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The Impact of Big Math for Little Kids on Children's Number Skills[1]

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Ayşe Kılıçkaya [2]
Marmara University

Canan Avcı [3]
Ondokuz Mayıs University

Abstract

It is acknowledged that, of the math skills, the number skills are the most significant factor which affects math achievement in the forthcoming grades. Thus, it is critical to support the development of number skills early in life. The present study examines whether supplementing a global curriculum with the Big Math for Little Kids (BMLK) affects the growth of children's number skills. Pretest-posttest experimental design was used. Seventy-seven kindergarten children (38 experimental; 39 comparison) participated in the study. For six weeks, children in the experimental group were exposed to the Ministry of National Education (MoNE) program plus the BMLK while those in the comparison group only experienced the MoNE program. Children's number skills were measured by the Anatolian Early Childhood Mathematics Skills Scale (ANOMAT). Findings indicated that children who were exposed to the global MoNE curriculum supplemented with the BMLK had greater gains than did those who experienced only the MoNE curriculum. The results indicate that a global curriculum supplemented with a skill-based curriculum has a positive impact on children's number skills.

Keywords: kindergarten, number skills, early childhood, big math for little kids, early mathematics education.

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[2]*Corresponding Author*: Research Assistant, Faculty of Education, Early Childhood Education, İstanbul, Turkey, e-mail: aysekilickayaa@gmail.com, https://orcid.org/0000-0001-6622-7206

[3]Asist. Prof. Dr., Faculty of Education, Early Childhood Education, Samsun, Turkey, e-mail: canan.avci@omu.edu.tr, https://orcid.org/0000-0002-9313-4977

Everyone needs math to be able to make reasonable decisions on several occasions in daily life. By going further beyond that, advanced math knowledge is considered as a determinant of whether an individual will have a good career (Garon-Carrier et al., 2018; Magnuson, Duncan, Lee and Metzger, 2016). There is influential evidence that a strong foundation in the early years can help to promote children's mathematical development in the subsequent years (Claessens and Engels, 2013; Garon-Carrier et al., 2018; Göbel, Watson, Lervåg and Hulme, 2014; Nguyen et al., 2016; Rittle-Johnson, Fyfe, Hofer and Farran, 2017; Watts, Duncan, Siegler and Davis-Kean, 2014). Of the early math skills, the number skills are acknowledged as the most significant factor which affects math achievement in the forthcoming grades (Aunio and Niemivirta, 2010; Chu, vanMarle, Rouder and Geary, 2018; Garon-Carrier et al., 2018; Hawes, Nosworthy, Archibald and Ansari, 2019; Jordan, Glutting and Ramineni, 2010; Jordan, Kaplan, Ramineni and Locuniak, 2009; Marcelino, de Sousa and Lopes, 2017; Merkley and Ansari, 2016).

High-quality early childhood education is critical to equip children with a strong math foundation and using a research-based math curriculum that is proven to promote children's mathematical development could ensure this strong foundation (Bojorque, Torbeyns, Van Hoof, Van Nijlen and Verschaffel, 2018; Clements and Sarama 2007, 2008; Çelik and Kandır, 2013; Hofer, Farran and Cummings, 2013; Kandır, Uyanık and Çelik, 2017; Khomais, 2014; Presser, Clements, Ginsburg and Ertle, 2015; Sarama, Lange, Clements and Wolfe, 2012). The present study examines whether supplementing the developmentally-oriented MoNE program with the math-oriented BMLK program has an effect on the growth of children's number skills in kindergarten. We first discuss young children's number skills. Then, we present the nature of mathematics instruction in Turkish early childhood educational settings. Finally, we discuss the development of math-oriented early childhood curricula in the US and the features and the effects of one of the math-based curriculum, the BMLK program, on children's mathematics learning.

Early Number Skills

Numerical competencies in early childhood generally consist of number knowledge, relations between numbers and operational knowledge (Jordan et al., 2009, 2010; Powell and Funchs, 2010). Number knowledge includes the ability to determine numerical quantity instantly or by counting and to associate numerical quantity with verbal and written number symbols. Relationships between numbers consist of the ability to compare numbers based on their magnitude and to represent them on a mental number line. Number operations include being able to add and subtract with objects, oral story problems, and numbers (Jordan et al., 2009, 2010).

Children start kindergarten with a wide range of early number competencies. Some children know number names and can solve simple addition and subtraction problems, while others can identify numbers but have trouble counting from 1 to 10 (Lembke and Foegen, 2009). Early exposure to numeracy activities at home or in early education settings plays an important role in building early numeracy competencies

for children (Jung, 2011; Skwarchuk, 2009). The more children develop early number skills through play and meaningful learning activities before formal education begins, the better they grasp the core concepts of mathematics (Ramani and Siegler, 2008). This study explores the influence of early exposure to numeracy activities on the development of children's number skills in kindergarten.

Early Mathematics Instruction in Turkey

A national curriculum which has been last updated in 2013 by the MoNE is utilized in Turkish early learning environments. This curriculum is developmentally appropriate, has a whole-child approach, and is built on the synthesis of the child-oriented practices of different learning theories and models. Considering children's developmental characteristics, the teachers are asked to prepare activities in the context of the achievements and indicators prescribed in the program to support children's learning through play. The achievements and indicators related to mathematical development are in parallel to the content standards of NCTM. Nevertheless, the program contains no information about young children's math learning processes, developmental sequence of activities that need to be followed while introducing new math concepts to children, and effective methods and techniques to be implemented in this process. Only brief information about the types of math activities to be implemented in learning environments and the materials to be employed in these activities is present in the program (Ministry of National Education [MoNE], 2013). In short, the MoNE program addresses multiple developmental domains and is not deeply focused on a specific domain. Therefore, the content, the quality, and the duration of the math activities to be practiced in the classroom are designated only by teachers in Turkey.

There is empirical evidence on the foci, the duration and the structure of the math instruction in Turkish early learning environments. Findings of the a study exploring the nature of math instruction indicated that the children aged 3-6 years frequently included math in their free play, however, teachers did not spend adequate time on math activities during the day and in the structured activities observed rarely, the content had a limited scope, the instruction was focused on the basic skills (e.g., rote counting and naming single-digit numbers and basic shapes), and frequently performed with worksheets in large group settings (Alat, 2019). Other studies have also shown the frequent occurrence of basic math instruction in early childhood classrooms and the negative effect of this type of instruction on children's mathematics learning (Claessens, Engel and Curran, 2014; Engel, Claessens and Finch, 2013; Engel, Claessens, Watts and Farkas, 2016). Furthermore, Nguyen et al. (2016) showed that the advanced number skills were a stronger predictor of later math achievement than the basic number skills. Thus, it is important to support the development of advanced math skills, as well as basic math skills in young children at school.

Even though children learn math concepts better through play, they need adult support to make their experiences mathematize (Ginsburg, Lee and Boyd, 2008).

Contradicting with this point of view, the observations made in the classrooms with children aged 5-6 years showed that the duration of the time assigned to the math activities was on average three minutes per day (Aydoğan and Sağsöz-Başyurt, 2013; Varol, 2013). The shortness of the assigned time indicates that the math activities presented to the children in the kindergartens spontaneously came into play.

The activity settings in which the math instruction is occurred also influence children's learning outcomes (Ansari and Purtell, 2017). Although the MoNE program suggests teachers use a variety of activity settings, namely, whole group, small group, and individual during the school day, teachers spend most of their instructional time in the whole group (Alat, 2019; Göl-Güven, 2009; Varol, 2013). For instance, Varol (2013) found that kindergarten teachers held whole group activities for 32% of the observation time, whereas they spent only 3% of the time on small group activities. On the other hand, there is empirical evidence on the positive influence of the use of small groups on children's mathematics learning (e.g., Ansari and Purtell, 2017; Camilli, Vargas, Ryan and Barnett, 2010; Jacob, Erickson and Mattera, 2020; Wasik, 2008).

To ameliorate the quality of early math instruction, it is necessary to have a math curriculum that is research-based and systematically addresses the coverage and the sequence of the math instruction process in early childhood (Presser et al. 2015). Align with this point of view, the study by Wakabayashi et al. (2020) indicated that supporting a developmentally-based curriculum with a curriculum specifically focused on math skills enhanced children's math achievement even further. Based on this finding, we consider that the simultaneous use of the developmentally-based MoNE curriculum and a math-based curriculum could affect Turkish children's mathematics learning positively.

The Importance of Early Childhood Mathematics Programs

Departing from the fact that the initiatives in math development in the early childhood period were essential to the enhancement of math achievement in the upcoming years, math instruction standards were created in the USA for improving young children's math skills (National Council of Teachers of Mathematics [NCTM], 2000). Moreover, national panels were organized for highlighting that the utilization of comprehensive and research-based math curricula in early childhood education was necessary for an effective initiative (National Association for the Education of Young Children [NAEYC] and NCTM, 2002, 2010; NCTM, 2007). To this end, Number Worlds by Griffin (2004), Building Blocks by Clements and Sarama (2004), and Big Math for Little Kids (BMLK) by Ginsburg, Greenes and Balfanz (2003) were developed as the math curricula for young children. These curricula aimed to support children's both basic and advanced math skills via systematically and comprehensively planned activities. Through research studies, it was proved that these math-oriented curricula were effective in enhancing children's math achievements (Clements and Sarama 2007, 2008; Çelik and Kandır, 2013; Hofer et al., 2013; Kandır et al., 2017; Khomais, 2014; Presser et al., 2015; Sarama et al., 2012). In the present

study, we implement one of these programs, namely the BMLK program, to promote children's number skills so that we only present the characteristics and the effectiveness of this program in the following section.

The BMLK Program

The BMLK is a research-based, comprehensive, well-planned, and entertaining math program. The program is shaped as per the principles of introducing rich math ideas in a planned manner, developing sophisticated math ideas, supporting the development of mathematical language in children, and tempting the children to think like a mathematician (Ginsburg, Greenes and Balfanz, 2003; Greenes, Ginsburg and Balfanz, 2004). The BMLK is designed to use the topics known by children and children's interests and abilities, combining the math ideas with daily experiences and other activities enjoyed by children, offering rich opportunities to the children at risk of school failure, and giving the children a chance to discuss and reflect on what they have explored (Greenes et al., 2004). The program presents sequential, structured, and extended math activities that are designed for supporting children's meaningful learning of several math concepts. Child play is mathematized through these activities that enable the teachers to realize the math in children's play and transform the play into an instructional opportunity. The curriculum also uses an integrated approach so that children could make meaningful connections across different learning areas, namely, language, literacy and mathematics. Furthermore, the program supports children's mathematical development at home through home learning materials, such as picture books and games.

There are two versions of the BMLK program; one for prekindergarten and the other for kindergarten children. Each program lasts 32 weeks in total and is composed of practices taking a minimum of 20-30 minutes per day. There are six units that comprised of play-based activities involving materials, such as manipulatives and picture books. The units consist of numbers, shapes, patterns and logic, measurement, operations, and spatial relations (Presser et al., 2015). In this study, units on numbers and number operations in the BMLK for children aged 5 years were implemented. In the number unit, children are engaged in activities focusing on nominal, cardinal and ordinal numbers, counting sequence, and forward and backward counting. The number operations unit involves addition, subtraction, and introductory multiplication and division concepts so that children could further develop their number skills (Ginsburg et al., 2003; Greenes et al., 2004).

The effectiveness of the BMLK curriculum on children's learning has been tested with the experimental (Çelik and Kandır, 2013; Presser et al., 2015) and the quasi-experimental studies (Kandır et al., 2017; Khomais, 2014), and a nonexperimental study (DeLoach, 2012). The previous experimental studies investigated the influence of the BMLK curriculum on children's general mathematical development (Çelik and Kandır, 2013; Presser et al., 2015), while the quasi-experimental and the nonexperimental studies tested the effect of the BMLK specifically on children's number skills (DeLoach, 2012; Kandır et al., 2017;

Khomais, 2014). More specifically, in a cluster-randomized controlled trial that lasted for two years, Presser and her colleagues (2015) investigated whether the BMLK program is effective in improving low-income children's mathematics learning "above and beyond the mathematics instruction that typically occurs in preschool and kindergarten" (p. 408). The BMLK curriculum was implemented in the experimental condition, while the business-as-usual curriculum was used in the control condition over two school years. Prekindergarten and kindergarten teachers in the intervention group were provided curriculum materials and professional development workshops on the utilization of the BMLK curriculum during their implementation year. 762 participating children were individually tested at the beginning and the end of the prekindergarten and kindergarten year with a distal math assessment tool. Findings indicated higher gains in general mathematical skills for the children in the experimental condition. In another efficacy study of the BMLK program conducted in Turkey, a small sample of kindergarten children (n=42) from middle-income families were experienced activities planned based on the BMLK for 14 weeks and administered a test measuring their knowledge of various math concepts at the beginning and the end of the experiment. The results of the non-parametric analysis indicated that the mean of the difference scores in the experimental group was statistically larger than that in the control group (Çelik and Kandır, 2013). Both studies, however, lack information about the effect of the BMLK curriculum on the growth of specific mathematical skills, such as number skills.

Studies investigating the influence of the BMLK program on young children's number skills provided empirical evidence for the positive effect of the program (DeLoach, 2012; Kandır et al., 2017; Khomais, 2014). However, the findings of these studies need to be taken with caution since the baseline equivalence for comparison groups in terms of children's number skills was not confirmed (DeLoach, 2012; Khomais, 2014) and difference scores were used to examine the effect of the BMLK program on children's number skills, that leads to several methodological problems such as reduced reliability, confounded effects, and ambiguity (Kandır et al., 2017). For instance, Khomais (2014) examined the effect of the BMLK program on 107 Saudi prekindergarten and kindergarten children with varying socioeconomic backgrounds. An early childhood center affiliated with the university where the researcher works was assigned to the experimental condition whereas a public and a private school were assigned to the control condition. For nine weeks, children in the experimental group were exposed to the BMLK program's unit on numbers, while children in one of the control conditions were experienced the governmental program involving activities on numbers once a week, and children in the other control condition were presented an Arabic program including activities on numbers every day. Findings of the study indicated that children in the experimental condition had higher post achievement scores than those in the two control conditions after controlling for pre-test scores. Since participating children's number skills were not equivalent at pretest and the background characteristics of the children were different across groups, the observed differences among groups could be explained by

confounding variables that were not controlled in the study. In short, future research taking the methodological issues related to the past research into account is needed to examine the influence of the BMLK program on young children's number skills.

Taking all together, to equip children with a strong mathematical foundation in Turkey, the utilization of a systematic and comprehensive math-oriented curriculum is needed in early education settings that implement the developmentally-oriented national curriculum. However, no curriculum is specifically designed for early mathematics education in Turkey. Thus, education programs developed abroad have been utilized upon being adapted to the Turkish context (see Çelik and Kandır, 2013; Kandır et al., 2017). Likewise, in the scope of this study, the development of the number skills of the children was supported through the adaptation of the part of the BMLK program on numbers and number operations. In short, this study aims to investigate whether supplementing the MoNE curriculum with the BMLK produces gains in kindergarten children's number skills more than the mathematics instruction aligned only with the MoNE curriculum, as measured by a nationally developed mathematics assessment tool. Our research questions were:

1. Do children participating in the MoNE curriculum plus the BMLK result in higher gains in numbers than those experiencing the MoNE curriculum only?
2. Do children participating in the MoNE curriculum plus the BMLK result in higher gains in operations than those exposed to the MoNE curriculum only?

Method

In the present study, the pre- and post-test experimental design was used to examine whether gains in number skills varied for children who experienced the developmentally-oriented MoNE program plus the skill-based BMLK program compared to those who were solely exposed to the MoNE program. Using a randomized controlled design and a more rigorous statistical analysis (mixed-design two-way repeated-measures ANOVA) this study aims to overcome some shortcomings of the previous studies.

Participants

This study was conducted with 77 children who were aged 61-72 months and enrolled at public kindergartens serving middle-income families in an eastern city in Turkey. Two of the schools which volunteered to take part in the study were selected for the sample. Two classes from each school were randomly selected. Then, the study groups were created with random assignment. Informed signed consent was received from the parents of the children. In the experimental group, 60.5% of the children were female while in the comparison group, 48.7% of those were female. The children's average age was 68 months. 34.2% of the mothers and 52.6% of the fathers in the experimental group had bachelor's degrees while 20.5% of the mothers and 51.3% of the fathers in the comparison group had bachelor's degrees. There were no statistical differences between the two groups on child's gender and age, as well as on the mother's and father's level of education. These demographic variables'

associations with children's post-test scores were also examined, but none of the findings was significant. Thus, the demographic characteristics of the children were not controlled in the subsequent analyses.

Measure

Children's number skills were measured with the Anatolian Early Childhood Math Skills Scale (ANOMAT), a nationally developed measurement tool (Erdoğan et al., 2014). The permission and the training to use the scale were received from the developers. The scale is designed to assess the mathematical skills of children aging from 36 to 72 months old. Every question in the scale is associated with a short story that is derived from children's daily experiences. The developers aim to encourage children's engagement with the assessment through stories that are familiar to them. The assessor first shows the short story card and then asks the question to the child. For example, the assessor presents the child a card on which there are two children and then, says "Ali and Ayşe were eating fruit. Both had apples on their plates. They wonder which one has more apples. Now, let's look at the plates together." Afterward, the assessor shows another card on which there are two plates with apples and asks the child "Which one has fewer apples?"

The ANOMAT consists of three sub-scales, namely, the numbers, operations, and geometric shapes. Solely the numbers and operations sub-scales were used in the study. The numbers sub-scale is made up of nine sub-domains and a total of 35 items. The numbers sub-scale consists of items assessing children's knowledge in counting forward or backward one by one rhythmically, skip counting, counting objects, recognizing written numerals, and telling the number that comes before and after a number. The operations sub-scale is comprised of four sub-domains and a total of 21 items. The operations sub-scale involves items testing children's skills to use addition, subtraction, division, and multiplication with numbers 1 to 9. The maximum scores to be obtained from the numbers and the operations sub-scales of the ANOMAT are successively 48 and 21 points. In the present study, total scores for the numbers and the operations sub-scales were calculated for each child.

The ANOMAT was applied to 140 children enrolled in kindergarten, and item analysis, and validity and reliability tests were performed for the scale. Cronbach's Alpha coefficients were found as 0.94 and 0.80 consecutively for the numbers and the operations sub-scales. To assess the construct validity of the scale, the correlations between children's mean age (in months) and their mean scores on the ANOMAT and its sub-scales were calculated. The correlation coefficients were calculated as 0.64 and 0.58 respectively for the numbers and the operations sub-scales (Erdoğan et al., 2014). In the current study, we conducted similar analyses and our reliability and validity estimations were aligned with the results reported by Erdoğan and her colleagues. Our Cronbach Alpha reliability coefficients were 0.87 and 0.84 for the numbers and the operations subscales, respectively. We estimated the correlation coefficients between children's mean age and their mean scores on the numbers and the operations sub-scales as 0.61 and 0.53, respectively.

Procedures and Data Analysis

To identify children's preliminary number skills, each child included in the sample was individually tested via the ANOMAT in an empty classroom. The application of the scale took on average 15 minutes. After the pre-test assessment, the children in the experimental group experienced both the activities planned according to the MoNE program and those prepared according to the BMLK program for six weeks, while those in the comparison group were exposed to the activities solely planned according to the MoNE program. Thus, all participating children experienced the developmentally-oriented MoNE program.

Achievements and their indicators about numbers and operations included in the MoNE program consist of counting (i.e., counting forward or backward one by one rhythmically, showing the specified number of objects, telling the cardinal value, saying the ordinal number, and telling the number that comes before and after a number in numbers up to 10), comparing, ordering, grouping and matching objects by quantity, and performing simple addition and subtraction with objects (i.e., adding the specified number of objects to the given group of objects and taking away the specified number of objects from the given group of objects). The MoNE program recommends teachers that the number of objects used in math activities should not be more than 10 and children should learn to count numbers up to 20. The program is against the use of ready-made plans and subject- or themed-centered education. The teacher using this program prepares, implements, and evaluates the education plans himself/herself. He/She can bring together the achievements and indicators and concepts in the curriculum in different ways; can prepare activities as integrated or separately; can enrich learning processes by making use of different topics, activities, environments, and materials. Learning through play is seen as an integral part of this program. Since the program aims to support the whole development of the children, it is necessary to consider the achievements and the indicators related to all development areas in a balanced way in education plans (MoNE, 2013). Even though the program expects teachers to have deep knowledge of child development in all areas, it provides general information on child development. Thus, there is no information on the developmental sequence of children's number skills in the program.

In addition to the MoNE program, children in the experimental condition were exposed to the math-oriented BMLK program. The developers of the BMLK program believe that young children are ready for and capable of learning complex math concepts when they are supported with systematically planned activities (Greenes et al., 2004). Thus, the program offers field-tested detailed activity plans structured based on children's free play for each math concept. The activity plans involve games, the use of manipulatives and stories, a list of mathematical terms, learning goals, and suggestions for how to evaluate children's learning during the instruction (Presser et al., 2015).

Before implementing the program, the researchers received permission from the developers. First, the units on numbers and number operations, instructions for the fidelity of implementation, and sample activity videos were examined. Then, the

activities were adapted to Turkish culture and expert opinions on the adapted activities were sought. The final version of the implementation program was prepared based on expert opinions. The nature of mathematical thinking, the structure of the activities and the tools used in the activities, and the children's past experiences allow the implementation to be designed in small groups. Thus, the first researcher implemented the adapted activities in the number and the number operations units of the program to 38 children in the experimental group in groups of 5 for 30 minutes each day for six weeks.

The number unit of the program involves activities on different use of numbers, namely cardinal, nominal and ordinal numbers, verbal counting up to 100, skip counting by 2s, 5s, 10s, and 100s, subitizing, object counting, comparing objects by quantity, and representing numbers as numerals, sets of dots on cards and word names. The number operations unit includes activities on the putting together (addition and multiplication) and the taking apart (subtraction and division) operations (Greenes et al., 2004). In the addition and subtraction tasks, children are asked to find out the total number of objects given to them and then, add up or take away a new set of objects from the given objects. In the basic multiplication activities, children are given the same number of objects in different groups and asked to estimate the total amount of the given object. In the basic division tasks, children are asked to divide a certain amount of objects equally (Ginsburg et al., 2003). At the end of the implementation period, for identifying the change in children's number skills, the ANOMAT was applied once again to the children in both groups.

In the data analysis, descriptive statistics, t-test, and ANOVA were utilized. Before running these analyses, a series of preliminary analyses were conducted. First, the significant outliers in the pre- and post-test scores of the children in the experimental and the comparison groups were separately tested with the Normal P-P Plots and the results indicated no significant outliers. Then, the normality of the distribution of the pre- and post-test scores for each group was examined with the Kolmogorov-Smirnov test and the results showed approximately normal distributions ($p > .05$). Afterward, an independent samples t-test was performed to test the equivalence of the preliminary number skills measured for the children in the experimental and the comparison groups with the ANOMAT. Research data conformed to the independence of the observations, no significant outliers, the normality, and the homogeneity of variances assumptions of the t-test. Levene's test was conducted to test homogeneity of variances of the pre-test scores on numbers and operations sub-scales across conditions and the findings showed the equivalence of the variances, $F(1, 75) = 0.353$, $p = .55$ and $F(1, 75) = 1.398$, $p = .24$, respectively. Subsequently, to determine whether post achievement scores on the numbers and the operations sub-scales varied for children who experienced the MoNE plus the BMLK program compared to those who were solely exposed to the MoNE program, the mixed-design two-way repeated-measures ANOVAs were conducted. Research data conformed to the normality, the homogeneity of variances, and covariances assumptions of the ANOVA to produce reliable results. More specifically, the results

of the Levene's test indicated that the homogeneity of variances of the post-test scores on numbers and operations sub-scales across conditions were equal, $F(1, 75) = 0.136$, $p = .71$ and $F(1, 75) = 0.611$, $p = .44$, respectively. Also, the Box's M Test showed equal covariance matrices for the post-test scores on the numbers and the operations sub-scales, $F = 1.738$, $p = .16$ and $F = 3.365$, $p = .02$, respectively.

Results

Below we first discuss children's number skills before and after the intervention. Then, we test the baseline equivalence between the experimental and the comparison groups for number skills. Finally, we analyze the effect of supplementing the developmentally-oriented MoNE program with the math-oriented BMLK program on the growth of children's number skills.

Children's Number Skills

Table 1

Descriptive Statistics for Children's Pre- and Post-test Scores by Condition

		Experimental (n = 38)				Comparison (n = 39)			
		$\bar{X}$	SD	Min.	Max.	$\bar{X}$	SD	Min.	Max.
Numbers	Pre-test	24.65	11.11	2	40	23.23	10.30	3	42
	Post-test	32.44	10.43	12	46	24.12	10.36	5	44
Operations	Pre-test	6.13	3.58	0	12	6.00	3.30	0	16
	Post-test	12.10	3.95	3	19	6.61	3.34	0	15

Table 1 displays the descriptive statistics about the scores on the numbers and operations sub-scales obtained by the participants. The increase in children's mean scores on the sub-scales from pre-test to post-test was observed both in the experimental and the comparison groups. However, the children in the experimental group gained more than those in the comparison group. More specifically, the children in the experimental group had an increase of 7.79 points in the mean of scores for the numbers sub-scale whereas those in the comparison group had an increase of 0.89 points. Moreover, the children in the experimental group had an increase of 5.97 points in the mean of scores for the operations sub-scale while those in the comparison group had an increase of 0.61 points.

Comparison of the Mean Pre-test Scores of the Experimental and Comparison Groups

Table 2

Comparisons of Children's Pre-test Scores

		n	$\bar{X}$	SD	df	t	p
Numbers	Experimental	38	24.65	11.11	75	0.584	0.554
	Comparison	39	23.23	10.30			
Operations	Experimental	38	6.13	3.58	75	0.168	0.867
	Comparison	39	6.00	3.00			

To test whether there were any baseline differences between the experimental and the comparison groups in number skills, independent samples t-test was used in comparing the means of pre-test scores. As per Table 2, there was baseline equivalence between the two groups for the means of scores in the pre-test phase (the numbers sub-scale [$t(75) = 0.584$, $p > .05$] and the operations sub-scale [$t(75) = 0.168$, $p > .05$]). In this context, it can be put forward that the number skills of the children in the experimental and the comparison groups had similar characteristics at the beginning of the study.

Impact on the Children's Number Skills

Table 3

Effectiveness of the BMLK Program on Children's Number Skills

		F	p	η_p^2
Numbers	Condition	4.27	.042	.054
	Time	78.37	.000	.511
	Condition×Time	49.33	.000	.397
Operations	Condition	13.98	.000	.157
	Time	119.55	.000	.615
	Condition×Time	79.06	.000	.513

To test the effect of supplementing the MoNE program with the BMLK on children's number skills, a series of mixed-design two-way repeated-measures ANOVAs was conducted. As per Table 3, it was ascertained that there was a statistically significant difference in the increases identified in the numbers sub-scale scores of the children in the experimental group and the comparison group [$F(1,75)= 49.33$, $p< .001$, $\eta_p^2= .397$]. In other words, supporting the MoNE program with the BMLK program enhanced children's number skills more than applying the MoNE program alone did. Upon the review of the scores obtained from the operations sub-scale, it was found that the interaction effect of the experimental condition and time of testing on children's operations sub-scale scores was statistically significant [$F(1,75)= 79.06$, $p< .001$, $\eta_p^2= .513$]. Children's skills on operations in the experimental group were enhanced more than those in the comparison group.

Discussion

This research was performed for analysing whether using the MoNE program together with the BMLK had any effect on children's number skills. Children's number skills were measured by the ANOMAT, a nationally developed measurement tool. Findings indicated that the number skills of the children exposed to the MoNE program plus the BMLK developed more than those experienced only the MoNE program. This finding of the research is in a similar vein to the findings of the previous experimental (Çelik and Kandır, 2013; Presser et al., 2015) and quasi-experimental studies (Kandır et al., 2017; Khomais, 2014), and a nonexperimental study (DeLoach, 2012). There are some differences between the current study and the past studies. First, some previous studies implemented only the BMLK curriculum in the

experimental group (DeLoach, 2012; Khomais, 2014; Presser et al., 2015), while the current study implemented the BMLK in addition to the developmentally-oriented national curriculum in the experimental group. Second, the past experimental studies investigated the influence of the BMLK curriculum on children's general mathematical development (Çelik and Kandır, 2013; Presser et al., 2015), while the current study specifically focused on the influence of the BMLK program on children's number skills. Third, the previous studies could not ensure the equivalence of the number skills of the children at the beginning of the study (Khomais, 2014) or the reliability of the results (Kandır et al., 2017), while the present study proved baseline equivalence between the two groups and increased the reliability of the results with the use of more rigorous analysis. Fourth, the past studies implemented the BMLK curriculum for 14 to 32 weeks (Çelik and Kandır, 2013; DeLoach, 2012; Kandır et al., 2017; Khomais, 2014; Presser et al., 2015), while the current study utilized the program only for six weeks. Since Presser and her colleagues (2015) reported that the significant effect of the program could be observed after children were exposed to the program for two years, more longitudinal studies implementing the BMLK program are needed to better evaluate the efficacy of the program. Finally, studies conducted abroad provided professional development workshops for teachers about the program (DeLoach, 2012; Khomais, 2014; Presser et al., 2015) and allowed them to implement the program in the classroom. However, the implementation of the program in the studies launched in Turkey (including the current study) was carried out by the researchers (Çelik and Kandır, 2013; Kandır et al., 2017). To assure the internal validity of the implementation of the program, further research testing the effect of the BMLK program by training the classroom teachers on the use of the program is needed in Turkey.

There are certain reasons for the BMLK program to enhance the effect of the MoNE program on children's number skills in the present study. The MoNE program (2013) is a comprehensive program that is well-suited to the children's developmental stage and has a whole-child approach. This program emphasizes the learning environment, children's play, and teachers' observation and evaluation of children's development. What is essential is the attainment of the developmental achievements whereas skill- or theme-centered instruction is not highlighted. Unlike the MoNE curriculum, the BMLK is a curriculum designed for enabling young children to acquire basic and sophisticated math skills through developmentally sequential, systematic, and structured activities. The studies performed in recent years indicated that the skill-based curricula, such as the BMLK, were more effective in supporting children's learning in math than comprehensive curricula with the holistic-child approach (e.g., Clements and Sarama, 2007; DeLoach, 2012; Hofer et al., 2013; Presser et al., 2015; Sarama et al., 2012; Wakabayashi et al., 2020). Thus, the use of the research-based BMLK could increase the efficacy of the MoNE program on children's mathematics learning.

The math-focused programs support children's mathematical development better as the children exposed to these programs involve in math activities and hear

and use the mathematical discourse more frequently (Greenes et al., 2004). The studies performed in Turkey showed that the time allocated to the math activities in the early childhood settings where the comprehensive MoNE program was implemented was much shorter than that allocated to the other types of activities, such as literacy and art (Alat, 2019; Aydoğan and Sağsöz-Başyurt, 2013; Varol, 2013). Even if it is not possible to firmly state what type of math activities the children were involved with, and how often and for how long they were involved with math activities in the classroom because the class activities were not observed in the current study, the relatively small gain was observed in the number skills of the children in the comparison group. Departing from this finding, it can be supposed that the mathematical development of the children to whom only the comprehensive MoNE program was applied was not sufficiently supported. To identify this situation more accurately, new experimental studies in which in-class activities will also be observed should be performed.

Another reason for the BMLK curriculum to enhance the effectiveness of the MoNE curriculum is that, for each day, the BMLK program has systematically structured a set of sequential activities that take into consideration children's mathematical development stages. The activities were prepared following the principles of being structured as per the children's existing knowledge and interests, incorporating math into the daily routine activities, teaching math in a planned manner through a variety of activities, providing the children with the opportunity to use mathematical discourse, supporting the children to develop sophisticated math ideas, and giving the opportunity to repeat what was learned (Greenes et al., 2004). On the other hand, the activities created as per the MoNE program were planned by the teacher in a way to conform to the interests, needs, and development levels of the children individually and as a group in the classroom. The responsibility for making decisions about the method, content, sequence, and intensity of instruction were all given to the teacher. Unfortunately, only a small number of early childhood teachers have adequate education about math instruction or use a comprehensive and research-based math curriculum (Ginsburg, Lee and Boyd, 2008; Kaçan and Halmatov, 2017). Also, teachers believe that math was not an interesting topic for children (Alat, 2019), and supporting the development of social and emotional skills and early literacy skills is more important than math skills (Kaçan and Halmatov 2017). That is why, systematic, sequential, well-planned, and in-depth math instruction is not in place in Turkey. Generally, in daily plans, there are unconnected activities that aim to support different aspects of child development (social-emotional, language, cognitive, and so on). However, a comprehensive and skill-based math curriculum is needed for providing high-quality early math instruction (NAEYC and NCTM, 2002, 2010; NCTM, 2007; Presser et al., 2015).

The mathematical content and the structure of the activities also differ between the MoNE and the BMLK programs. Even though achievements and their indicators about numbers and operations included in the MoNE program seem to be similar to the goals of the BMLK program, the MoNE program approves the use of 10 objects

at maximum in math activities and teaching children to count numbers up to 20 (MoNE, 2013). On the other hand, the developers of the BMLK program believes that young children can accomplish more than that, so they encourage children to count up to hundreds, skip counting by 2s, 5s, 10s, and 100s, and estimate the quantity of a group of objects without counting and do basic multiplication and division (Greenes et al., 2004). Thus, the BMLK program seems to involve more advanced math instruction compared to the MoNE program. However, studies showed that kindergarten children who were exposed to basic math instruction had lower math achievement while those who experienced advanced math instruction had higher math achievement at the end of kindergarten (Claessens et al., 2014; Engel et al., 2013, 2016) and at the end of fifth grade (Nguyen et al., 2016). Thus, the exposure to more advanced math instruction could lead to better outcomes for children experiencing the MoNE program plus the BMLK in the present study.

Furthermore, the activities prepared based on the BMLK program in the present study were implemented in small groups. Studies indicated a positive effect of the use of small group math instruction on children's mathematics learning (Ansari and Purtell, 2017; Jacob et al., 2020). For example, Jacob and his colleagues (2020) implemented the High 5s program designed to provide "a small-group math enrichment experience" to kindergarten children three times a week for approximately 30 minutes. They found that children in the High 5s program had higher math achievement than those in the comparison group. In teacher-directed small group activities, children are more likely to experience more responsive interaction with the teacher and more individualized and differentiated instruction, and to be actively engaged in the activity (Camilli et al., 2010; Jacob et al., 2020; Wasik, 2008). In contrast, observational studies conducted in Turkish early education settings indicated that instructional activities were widely held in whole groups (Alat, 2019; Göl-Güven, 2009; Varol, 2013). Thus, supplemental instruction provided through the BMLK program in small groups allows children in the experimental group to experience higher quality math instruction so that their number skills could have improved more. New studies utilizing small group math instruction in the regular classroom are needed to extend the findings of this study.

Limitations

There are several limitations that can be considered. First, the findings of this study cannot be generalized to the population. The study sample was limited with only 77 children in just one mid-sized city in Turkey. The second limitation is that the implementation of the BMLK curriculum took place only for six weeks and a small part of the curriculum was utilized. To better assess the effect of the BMLK on children's number skills, the curriculum needs to be fully implemented throughout a school year. The efficacy study for the BMLK also showed that the influence of the curriculum on children's achievement was only found in the second year of the implementation (Presser et al., 2015). Also, the implementation fidelity of the BMLK curriculum was not checked in the present study, but it is important for the published curriculum to be evaluated for the fidelity of the implementation (Presser et al., 2015).

The third limitation is that since the classroom teachers' instructional practices were not observed, the information on the frequency, duration and quality of the math instruction offered to children by the classroom teachers both in the experimental and the comparison groups was absent. Therefore, we cannot attribute the differences between the two groups only to the utilization of the MoNE curriculum with the BMLK, for sure.

Conclusion

It is an undeniable fact that the math education obtained in the early childhood period is important to the enhancement of the individuals' school achievements and hence ensuring that they will have a good career. The individuals need an educational setting, which supports their development, for building their math knowledge and skills on solid foundations as of the early childhood period. Current research studies advocate that this can be achieved via curricula that are prepared specifically for developing children's math skills and comprised of developmentally sequential, systematic, and well-planned activities. The findings of this current study provide promising evidence of the efficacy of the math-oriented program on kindergarten children's number skills in spite of its all shortcomings. This study suggests that supporting a curriculum, which advocates a comprehensive holistic-child approach, with a math-focused curriculum could improve the effectiveness of the comprehensive curriculum on children's mathematics learning. Hence, the implementation of a well-structured skill-based math curriculum in tandem with the national curriculum by the classroom teachers could help to improve the quality of math instruction in Turkish early learning environments.

Ethical Committee Approval

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"Küçük Çocuklar İçin Büyük Matematik" Programının Çocukların Sayı Becerisine Etkisi[1]

MAKALE TÜRÜ	Başvuru Tarihi	Kabul Tarihi	Yayım Tarihi
Araştırma Makalesi	04.05.2021	02.09.2021	03.11.2021

Ayşe Kılıçkaya[2]
Marmara Üniversitesi

Canan Avcı[3]
Ondokuz Mayıs Üniversitesi

Öz

Matematik becerilerinden sayı becerisinin ilerleyen yıllardaki matematik edinimini sağlayan en önemli etken olduğu bilinmektedir. Bu nedenle erken dönemde sayı becerilerinin gelişiminin desteklenmesi önemlidir. Bu çalışma, küresel bir öğretim programını, "Küçük Çocuklar İçin Büyük Matematik" programı ile desteklemenin çocukların sayı becerisi gelişimini etkileyip etkilemediğini incelemektedir. Çalışmada, öntest-sontest deneysel desen kullanılmıştır. Yetmiş yedi anasınıfı çocuğu (38 deney; 39 karşılaştırma) çalışmaya katılmıştır. Altı hafta boyunca deney grubunda yer alan çocuklar, Milli Eğitim Bakanlığı'nın (MEB) programı ve "Küçük Çocuklar İçin Büyük Matematik" programına katılırken karşılaştırma grubundakiler sadece MEB programını deneyimlemiştir. Çocukların sayı becerisi, Anadolu Okulöncesi Matematik Beceri Ölçeği (ANOMAT) ile ölçülmüştür. Bulgular, "Küçük Çocuklar İçin Büyük Matematik" programı ile desteklenen küresel MEB programına maruz kalan çocukların, sadece MEB programını deneyimleyenlere göre daha fazla gelişim gösterdiklerini ortaya koymuştur. Sonuçlar, beceriye dayalı bir öğretim programıyla desteklenen küresel bir öğretim programının çocukların sayı becerisi üzerinde olumlu bir etkisi olduğunu göstermektedir.

Anahtar sözcükler: Anasınıfı, sayı becerisi, erken çocukluk, küçük çocuklar için büyük matematik, erken matematik eğitimi.

Etik kurul kararı: Bu araştırma, Erzincan İl Milli Eğitim Müdürlüğünün iznine (No: 45468433/604/E.2501779, Tarih: 01.03.2016) sunulmuştur.

[1]Bu çalışma, İnönü Üniversitesi, Okul Öncesi Öğretmenliği bilim dalında, Şubat 2017 yılında Dr. Öğretim Üyesi Canan Avcı danışmanlığında yürütülen yüksek lisans tez çalışmasından üretilmiştir.

[2]*Sorumlu Yazar:* Araştırma Görevlisi, Eğitim Fakültesi, Temel Eğitim Bölümü, Okul Öncesi Eğitim Anabilim Dalı, e-posta: aysekilickayaa@gmail.com, https://orcid.org/0000-0001-6622-7206

[3]Dr. Öğretim Üyesi, Eğitim Fakültesi, Temel Eğitim Bölümü, Okul Öncesi Eğitim Anabilim Dalı, e-posta: canan.avci@omu.edu.tr, https://orcid.org/0000-0002-9313-4977

Amaç ve Önem

Erken çocukluk döneminde sahip olunan sayı becerisinin ilerleyen yıllardaki matematik başarısını belirleyen en önemli öğe olduğu bilinmektedir (Chu, vanMarle, Rouder ve Geary, 2018; Garon-Carrier ve diğ., 2018; Hawes, Nosworthy, Archibald ve Ansari, 2019; Jordan, Glutting ve Ramineni, 2010; Jordan, Kaplan, Ramineni ve Locuniak, 2009; Marcelino, de Sousa ve Lopes, 2017; Merkley ve Ansari, 2016). Bu nedenle erken çocukluk döneminde sayı becerisinin gelişiminin desteklenmesi önemlidir. Yüksek nitelikli erken çocukluk eğitimi, çocukları güçlü bir matematik temeli ile donatmak için hayati öneme sahiptir ve çocukların matematiksel gelişimini desteklediği kanıtlanmış araştırmaya dayalı bir matematik programı kullanmak bu güçlü temelin oluşturulmasına yardımcı olabilir (Bojorque, Torbeyns, Van Hoof, Van Nijlen ve Verschaffel, 2018; Clements ve Sarama 2007, 2008; Çelik ve Kandır 2013; Hofer, Farran ve Cummings, 2013; Kandır, Uyanık ve Çelik, 2017; Khomais, 2014; Presser, Clements, Ginsburg ve Ertle, 2015; Sarama, Lange, Clements ve Wolfe, 2012). Bu çalışma, gelişim odaklı MEB programının matematik odaklı "Küçük Çocuklar İçin Büyük Matematik" programı ile desteklenmesinin anaokulundaki çocukların sayı becerilerinin gelişimine etkisinin olup olmadığını incelemektedir.

Çocuklar, anaokuluna çok çeşitli erken sayı yeterlikleri ile başlar. Bazı çocuklar sayı isimlerini bilir ve basit toplama ve çıkarma problemlerini çözebilirken, diğerleri sayıları tanıyabilir ancak 1'den 10'a kadar saymakta zorlanabilirler (Lembke ve Foegen, 2009). Evde veya erken çocukluk eğitim ortamlarında matematik etkinliklerine maruz kalma, çocukların erken matematik yeterliklerinin oluşmasında önemli bir rol oynar (Jung, 2011; Skwarchuk, 2009). Çocuklar, formal eğitim başlamadan önce oyun ve anlamlı öğrenme etkinlikleri yoluyla erken sayı becerilerini ne kadar çok geliştirirlerse, matematiğin temel kavramlarını o kadar iyi kavrarlar (Ramani ve Siegler, 2008).

Türkiye'deki erken çocuklukta matematik eğitiminin doğasını araştıran çalışmalar, 3-6 yaş arası çocukların matematiği serbest oyunlarında sıklıkla kullandıklarını ancak öğretmenlerin gün içinde matematik etkinliklerine yeterli zaman ayırmadıklarını, gözlemlenen matematik etkinliklerinin içeriğinin temel matematiksel beceriler ile sınırlı olduğunu ve sıklıkla büyük grup ortamlarında gerçekleştirilen etkinliklerde çalışma kağıtlarının kullanıldığını göstermiştir (Alat, 2019). Diğer araştırmalar da okul öncesi öğretmenlerinin matematik etkinliklerinde çoğunlukla temel matematiksel becerilere odaklandığını ve bunun çocukların matematiksel gelişimini olumsuz etkilediğini bulmuştur (Claessens, Engel ve Curran, 2014; Engel, Claessens ve Finch, 2013; Engel, Claessens, Watts ve Farkas, 2016). Bu nedenle erken çocukluk eğitimi ortamlarında küçük çocukların temel matematiksel becerilerinin yanı sıra ileri matematiksel becerilerinin gelişiminin desteklenmesi önemlidir.

Çocuklar oyun yoluyla matematik kavramlarını daha iyi öğrenseler de deneyimlerini matematikleştirmek için yetişkinlerin desteğine gereksinim duyarlar (Ginsburg, Lee ve Boyd, 2008). Bu bakış açısıyla çelişen bir şekilde 5-6 yaş grubu çocukların bulunduğu sınıflarda yapılan gözlemlerde, matematik etkinliklerine

ayrılan sürenin günde ortalama üç dakika olduğu görülmüştür (Aydoğan ve Sağsöz-Başyurt, 2013; Varol, 2013). Verilen sürenin kısalığı, anaokullarında çocuklara sunulan matematik etkinliklerinin önceden planlanmadığını göstermektedir.

Matematik eğitiminin gerçekleştirildiği etkinlik ortamları da çocukların öğrenme çıktılarını etkiler (Ansari ve Purtell, 2017). MEB'in programı öğretmenlere günlük planlarında büyük grup, küçük grup ve bireysel olmak üzere çeşitli etkinlik ortamlarını dengeli bir şekilde kullanmalarını önermekle birlikte, öğretmenler etkinliklerin çoğunu büyük grupta gerçekleştirmektedir (Alat, 2019; Göl-Güven, 2009; Varol, 2013). Öte yandan, küçük grup kullanımının çocukların matematiği öğrenmesini olumlu yönde etkilediğine ilişkin bilimsel kanıtlar bulunmaktadır (örn., Ansari ve Purtell, 2017; Camilli, Vargas, Ryan ve Barnett, 2010; Jacob, Erickson ve Mattera, 2020; Wasik, 2008).

Özetle, erken çocuklukta matematik eğitiminin niteliğini iyileştirmek için, araştırmaya dayalı ve erken çocukluk döneminde matematik eğitiminin kapsamını ve sırasını sistematik olarak ele alan bir matematik öğretim programına gereksinim duyulmaktadır (Presser, Clements, Ginsburg ve Ertle, 2015). Bu bakış açısına uygun olarak Wakabayashi ve diğ. (2020), özellikle matematik becerilerine odaklanan bir öğretim programıyla gelişim temelli bir öğretim programını desteklemenin çocukların matematik başarısını daha da artırdığını belirtmiştir. Bu bulgudan hareketle bu araştırmanın amacı, gelişim temelli MEB öğretim programını matematik temelli "Küçük Çocuklar İçin Büyük Matematik" programı ile birlikte kullanmanın, anasınıfı çocuklarının sayı becerilerini desteklemede yalnızca MEB öğretim programını kullanmaktan daha etkili olup olmadığını araştırmaktır.

Yöntem

Bu araştırma, 2015-2016 öğretim yılında Türkiye'nin doğusunda yer alan bir il merkezinde iki farklı yarı bağımsız anaokuluna giden, normal gelişim gösteren 61-72 aylık 77 çocuk ile gerçekleştirilmiştir. Ön-test son-test kontrol gruplu deneysel desende tasarlanan bu çalışmada deney grubunda 38 (%60.5'i kız, %39.5'i erkek) karşılaştırma grubunda ise 39 (%48.7'si kız, %51.3'ü erkek) çocuk bulunmaktadır.

Bu araştırmada çocukların sayı becerisi gelişimine destek olmak hedefiyle Ginsburg, Greenes ve Balfanz (2003) tarafından geliştirilen "Küçük Çocuklar İçin Büyük Matematik" programı uygulanmıştır. "Küçük Çocuklar İçin Büyük Matematik" programı, araştırma temelli, geniş içerikli, programlı ve eğlenceli bir matematik programıdır. Program, verimli planlanmış matematik düşüncelerini tanıtma, karmaşık matematik görüşleri geliştime, matematiksel dili kullanma ve çocukların matematikçi gibi düşünmelerini sağlama amaçlarını içermektedir. Çalışmada "Küçük Çocuklar İçin Büyük Matematik" programının 5 yaş programında öğretim programında yer alan ünitelerden sadece sayılar ve işlemler kullanılmıştır.

Örneklemde yer alan çocukların sayı becerisi becerilerini ölçmek amacıyla Anadolu Okulöncesi Matematik Beceri Ölçeği (ANOMAT) kullanılmıştır (Erdoğan ve diğ., 2014). Ölçek; sayılar, işlemler ve geometrik şekiller olmak üzere üç alt

boyuttan meydana gelmektedir. Bu araştırmada sayılar ve işlemler boyutları ele alınmıştır. Her çocuk için sayı alt boyutu toplam puanı ve işlem alt boyutu toplam puanı olmak üzere iki ayrı puan hesaplanmıştır.

Çocukların sayı becerisi ile ilgili ön beceri düzeylerini belirlemek amacıyla örneklemde yer alan her bir çocuğa, ANOMAT beceri ölçeği tek tek uygun bir ortamda uygulanmıştır. Öntest uygulamalarından sonra altı hafta boyunca birinci araştırmacı tarafından deney grubunda MEB programına göre uygulanan sınıf etkinliklerine ek olarak günlük 30'ar dakika beşer çocuk olacak şekilde "Küçük Çocuklar İçin Büyük Matematik" programına göre hazırlanmış etkinlikler küçük grupta uygulanmıştır. Bu sırada karşılaştırma grubundaki çocuklara sadece MEB programına göre hazırlanan öğrenme etkinlikleri uygulanmıştır. Altı hafta süren eğitimin sonunda deney ve karşılaştırma grubunda bulunan çocukların sayı yetilerindeki değişikliği belirlemek için ANOMAT beceri ölçeği tekrar uygulanmıştır.

Bulgular

Çalışmaya katılan tüm çocukların ön-testten son-teste ANOMAT ölçeğinin tüm boyutlarında ortalama puanlarının arttığı gözlenmiştir. Ancak deney grubunda bulunan çocukların puan artışının karşılaştırma grubundakilere göre daha fazla olduğu belirlenmiştir.

Deney grubunda yer alan çocukların araştırmanın başlangıcında sayı becerisi yetilerinin benzerlik gösterip göstermediğini belirlemek amacıyla ön test puanlarına ilişkisiz örneklemler için t-testi analizi yapılmıştır. Tüm boyutlar için uygulama gruplarındaki çocukların başlangıç başarı düzeylerinin benzer olduğu bulunmuştur (sayı alt boyutu [$t(75) = 0.584$, $p > .05$] ve işlem alt boyutu [$t(75) = 0.168$, $p > .05$]).

MEB'in programının "Küçük Çocuklar İçin Büyük Matematik" programı ile desteklendiği deney ve sadece MEB'in programının uygulandığı karşılaştırma gruplarının sayı becerisi puanlarındaki (sayı ve işlem alt boyut puanları) değişimin anlamlı bir farklılık gösterip göstermediğini ölçmek amacıyla karışık ölçümler için iki faktörlü ANOVA analizi kullanılmıştır. Deney grubundaki çocukların sayı beceri düzeylerinde gözlemlenen artış miktarının karşılaştırma grubundaki çocukların sayı beceri düzeylerinde gözlemlenen artış miktarından anlamlı derecede farklı olduğu görülmüştür [$F(1,75) = 49.33$, $p < .001$]. Benzer şekilde, uygulama grubu ile tekrarlı ölçümlerin ortak etkisinin işlem alt boyutu puanlarında gözlemlenen artış ile istatistiksel olarak ilişkili olduğu görülmektedir [$F(1,75) = 79.06$, $p < .001$].

Tartışma, Sonuç ve Öneriler

Yapılan analizler sonucunda MEB'in programının "Küçük Çocuklar İçin Büyük Matematik" programı ile desteklendiği grupta yer alan çocukların sayı becerilerinin yalnız MEB'in programının uygulandığı grupta bulunan çocukların becerilerinden daha fazla gelişim gösterdiği keşfedilmiştir. "Küçük Çocuklar İçin Büyük Matematik" programının çocukların sayı becerileri üzerinde etkili olduğunu kanıtlayan bu çalışma bulgusu, daha önce yapılan deneysel (Çelik ve Kandır, 2013; Presser ve diğ., 2015)

ya da yarı deneysel çalışmaların (Kandır ve diğ., 2017; Khomais, 2014) ve deneysel olmayan bir çalışmanın (DeLoach, 2012) bulgularıyla paralellik göstermektedir.

Çocukların sayı becerisini geliştirmede "Küçük Çocuklar İçin Büyük Matematik" programının MEB'in programının etkililiğini arttırmasının bazı nedenleri bulunmaktadır. MEB'in (2013) programı gelişimsel olarak uygun, bütüncül-çocuk anlayışına sahip ve geniş kapsamlı bir programdır. Esas olan gelişimsel kazanımların edindirilmesidir, konu veya tema merkezli eğitime vurgu yapılmamaktadır. MEB'in öğretim programının aksine "Küçük Çocuklar İçin Büyük Matematik" programı, küçük çocuklara, temel ve karmaşık matematik becerilerinin gelişimsel olarak sıralı, sistematik ve yapılandırılmış etkinlikler aracılığıyla kazandırılması amacıyla tasarlanmış bir öğretim programıdır. Son yıllarda yapılan çalışmalar "Küçük Çocuklar İçin Büyük Matematik" programı gibi beceri temelli öğretim programlarının çocukların matematiksel gelişimini desteklemede geniş kapsamlı, bütüncül-çocuk anlayışına sahip öğretim programlarından daha etkili olduğu görülmüştür (örn., Clements ve Sarama, 2007; Hofer ve diğ., 2013; Sarama ve diğ., 2012; Wakabayashi ve diğ., 2020).

Matematik alanına odaklanmış programlara maruz kalan çocuklar, matematiksel söylemi daha fazla duymaktadır ve kullanmaktadır. Program kapsamında gün boyu süren matematik etkinliklerine daha çok maruz kalmaktadır (Greenes, Ginsburg ve Balfanz, 2004). Oysaki Türkiye'de gerçekleştirilen araştırmalarda, MEB'in geniş kapsamlı okul öncesi eğitim programının uygulandığı eğitim ortamlarında matematik etkinliklerine ayrılan zamanın, diğer tür etkinlikler ile karşılaştırıldığında çok kısa olduğu görülmektedir (Alat, 2019; Aydoğan ve Sağsöz-Başyurt, 2013; Varol, 2013).

"Küçük Çocuklar İçin Büyük Matematik" programının MEB'in öğretim programının etkililiğini arttırmasının bir diğer nedeni, "Küçük Çocuklar İçin Büyük Matematik" programının çocukların matematiksel gelişim aşamalarını göz önünde bulunduran, sistematik olarak yapılandırılmış, sıralı bir dizi etkinlik içermesidir (Greenes ve diğ., 2004). MEB programına göre oluşturulan etkinlikler ise sınıf içinde bireysel ve grup olarak çocukların ilgi, gereksinim ve gelişim düzeylerine uygun olacak şekilde öğretmen tarafından planlanmıştır. Eğitimin yöntemi, içeriği, sırası ve yoğunluğu ile ilgili karar verme sorumluluğu öğretmene verilmiştir. Ne yazık ki, Türkiye'de erken çocuklukta sistematik, sıralı, planlı ve derinlemesine matematik eğitimi yapılmamaktadır. Günlük planlarda genellikle çocuk gelişiminin farklı yönlerini (sosyal-duygusal, dilsel, bilişsel vb.) desteklemeyi amaçlayan bağlantısız etkinlikler vardır. Yüksek nitelikli erken matematik eğitimi için kapsamlı ve beceriye dayalı bir matematik öğretim programına gereksinim duyulmaktadır (NAEYC ve NCTM, 2002, 2010; NCTM, 2007; Presser ve diğ., 2015).

Bu çalışmanın bulguları, tüm eksikliklerine karşın matematik odaklı programın anasınıfı çocuklarının sayı becerileri üzerindeki etkililiğine yönelik umut verici kanıtlar sunmaktadır. Bu çalışma, kapsamlı bir bütüncül çocuk yaklaşımını savunan bir öğretim programının matematik odaklı bir programla desteklenmesinin, kapsamlı öğretim programın çocukların matematik öğrenimi üzerindeki etkinliğini

artırabileceğini öne sürmektedir. Bu nedenle okul öncesi öğretmenleri tarafından ulusal öğretim programıyla birlikte iyi yapılandırılmış beceri temelli bir matematik öğretim programının uygulanması, Türkiye'deki erken çocukluk eğitimi ortamlarında matematik eğitiminin niteliğinin artırılmasına yardımcı olabilir.

Etik Kurul Kararı

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