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Examination of Home-Based Number and Operation Training Program on Early Mathematics Ability and Mother-Child Relationship*

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Abstract

This study aims to examine the effect of the "Number and Operation Training Program" on early mathematics ability and mother-child relationship at home. In an experimental design, pre-test, post-test, permanence test were used with control groups. A total of 21 children and their mothers participated in the research; consisting of 13 children in the experimental group and 8 children in the control group in the Aksaray province (in Turkey). Personal Information Form, Early Mathematics Ability Test-3, Child-Parent Relationship Scale and Mother Interview Form were used as data collection tools. The training program had been implemented for 13 weeks prior to the data collection. The study found that the training program increased children's scores on early mathematics ability and the positive relationship with their mothers. Mothers stated that the most important contributions of the training program to their children were "recognizing numbers, learning numbers, learning geometric shapes, knowing the total number of objects displayed in the group, learning new games and playing games with family members". They also stated that the most important gains for them were "better relationship and quality time with their children and increased use of mathematics in daily life".

Keywords:

Early Mathematics Education, Home Visit, Home Math Environment, Mother-Child Relationship

Introduction

The basic mathematical skills that children acquire at an early age have a significant impact on the development of mathematics skills and other academic abilities in the following years (Aunio & Niemivirta, 2010; Claessens et al., 2009; Huntsinger et al., 2016; Merz et al., 2014). Low counting skills have a negative impact on employment prospects and the economic status of countries (Kadosh et al., 2013). Given the impact of early academic skills on children's future academic success, employment prospects, and the economic status of countries; the importance of developing these skills of young children is evident.

Studies highlight some of the main factors that affect children's academic achievement and mathematical performance, which include the socioeconomic status of the family (Jordan & Levine, 2009), child's gender (Dickhäuser & Meyer, 2006), race and ethnicity (Cross et al., 2009). In recent years, there has been an increase in studies investigating the effects of the home math environment on children's mathematical skills (Daucourt et al., 2021; DeFlorio & Beliakoff, 2015; Hart et al., 2016; Kluczniok et al., 2013; Kwing- Cheung & McBride, 2017; Lombardi & Dearing, 2020; Niklas al., 2016; Niklas & Schneider, 2014; Sonnenschein et al., 2012; Susperreguy et al., 2020; Susperreguy & Davis-Kean, 2016; Zhang et al., 2019). These studies show that the quality of the home environment in which young children live, their parents' academic expectations, beliefs and attitudes towards mathematics significantly affect children's mathematical skills (Anders et al., 2012; Kleemans et al., 2012; Skwarchuk et al., 2014; Sonnenschein et al., 2012).

The Home Math Environment (HME), which includes all math-related activities, parental attitudes and expectations, resources provided to the child at home, and parent-child interactions, is considered a potentially promising environment in promoting children's early math development (Daucourt et al., 2021; DREME, 2020). The home math environment covers experiences in which children participate interactively with their parents as well as counting, recognizing numbers and playing logical games (LeFevre et al., 2009; Napoli & Purpura, 2018).

According to the "home mathematical skill model" proposed by Skwarchuk, Sowinski and LeFevre (2014), parental attitudes have an indirect effect on children's mathematical skills through their behaviours. This model emphasizes the role of the parent as the main determinant of the home math environment. Parents play an important role in early learning at home by providing a learning environment that will allow children to become aware of everyday situations (Cross et al., 2009; Hart et al., 2016).

Formal math activities at home denote experiences in which parents directly and purposefully teach numbers, quantity or arithmetic to their children to improve their knowledge of mathematics. In contrast, informal math activities refer to experiences or situations, such as cooking, measurement activities or crafts required in carpentry, quantity comparisons, spatial processing, which do not have a direct mathematical teaching purpose (Skwarchuk, Sowinski & LeFevre, 2014). Doing math activities appropriate to the developmental characteristics of children in the home environment is positively associated with children's early mathematics knowledge in kindergarten and primary school (Blevens-Knabe & Musun-Miller, 2016; Eason, & Ramani, 2018; Huntsinger et al., 2016; Levine et al., 2019; Sonnenschein, Metzger &, Thompson, 2016; Susperreguy & Davis-Kean, 2016; Thompson et al., 2017; Zippert & Rittle-Johnson, 2020). Studies show that mathematical activities based on the interaction between parents and children in the home environment improve children's mathematical skills and increase mothers' awareness of mathematics (DeFlorio & Beliakoff, 2015; Hojnoski et al., 2014; Kwing-Cheung & McBride, 2017; LeFevre et al., 2010; Manolitsis et al., 2013; McCarthy et al., 2012; Melhuish et al., 2008; Niklas et al., 2016). The most effective factor in the success of the mathematics intervention programs is the determination of the strong and predictive factors that affect mathematics achievement (Güleç & İvrendi, 2017).

Considering the results of the research, it is expected that examining the variables of "mother" and "home environment" in order to improve children's mathematical skills in this study will be effective in gaining early math skills. There are few studies on home-centered mathematics implementations in early childhood in Turkey (Güleç & İvrendi, 2017; Gürgah-Oğul & Aktaş-Arnas, 2020; Orçan-Kaçan et al., 2016; Uslu-Çavdarcı, 2016; Uzun, 2013). Therefore, this study aims to increase children's early mathematical abilities and improve mother-child relationships by implementing a mathematics training program at home.

The Current Study

The aim of the study is to examine the effect of the Number and Operation Training Program on children's early mathematics ability and mother-child relationship. The program is directed towards young children aged between 48-65 months old, who do not attend pre-school education institutions. The implementation of the program requires home visits by the researchers and the active participation of mothers.

Ethical Consideration

Mothers were informed about the data collection process, their rights and the rights of their children as participants, and the measures taken to ensure their confidentiality. The first author highlighted that no personally identifying information would be used in the study in order to protect the participants' anonymity. In addition, mothers were told that they could leave the study at any time, if they or their children did no longer want to participate.

Method

This study adopts a mixed-methods research design, which utilizes both quantitative methods to provide a more general understanding of the problem as well as qualitative methods to generate an in-

depth awareness of the issue under investigation. Quantitative and qualitative data were used to examine the effect of the training program on the early mathematics ability of 48-65 month-old children and mother-child relationship. A hybrid method is a preferred method in research where a single data source is insufficient, a second method is required to develop the first method, and a general research goal can best be addressed in multiple stages or projects (Creswell & Plano Clark, 2011). In the quantitative part of the research, a semi-experimental pattern was used in multi-subject patterns from experimental research patterns. Experimental studies aim to test the effect of differences created by the researchers on the dependent variable. In experimental patterns, the main goal is to test the cause and effect relationship between variables (Büyüköztürk et al., 2014).

Participants

The participants of the study consists of 21 mothers and their children who do not attend any pre-school education institutions in Aksaray (a city of Turkey) and show normal development of 48-65 months. There are 8 children in the control group and 13 children in the experimental group. At the beginning of the study, the control group consisted of 12 mothers, however, 4 mothers with their children decided to leave the study due to health problems. Nine children in the experimental group were 48-59 months old and 4 were 60-65 months old. In addition, 5 of the children were girls and 8 were boys. Mothers of 8 of these children were aged between 20-35 years, and the rest of the mothers were 36 and above. Fathers of 7 of the children were aged between 25-35 years and the rest of the fathers were 36 and above. It was found that mothers of 9 of the children in the experimental group had education below high school level and 4 of them had high school or higher education; fathers of 8 children had education below high school level and fathers of 5 children had high school or higher education. It was determined that 2 of the children in the experimental group were the only child of their family, 8 of the children had two siblings, and 3 children had three or more siblings. It was found that 7 of the children in the control group were 48-59 months old and 1 was 60-75 months old. Four of these children were girls and 4 were boys. It was determined that mothers of 3 of the children in the control group were aged between 20-35 years and mothers of 5 of them were 36 years old and above. In addition, it was determined that fathers of 3 of the children were aged between 25-35 years old, and fathers of five of them were 36 and above. It was determined that mothers of 2 of the children in the control group had education below high school level, and 6 of them had a high school or higher education. Fathers of 4 of the children had education below high school level, while fathers of 4 of the children had high school or higher education. It was determined that 2 of the children in the control group were the only child in the family, 2 had two siblings, and 4 had three or more siblings.

Measures

Personal information form

Mothers of the children participating in the program were asked to fill the personal information form, which was generated to gather information on the ages and gender of the children, the number of children in the family, the ages of the parents, and their levels of education.

Test of early mathematics ability third edition (TEMA-3)

The Early Mathematics Ability Test - 3 (TEMA-3) (Ginsburg and Baroody, 2003) was used to assess children's mathematical skills. The scale measures the mathematics ability of children between the ages of 3 and 8 years and 11 months. It contains items designed to measure formal and informal mathematical knowledge. The math score of the children is determined by converting their raw score on the scorecard according to their chronological age. An increase in the math score indicates an increase in the children's math ability. The internal consistency scores of the tool were found to be 0.92 or higher (Ginsburg & Baroody, 2003). TEMA-3 was adapted into Turkish by Erdoğan (2006). The test-retest correlation calculated for reliability was calculated as 0.90. The internal consistency coefficient was found to be 0.92 for Form A (Erdoğan, 2006).

Child parent relationship scale

The Child-Parent Relationship Scale, which was developed by Pianta (1992) and adapted into Turkish by Akgün and Yeşilyaprak (2010), was used to determine the quality of the relationship between pre-school children and their parents before and after the implementation of the program. Regarding the reliability of the scale, the internal consistency coefficients (Cronbach's alpha) were found to be 0.85 for the conflict dimension subscale, 0.73 for the positive dimension subscale and 0.73 for the total scale.

Mother interview form for the number and operation training program

Mother Interview Form was designed to understand mothers' perspectives on the training program. Items on the form address mothers' expectations of the training program, the implementation process, meeting their expectations after the implementation, and the general contributions of the program to children's mathematics ability. The form consists of 10 unstructured questions.

Analysis Plan

Quantitative and qualitative data were collected for the research. Descriptive statistics (minimum, maximum, mean, standard deviation) were used in the analysis of the data. In addition, the Mann Whitney-U Test, which is one of the nonparametric tests used in experimental studies, especially when the sample size is low and the normality assumption is not met, and the Wilcoxon Signed Rank Test, which is used in cases where it is tried to determine whether there is a significant relationship between the pretest and posttest scores, is the parametric analysis of two-way analysis of variance. Friedman Test, which is calculated as an alternative to non-existent, was used. Content analysis was used in the analysis of qualitative data. The quantitative data collection tools used in the research are Early Mathematics Ability Test-3 and Child Parent Relationship Scale. The qualitative data collection tool used in the research is Mother Interview Form for the Number and Operation Training Program.

Procedure

Data Collection

Preparation of the number and operation training program

The training program is designed for 48-65 month-old children who do not attend any pre-school education institutions and for the mothers of these children who also do not attend any family education programs. The program aims to improve the number and operation skills of children and the mother-child relationship. The preparation stages of the training program are given as follows:

- In the creation of the content of the training program, a literature review on early childhood mathematics education was conducted. In this direction, firstly, the achievements and indicators established by the Ministry of Education - Preschool Education Program (2013) and the mathematics standards determined by NCTM (National Council of Teachers of Mathematics) (2000) for the pre-school period were examined.
- Secondly, mathematics education programs and some projects prepared for the school and home environment for the acquisition of mathematics skills in the pre-school period in Turkey and abroad were examined.
- Thirdly, the number and operation skills that are expected to be acquired in pre-school period and the basic skills associated with these skills were determined in accordance with the purpose of the educational program. These skills are defined as "matching, counting, recognizing numbers, classification, comparison, problem solving, addition and subtraction".
- Subsequently, the contents of the 13 home visits, which make up the training program were included in the program.
- A total of 5 experts evaluated the contents of the program and the appropriateness of the activities prepared for the program in terms of "acquisition and indicator, instructions, material properties, the subjects discussed and the evaluation".
- According to the feedback received, the program was given its final form.

Pre-Tests

Personal Information Form, Early Mathematics Ability Test-3 (TEMA-3), Child-Parent Relationship Scale were implemented as pre-tests. In addition, Mother Interview Form was applied to understand the perspectives of the mothers on the purpose of their participation in the Number and Operation Training Program.

Implementation of the Number and Operation Training Program

In the first week of the training program, all the mothers and their children were visited in their home environment, and the mothers were informed about the contents of the training program. After an introductory game, the days and hours of the visit were determined with each mother, taking into account the availabilities of the mothers. The families were informed that the researcher would visit their homes once a week for 13 weeks and the home would last an average of 45 minutes. Each week, the mothers were asked to prepare the necessary materials for the following week. Mothers were asked to repeat the activity with the participation of other family members (father, sibling, and so on) during the week.

Post-Tests and Permanence Tests

Early Mathematics Ability Test-3 (TEMA-3) and Child-Parent Relationship Scale were implemented as post-tests and permanence tests. In addition, Mother Interview Form was used.

Results

The data collected in this part of the study are analyzed and the results are presented in the following tables.

Findings on Children's Early Math Ability

Table 1

Descriptive Statistics Calculated on the Early Mathematics Abilities of the Children in the Experimental and Control Groups before the Implementation.

Tests	Groups	N	Min.	Max.	M	SD
Pre-test	Experimental	13	77.00	124.00	92.46	11.48
	Control	8	75.00	118.00	93.88	13.37

As demonstrated in Table 1, the lowest score in TEMA-3 received by the children in the experimental group

before the implementation was 77 while the highest score was 124. The average score of the children in the experimental group on the Early Mathematics Ability Test was 92.46, with a standard deviation of 11.48. It was determined that the scores of the children in the control group on the Early Mathematics Ability Test ranged between 75 and 118. The average score of the children in the control group on the Early Mathematics Ability Test before the implementation was 93.88, with a standard deviation of 13.37. According to the categorization made in line with the points that can be obtained from TEMA-3, scores within 90-110 range indicate the average skill level (Gingsburg & Baroody, 2003).

Table 2

Mann Whitney U Test Results on the Early Mathematics Ability Pre-Test Scores of Children in Experimental and Control Groups.

Test	Group	N	Mean Rank	Sum of Ranks	*U*	*z*	*p*
Pre-test,	Experimental	13	10.62	138.00			
	Control	8	11.63.	93.00	47.000	0.364	0.716

**p < 0 .05*

As shown in Table 2, the average scores of the children in the experimental and control groups before the implementation of the program did not show a significant difference (z = 0.364; p > 0.05).

Table 3

Mann Whitney U Test Results on Early Mathematics Ability Post-Test Scores of Children in Experimental and Control Groups.

Test	Group	N	Mean Rank	Sum of Ranks	*U*	*z*	*p*
Post-test	Experimental	13	13.77	179.00			
	Control	8	6.50	52.00	16.000	2.618	0.009*

**p < 0 .05*

As indicated in Table 3, the average scores of the children in the experimental and control groups on the Early Mathematics Ability post-test show a significant difference ($z = 2.618$; $p < 0.05$).

Table 4

Friedman Test Results on Early Mathematics Ability Pre-Test, Post-Test and Permanence Test Scores of Children in Experimental Group.

Group	Test	*N*		X^2	*p*
Experimental	Pre-test	13	1.08		
Group	Post-test	13	2.65	21.256	0.000*
	Permanence Test	13	2.27		

**p < 0 .05*

As demonstrated in Table 4, it is determined that the scores of the children in the experimental group on the Early Mathematics Ability Test before the implementation, after the implementation and in the permanence practice indicate a significant difference ($X^2 = 21.256$; $p < 0.05$).

Table 5 shows that the Early Mathematics Ability post-test scores and pre-test scores of the children in the experimental group differ significantly (z = 3.062; $p < 0.05$). When the mean and total scores are examined, it is seen that the post-test scores of the children in the experimental group are higher than the pre-test scores. Based on the results in Table 5, the Early Mathematics Ability permanence test and pre-test scores of the children in the experimental group also differ significantly (z = 3.065; $p < 0.05$). An examination of the mean rank and total scores shows that the permanence test scores of the children in the experimental group are higher than the pre-test scores. In line with the information in Table 5, it is found that there is no significant difference between the Early Mathematics Ability post-test average score and permanence test average score of the children in the experimental group (z = 1.205; $p > .05$).

Table 5

The Results of the Wilcoxon Signs Test Regarding the Early Mathematics Ability Pre-Test, Post-Test and Permanence Test Scores of the Children in the Experimental Group.

Group	Test		*N*		Rank Sum	*z*	*p*
Experimental Group	Post-test- Pre-test	Negative Ranks	0	0.00	0.00		
		Positive Ranks	12	6.50			
		Ties	1		78.00	3.062	0.002*
	Permanence Test-Pre test	Negative Ranks	0	0.00	0.00		
		Positive Ranks	12	6.50			
		Ties	1		78.00	3.065	0.002*
	Permanence Test- Post-test	Negative Ranks	6	3.50	21.00		
		Positive Ranks	1	7.00			
		Ties	6		7.00	1.205	0.228

**p < 0 .05*

Table 6

The Results of the Wilcoxon Signs Test Regarding the Early Mathematics Ability Pre-Test and Post-Test Scores of the Children in the Control Group.

Group	Test	Rank	N	Mean Rank	Rank Sum	z	p
Control Group	Post-test-Pre-test	Negative Rank	4	3.50	14.00	0.001	0.999
		Positive Rank	3	4.67	14.00		
		Ties	1				

*p < 0 .05

As demonstrated in Table 6, there is no significant difference between the pre-test and post-test results on the early mathematics abilities of the children in the control group (z = 0.001; *p* > 0 .05).

Findings Regarding the Mother and Child Relationship

The Mother-Child Relationship Test has two sub-dimensions: conflict relationship and positive relationship. The lowest score that can be obtained from the 14 items in the conflict relationship sub-dimension of the scale is 14 while the highest score is 70. High scores indicate a high conflict relationship between children and their mothers. Of the 10 items in the latter sub-dimension, designed to determine the positive relationship between pre-school children and their mothers, the lowest score that can be obtained is 10 while the highest score is 50. High scores from the positive relationship sub-dimension indicate a high positive relationship between children and their mothers.

Table 7

Descriptive Statistics Calculated Regarding the Mother-Child Relationship Test Scores of the Children in the Experimental and Control Groups before the Implementation.

Sub Dimension	Group	N	Min.	Max.	*M*	*SD*
Conflict Relationship	Experimental	13	29.00	47.00	36.77	6.07
	Control	8	29.00	50.00	38.13	6.92
Positive Relationship	Experimental	13	34.00	48.00	42.00	4.26
	Control	8	30.00	47.00	39.63	4.84

As revealed in Table 7, before the implementation of the program, the conflict relationship scores of the children in the experimental group varied between 29 and 47, with an average score of 36.77 (±6.07); while the scores of the children in the control group in this sub-dimension ranged between 29 and 50, with an average of 38.13 (±6.92). Thus, it can be concluded that the conflict relationship between the children with their mothers in both the experimental and control groups were moderate before the implementation of the program. Table 7 shows that the pre-test scores of the children in the experimental group on the positive relationship sub-dimension ranged between 34 and 48, with an average of 42.00 (±4.26). The positive relationship pre-test scores of the children in the control group with their mothers varied between 30 and 47, with an average score of 39.63 (± 4.84). In this context, the average scores calculated before the implementation indicate that the children in both the experimental and control groups had a positive relationship with their mothers, in general.

In accordance with the information in Table 8, it is determined that the mother conflict relationship pre-test scores of the children in the experimental and control groups do not show a significant difference (*z* = 0.472; *p* > 0.05). Similarly, it is found that the positive relationship between the children with their mothers in the experimental and control groups did not show a significant difference before the implementation of the program (*z* = 1.163; *p* > 0.05).

Based on the information in Table 9, the conflict relationship scores of the children in the experimental and control groups with their mothers do not show a significant difference after the implementation (*z* = 0.653; *p* > 0.05). As shown in the table, however, the positive relationships of children with their mothers differ significantly between groups (*z* = 2.760; *p* < 0.05). After the implementation, it is found that the children in the experimental group have a higher level of positive relationship with their mothers than the children in the control group.

As demonstrated in Table 10, the conflict relationship scores of the children in the experimental group before and after the implementation do not show a significant difference (*z* = 0.254; *p* > 0.05). In other words, it is determined that the mother conflict relationship pre-test and post-test scores of the children in the experimental group are similar. However, it is found that the positive relationship between the mothers and the children in the experimental group and the pre-test and post-test scores show a significant change (*z* = 0.254; *p* < 0.05). An examination of the mean rank and total scores indicates that the post-test scores of the children in the experimental group on the positive relationship sub-dimension are higher than the pre-test scores.

Table 11 displays that the conflict relationship post-test and permanence test scores of the children in the experimental group are significant different (*z* = 1.994; *p* < 0.05). Based on the mean rank and total scores, it is found that the scores on the conflict relationship of the children with their mothers are lower in the post-test than in the permanence test. It is found that the positive relationship permanence test and post-test scores of the children in the experimental group also show a significant change (*z* = 2.871; *p* < 0.05).

According to the information contained in Table 12, it is found that conflict relations with the mothers of children in the control group do not differ significantly

Table 8

Mann Whitney U Test Results Calculated for the Mother-Child Relationship Pre-Test Scores of the Children in the Experimental and Control Groups.

Sub Dimension	Group	N	Mean Rank	Rank Sum	*U*	*z*	*p*
Conflict Relationship	Experimental	13	10.50	136.50	45.500	0.472	0.645
	Control	8	11.81	94.50			
Positive Relationship	Experimental	13	12.23	159.00	36.000	1.163	0.268
	Control	8	9.00	72.00			

**p < 0 .05*

Table 9

Mann Whitney U Test Results Calculated for the Mother-Child Relationship Post-Test Scores of the Children in the Experimental and Control Groups.

Sub Dimension	Group	N	Mean Rank	Rank Sum	*U*	*z*	*p*
Conflict Relationship	Experimental	13	11.69	152.00	43.000	0.653	0.547
	Control	8	9.88	79.00			
Positive Relationship	Experimental	13	13.92	181.00	14.000	2.760	0.005*
	Control	8	6.25	50.00			

**p < 0 .05*

Table 10

The Results of the Wilcoxon Sign Test Calculated Regarding the Mother-Child Relationship Pre-Test and Post-Test Scores of the Children in the Experimental Group.

Sub Dimension	Test	Rank	*N*	Mean Rank	Rank Sum	*z*	*p*
Conflict Relationship	Post-test-Pre-test	Negative Rank	3	5.17	15.50	0.254	0.799
		Positive Rank	4	3.13	12.50		
		Ties	6				
Positive Relationship	Post-test-Pre-test	Negative Rank	1	1.50	1.50	2.120	0.034*
		Positive Rank	6	4.42	26.50		
		Ties	6				

**p < 0 .05*

Table 11

Wilcoxon Signs Test Results Regarding the Mother-Child Relationship Post-Test and Permanence Test Scores of the Children in the Experimental Group.

Sub Dimension	Test	Rank	*N*	Mean Rank	Rank Sum	*z*	*p*
Conflict Relationship	Permanence Test- Post-test	Negative Rank	11	5.67	17.00	1.994	0.046
		Positive Rank	2	7.40	74.00		
		Ties	0				
Positive Relationship	Permanence Test- Post-test	Negative Rank	3	7.86	86.50	2.871	0.004
		Positive Rank	10	2.25	4.50		
		Ties	0				

**p < 0 .05*

Table 12

Results of the Calculated Wilcoxon Signs test Regarding the Mother-Child Relationship Pre-Test and Post-Test Scores of the Children in the Control Group.

Sub Dimension	Test	Rank	*N*	Mean Rank	Rank Sum	*z*	*p*
Conflict Relationship	Post Test- Pre-test	Negative Rank	3	2.00	6.00	1.604	0.109
		Positive Rank	0	0.00	0.00		
		Ties	5				
Positive Relationship	Post Test- Pre-test	Negative Rank	3	2.67	8.00	1.105	0.269
		Positive Rank	1	2.00	2.00		
		Ties	4				

*$p < 0.05$

before and after the implementation ($z = 1.604$; $p > 0.05$). In other words, the mother conflict relationship pre-test and post-test results of the children in the control group are similar. The positive relationships of the children in the control group with their mothers do not show a significant change before and after the implementation ($z = 1.105$; $p > 0.05$).

Findings Regarding Mothers' Views on Number and Operation Training Program

The findings obtained from the answers given by the mothers to the interview form are given below.

Mothers' Views Regarding the Purpose of Participation in the Number and Operation Training Program.

In the interviews, the mothers stated that they aimed to participate in the training program both for themselves and their children. Twelve mothers expected the program to "contribute positively to their relationship with their children", eight mothers aimed to "learn new games", five mothers indicated that the program would allow them to "spend quality time with their children" and two mothers expected it to be a "fun activity and a way of having a pleasant time". Additionally, 13 mothers stated that their children would "learn numbers", eight mothers expressed that their children would "learn new games and learn addition and subtraction", five mothers participated in the education program for their children to play games with other family members, and two mothers participated in the program to prepare their children for the primary school. The following quotes from the mothers indicate their main purposes of participation in the program.

> *"I wonder if my child will be confused because he is young. But I've never played an educational game with my kid before. Maybe I can learn educational games." (M-2)*
>
> *"Having a pleasant, fun time with my child while playing the games you (educator) teach will contribute to our relationship." (M-11)*
>
> *"I want my child to develop math skills and go to kindergarten prepared. I want to spend quality time with my child so that he can have fun and not get bored." (M-13)*
>
> *"I, at least, want my child to play more with her sister and learn something, instead of watching TV at home." (M-5)*

Mother's Views Regarding the Achievements of their Children After the Implementation of the Number and Operation Training Program.

Thirteen mothers stated that their children "learned numbers and new games" and "played the game they learned with other family members". In addition, six mothers mentioned that their children "learned geometric shapes, understood the logic of cardinal numbers and recognized numbers". Four mothers stated that their children "had an idea about addition" and three mothers said that their children "had an idea about subtraction". Two mothers also expressed that their children could "match objects and numbers and their children learned to divide", and one mother indicated that her child "had an idea about the relative operation of numbers." In addition, two mothers stated that their children could "match objects and numbers", two mothers pointed out that their children could "apportion", and one mother expressed that her child "understood how close the numbers are to each other". Below are some of the responses of the mothers:

> *"Of course, my child has improved a little. He never knew the numbers before. Actually, he wasn't interested. Now he can count from 1 to 10. Although he mixes them up, he knows the numbers. He also learned to do addition within the numbers up to 10." (M-9)*
>
> *"My child says 'Look, mom, there is a spoon. One, two'. S/he says 'there was one, now there are two. One, two. There are two'. Our communication has increased thanks to the materials you (educator) brought in the training program and the activities we carried out." (M-8)*
>
> *"We are now counting many things that come across. He knows the door numbers we see. He counts*

spoons and forks in the kitchen. He helps me set the table. He asks "How many of us are there? How many forks should I bring?" (M-3)

"She learned how to count numbers rhythmically both forwards and backwards, match numbers with objects, add and subtract with objects." (M-1)

"My child learned to add and subtract. He learned which number is bigger and which number is smaller. He learned the proximity and distance of the numbers to each other." (M-10)

Mothers' Views Regarding Achievements from their Perspective after the Implementation of the Number and Operation Training Program.

Thirteen mothers stated that they learned educational games to play with their children after the implementation of the training program, seven mothers expressed that they spent more quality time with their children, and six mothers stated that the positive relationship with their child increased. Below are some of the mothers' statements:

"We had never played an educational game before. We had so much fun playing with the hopscotch carpet. We matched the numbers with the lids. My son got more enthusiastic as he got to know the numbers." (M-9)

"The games were so much fun. My daughter would be bored if it didn't involve playing together. Because she's a kid who gets bored easily. But we played the games together after you. We had fun." (M-13)

"It definitely contributed positively to my relationship with my child. We played more games. She also played with his brother and his father." (M-10)

General Opinions of the Mothers on the Number and Operation Training Program.

Thirteen mothers stated that the education program "contributed to the children's mathematical skills", 12 mothers said it "positively affected their relationship with their children", 10 mothers expressed that they "had an idea about how to support their children's mathematical skills" and 10 mothers stated that "it was good for the educator to come to the house". In addition, nine mothers mentioned that "they had the opportunity to see what their children could do in mathematics" and that "they played games not only with each other but also with other family members". The following quotations demonstrate the mothers' perspectives:

"My child and I now count the cars or bikes outside. Sometimes, he mixes the numbers up, but I help him. He's counting much better than before." (M-4)

"My child is now very eager to count. As we place the dishes, we count the forks and spoons. And now I want him to count things every chance he gets." (M-1)

Discussion

This study shows that the Number and Operations Training Program that necessitated the active participation of mothers in the home environment is effective on children's early mathematics skills and that the effects of the program are permanent. The permanence of the training program was determined by the permanence tests performed 4 weeks after the application of the post-tests. In a similar study conducted by Niklas et al. (2016), it was found that children in the experimental group showed more improvement in numerical competence than children in the control group. Several similar studies demonstrated a relationship between the learning environment at home and children's numerical skills (Ciping et al., 2015; Kleemans et al., 2012; Kluczniok, 2017; Skwarchuk et al., 2014). Hwang (2020) found in his study that students who engage in math activities at home earlier are more likely to have higher math achievement in fourth grade. In addition, considering that parents' beliefs about academic abilities and their children's academic abilities (Zippert & Rittle-Johnson, 2018) have an impact on children's educational investments (Dizon-Ross, 2019), programs such as the Number and Operations Training Program will contribute to the development of children by increasing parents' awareness of mathematics.

This study demonstrates that in addition to the early mathematics ability scores of the children in the experimental group, the positive relationship scores between the mothers and children also improved. In the training program, children had the opportunity to make mathematical conversations as well as spend more quality time with their mothers by engaging in different activities such as playing number games, playing with puppets, playing hopscotch and making cookies. Previous research also showed that children's problem solving and social skills are promoted through programs that incorporate activities suited to children's developmental characteristics, and through mothers' active participation by providing a stimulating environment for their children (Kılınç & Aral, 2015). According to Watts and Broaddus (2002), in a game-based mother-child education, mothers learn to improve their relationship with their children, thus contributing to children's personal development.

It can be said that the puppets, hopscotches, number cards, geometric shapes, cookie recipes brought to the home environment and informative conversations with mothers about the development of early mathematics skills within the scope of the Number and Operation Training Program contribute to the organization of the home environment in a way that

supports the development of children. In a similar study by Vandermaas-Peeler et al., (2012), which examined the arithmetic interactions of four-year-old children with their parents during home cooking activities, it was determined that parents of children in the experimental group created more opportunities for their children to use advanced mathematics. From this point of view, it can be said that home-centered interventions can be effective in improving the mathematics skills of children by informing parents about mathematics implementation (Sonnenschein et al., 2016). In another similar study, Şahin (2008) concluded that the concept acquisition scores of children in the experimental group to which the Toy Focused Home Education Program was applied were significantly higher than the control group. When these findings are evaluated together, participation in mathematics-related activities at home (Berkowitz et al., 2015; Clements & Conference Working Group, 2004; Sonnenschein et al., 2014; Peeters et al., 2012) and the frequency of math talk with parents (Hojnoski et al., 2014; Lukie et al., 2014; Ramani et al., 2015; Skwarchuk, 2009; Starkey & Klein, 2000; Uscianowski et al., 2020; Zippert & Ramani, 2017) can be said to contribute to pre-school children's numerical knowledge and skills.

In the investigation of mothers' views, the main achievements of the training program are found to be children's recognizing and learning numbers, sharing, adding and subtracting, learning geometric shapes, learning the total number of objects shown in a group, the distance between numbers, playing new games and playing with family members. Thus, it is vital for children to engage in mathematical activities in the home environment with their parents and for parents to create opportunities to use mathematical language in order to support children's development of early mathematical skills.

According to mothers who participated in the training program, the program seems to be beneficial for them in terms of "spending more time with their children, learning new games and playing these games with other family members". Through activities, mothers learned educational games that contributed to their quality time with their children. In a similar study, Mayer et al. (2015) found that parents who participated in the program used the readings provided by the educators to spent more time with the children after the implementation of the program. When these results are evaluated together, it can be concluded that activities that parents and children do together and the materials provided to them have a positive effect on both the parent-child relationship and children's mathematical skills.

In conclusion, this research finds that the Number and Operations Training Program, which was implemented with the active participation of mothers in the home environment, increased children's early mathematics skills, improved the mother-child relationship, and raised mothers' awareness of strategies that would directly support children's mathematics skills in the home environment.

Limitations and Future Directions

There are a few limitations to the present study that should be indicated. First, the scope of the measures (i.e. TEMA-3, Child Parent Relationship Scale (CPRS), Mothers' Interview Form) is limited by the items and responses. Second, the sample of the study consists of children between the ages of 48-65 months, who show normal development, and their mothers in Aksaray Province (in Turkey).

In line with these limitations, the following suggestions can be made:

- In the study, a home-based mathematics training program was designed for pre-school children. Longitudinal studies can be conducted to observe the mathematics achievements and mother-child relationships of children during their primary school years.
- Home-based early mathematics intervention programs can be designed that necessitate the active participation of fathers in order to improve children's early mathematics skills and father-child relationships.
- The training program can be applied to a wider sample of children from different age groups and can involve families from different socio-economic statuses and educational levels.
- Different programs can be applied in the home environment to support the development of children of different age groups.

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Appendix

**Methods and Techniques Used:* During the implementation of the Home-Centered Number and Operations Training Program, meeting, demonstration and role playing techniques were used.

**The home visit to be made within the scope of the "Home-Centered Number and Operations Training Program" and the targeted math skills are given below:*

1. Home Visit: Meeting Activity

2. Home visit: One-to-one correspondence, counting (from 1 to 5), comparison

3. Home visit: One-to-one correspondence, counting (from 1 to 10), number recognition

4. Home visit: Counting (from 1 to 10), number recognition, classification, problem solving, comparison

5. Home visit: Counting (from 1 to 10), recognizing numbers, One-to-one correspondence, problem solving

6. Home visit: Counting (from 1 to 10), operation (addition), problem solving

7. Home visit: Counting (from 1 to 10), operation (addition), problem solving

8. Home visit: One-to-one correspondence, counting (from 1 to 10), number recognition

9. Home visit: Counting (from 1 to 10), operation (subtraction), problem solving

10. Home visit: Recognizing numbers, problem solving

11. Home visit: Counting (from 1 to 10), classification, comparison

12. Home visit: One-to-one correspondence, counting (from 1 to 10), operation (addition, subtraction)

13. Home visit: Operation (addition), problem solving, number recognition, classification