TEMA-3 were conducted, and it was determined that the scale is suitable for measuring Turkish children's mathematics skills (Erdoğan, 2006; Şeker & Ali Sinanoğlu, 2017; Yüzbaşıoğlu & Tepeli, 2022).

Data Analysis

This study aimed to evaluate the effect of the Family Involvement Mathematics Program on preschool children's mathematics skills. the program was prepared by reviewing the literature, drafting by the researchers, and finalizing with input from 5 experts in child development. All necessary permissions (such as permission to use the scale and parental permissions) and ethical approval were obtained for the implementation of the program. As a pretest, Form A of the Theme 3 test was administered to both the experimental and control groups in February. In March, April, and May (12 weeks), the education program designed with the flipped learning education model was applied to the experimental group. The program included geometric shapes, sorting, grouping, patterns, graphing, reading, numbers, and simple operations (addition and subtraction), which are the basic topics of mathematics. These topics are taught to children in a planned and systematic way through the Google Class application and in-class activities. The math concepts and skills learned at home are reinforced at school. One of the strengths of this program is that it is based on the inclusion of families in education, allowing concepts to be learned at home and reinforced at school, enabling children to spend quality time with their families and fostering teacher-parent collaboration. The program's topics and concepts range from simple to difficult and include concepts that children are familiar with and topics that they will encounter in daily life, all of which are based on developmental principles. The 12-week education program is based on reinforcing one topic per day with an activity. The program was applied to the experimental group alongside their regular pre-school education. There are three phases in the program. The first phase is the flipped phase. This phase is conducted at home. For example, children are asked to watch a short video with their parents. The video includes: Introduction of numbers from 1 to 10. Demonstrations of counting with various objects (like apples, toys). Examples of grouping objects by color, size, shape, etc. Parents are encouraged to engage with their children by asking questions and helping them practice counting and grouping with their own toys or household objects while watching the video. In the class phase, the teacher starts by reminding the children about the video they watched at home and asks them to share what they learned. A counting song is sung together to help the children recall the numbers. Children are given different objects, such as blocks and

plastic animals, to count. Each child takes turns counting the objects they have chosen and says how many there are. The teacher supports each child's counting and encourages participation from the rest of the class. In the conclusion and review phase, the teacher summarizes what the children did and praises their progress in counting and grouping. The children can take home a small counting kit (e.g., number cards and objects) to repeat the activity with their parents. Parents were informed about the program before and during the implementation process through informative letters. The activities to be shared on Google Class at home were explained to the parents, and they were asked to photograph the activities and share them with the researcher. The control group was only included in pre-school education.

The data collected in the study were evaluated in SPSS statistical package. Descriptive statistics are given as mean (X) and standard deviation (SD) values.

At the decision stage, if the absolute skewness (Skewness) value is between -2.0 and 2.0 and the kurtosis (Kurtosis,) value is below 7.0, it is decided that the data are normally distributed (Kim, 2013). Accordingly, the skewness and kurtosis values of the variables used in the study are given in Table 2, indicating that the data are suitable for normal distribution. In addition, Shapiro-Wilk normality test results showed that the data were not suitable for normal distribution ($p<0.05$).

Table 2. *Normality Analysis For TEMA-3 Scores*

	Skewness	Kurtosis	Shapiro Wilk	
			Test	p
TEMA-3				
Pre-test	0.578	0.069	0.950	0.060
Post-test	0.540	0.291	0.966	0.109

Independent Sample t test was used to compare the numerical descriptive characteristics of the participants between groups, and chi-square tests (Pearson chi-square/Fisher exact test) were used to compare the categorical descriptive characteristics between groups.

Mixed-effects analysis of variance (ANOVA) was used to compare the variables according to the follow-up times. Bonferroni correction was applied for the comparison of main effects in the analysis. A value of $p<0.05$ was considered statistically significant.

Ethical Considerations

This study was conducted in accordance with scientific ethical principles and complied with research and publication ethics. It was found "appropriate" by Konya Necmettin Erbakan University Social and Human Sciences Scientific Research Ethics Committee with decision dated

2023 and 2025.

Findings

The findings regarding the effect of the flipped learning model on mathematics skills are presented below in tables and figures.Table 3 shows the comparison of TEMA-3 scores, at follow-up times according to the groups.

Table 3. *Comparison Of TEMA-3 Scores By Groups At Follow-Up Times*

	Group		**Test Statistics †**
	Experiment *n*=25	Control *n*=25	
TEMA-3			
Pre-test	18.12 ± 1.56	18.20 ± 1.26	F=0.040 p=0.843 η2=0.001
Post-test	21.12 ± 2.05	19.24 ± 1.23	**F=15.457 p<0.001 η2=0.244**
Test Statistics ϕ	**F=229.983 p<0.001 η2=0.827**	**F=27.639 p<0.001 η2=0.365**	
Difference & (Post-Pre)	3.00 ± 1.16	1.04 ± 0.79	**F=49.083 p<0.001 η2=0.506**

Mixed Design ANOVA (F), Effect Size (η2), ϕ Intra-group comparison, † Inter-group comparison, & Comparison of Initial and Final score differences between groups, Descriptive statistics are given as mean (X), standard deviation (SD) values. Bolded sections are statistically significant (p<0.05).

It was found that the mean TEMA-3 scores did not show a statistically significant difference between the groups at the pre-test measurement time (F=0.040, p=0.843). At the post-test measurement time, the mean TEMA-3 score of the experimental group was statistically higher than the control group (F=15.457, p<0.001).

In the control group, the mean TEMA-3 scores in the post-test were statistically higher (F=229.983, p<0.001) compared to the pre-test. In the experimental group, the mean TEMA-3 scores in the post-test were statistically higher (F=27.639, p<0.001) compared to the pre-test.

As a result, there was a statistically significant increase of 3.00 ± 1.16 units in the experimental group and 1.04 ± 0.79 units in the control group, in TEMA-3 scores. This increase was statistically higher in the experimental group than in the control group (F=49.083, p<0.001). The change in TEMA scores at measurement times is shown in Figure 1.

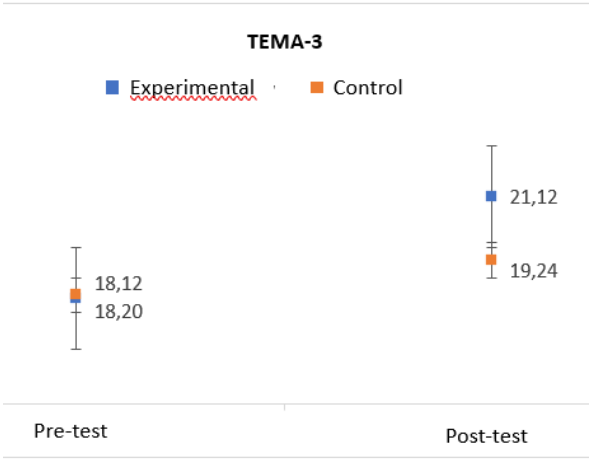

Figure 1. *Change in TEMA-3 scores according to groups at follow-up times*

Discussion

The study, which examined the effect of the mathematics education program designed with the Flipped Learning Model on the mathematics skills of preschool children, found that this program had a significant effect on children's mathematics skills as a result. When the results of the study were examined, statistically significant differences in the TEMA-3 Mathematics Aptitude Test mean scores were found in favor of the post-tests, after the education program was applied to the experimental group. There was no statistically significant difference between the pre-test and post-test scores of the children in the control group. According to these results, the mathematics education program designed with the Flipped Learning Model, applied to the children in the experimental group, was effective in supporting children's mathematics skills.

In the preschool period, a critical time in the development process, the quality educational environment offered to children in the home and at school will positively affect the development of mathematics skills. In this respect, it is necessary to plan and develop practices and activities for mathematics skills to be carried out in cooperation with home and school. There are various studies in the literature addressing the development of preschool children's mathematical skills. Susperreguy and Davis-Kean (2016) examined the relationship between the amount of mathematical talk that preschool children heard from their mothers at home and their early mathematics skills one year later. The study found that more exposure to mathematics talk in the home environment was positively associated with early mathematics skills. Anders et al. (2012) examined the effect of the quality of home and preschool learning environments on the development of early math skills. They found that the learning quality of the home environment was significantly associated with early mathematics skills in the first year of preschool education, and this advantage had a positive effect in the following years. On the other hand, the quality of preschool education did not have a significant relationship with early mathematics skills in the first years of preschool education; however, it had a significant effect on the development process. This draws attention to the different effects of home and preschool learning environments on the development of math skills. Karademir and Akman (2019) examined the effect of inquiry-based mathematics activities on preschool children's mathematics skills. The study found that inquiry-based mathematics activities had a positive and lasting effect on preschool children's operation and number skills. It was also emphasized that these activities enable preschool children to develop their mathematical concepts, learn new ones, and apply their mathematical skills meaningfully. Özkan and Baydar (2021) investigated the effects of mothers' encouraging parenting practices and children's verbal skills in early childhood on mathematics skills, at the age of 7, using data from a 5-year longitudinal study on children who started at age 3. The study found that encouraging parenting significantly predicted 7-year-old math skills. In addition, it was concluded that the mathematics education program

integrated with drama (Erdoğan, 2006), the mathematics education program for young children (Çelik & Kandır, 2013; Kumaş & Ergül, 2021), and the early mathematics comprehension program (Starkey et al., 2004) also had significant effects on the mathematical skills of preschool children.

When the literature are examined, it can be seen that the studies conducted with the flipped learning model in the preschool period are limited. Halili and Razak (2018) examined the effect of the flipped learning approach on preschool children's English language learning and concluded that this approach had positive effects on children's learning processes. Janwan, Lestary, and Simpol (2021), conducted a study with 17 preschool children to develop the flipped learning model during the COVID-19 pandemic, evaluate its efficiency, and examine the attitudes of preschool students and their parents who applied this model. As a result of the research, it was found that the flipped learning model increased student achievement, positively affected students' attitudes towards learning, and satisfied parents. Malekshahi, Esmaeeli, and Shojaee (2022) investigated the effect of play-based mathematics education on preschool children's social skills and academic self-efficacy through flipped learning. As a result of the research, it is emphasized that play-based mathematics teaching can increase preschool children's social skills and self-efficacy, and this can be achieved through flipped learning. Türk and Ev Çimen (2022) examined the views of mathematics teachers on the flipped learning model. In the study, it was concluded that the majority of pre-service teachers emphasized the strengths of the flipped learning model and noted it is applicable in the mathematics teaching process. Yüzbaşıoğlu et al. (2023) examined the effect of educational practices designed with the flipped learning model on children's science process skills and concluded that it had a significant effect. In the study conducted by Ünlütürk (2022), it has been determined that science education supported by out-of-school learning, structured with flipped learning, increases students' academic achievement and self-directed learning skills with technology. Additionally, it has been found that these methods reduce students' anxiety about science. It was also concluded that there is no significant relationship between self-directed learning and anxiety towards science (Ünlütürk, 2022).

The Flipped Learning Model has many advantages, such as supporting more hands-on learning, being student-oriented, enabling collaborative learning, and providing immediate and regular formative feedback (Altemueller & Lindquist, 2017). However, difficulties in preschool children's independent access to digital teaching platforms and making adaptations according to their needs can be seen as limitations in the application of this model (Pozo Sánchez et al., 2019). Research that examined studies conducted with the Flipped Learning Model in mathematics education concluded that this model had positive effects on student engagement, academic achievement, and attitude. In addition, it is emphasized that studies on the Flipped Learning Model in mathematics education are mostly carried out in the middle and high school groups, and there are insufficient studies in the pre-school and primary school groups (Ezentaş & Karakaş, 2021). The literature shows that there are limited studies on the use of the Flipped Learning Model in the preschool period. However, despite this limitation, it is an accepted model. Considering the important role of early mathematics experiences at home and school in the development of children's mathematics skills, it is thought that the Flipped Learning Model can be used in early childhood mathematics education.

Result and Recommendation

The mathematics education program developed for preschool children was designed using the flipped learning model, and the findings of the study show that this program has a significant effect on children's mathematics skills. In the experimental group where the program was implemented, it was observed that the post-test scores of the TEMA 3 mathematics ability test increased compared to the pre-test scores. This result indicates that the educational program is suitable for preschool children and supports their mathematical skills. The study was designed with the flipped learning model, and was limited to mathematics skills. Based on flipped learning model results, some recommendations can be given for parents, teachers, and researchers . Since flipped learning begins at home and deepens in the classroom, spending quality time with the child during home learning sessions helps the math learning. Providing short videos and interactive materials for

students to review and engage with at home can support math skills. These resources should be simple, clear, and age-appropriate. The effect of the flipped learning model on different skills and disciplines can be tested in preschool and other educational levels. In the education system, new learning-teaching approaches, models, methods, techniques, and various applications are emerging every day, and all these applications are gradually becoming widespread at different levels of education. Educators can be informed about making applications on educational technology-related subjects, such as the Flipped Learning Model, at all levels of education. The Flipped Learning model has distinct characteristics from the traditional method. This situation shows that students, teachers, and families need an adaptation process. Future studies can be conducted to examine the factors affecting the acclimatization process of students, educators, and families. It is also recommended to conduct qualitative studies to gather opinions from researchers who have applied this method and students who are trained in this method. Planning to investigate the long-term effects of the flipped learning model on preschool children to examine how early development of math skills benefits later educational outcomes can be undertaken. One can study how the flipped learning model influences other cognitive abilities, such as problem-solving and abstract thinking, to gain a broader understanding of its effects. It can also involve developing new strategies for effectively integrating technology with the flipped learning model for preschool children. These recommendations can help promote the wider adoption and effective implementation of the flipped learning model.

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