

A Home Connection Program to Promote Mathematical Interactions of Parents: Effects on Parents' Mathematical Interactions, Parent-Teacher Cooperative Relationship, and Three-Year-Olds' Mathematical Ability

Jinhui Bae

Jihyun Kim¹⁾

Myongji University

Abstract

This study aims to investigate the effects of a home connection program in promoting parental mathematical interaction, teacher-parent cooperative relationship, and 3-year-olds' mathematical ability. Forty-two 3-year-olds and their parents, from two childcare centers, were sampled; 21 children from one center served as the experimental group, and 21 children from the other center served as the comparison group. In order to investigate significant differences between the two groups, independent and paired *t*-tests were carried out after 26 sessions of the home connection program over 9 weeks applied to the experimental group. As a result, the home connection program was shown to contribute to the enhancement of parents' mathematical interaction, parent-teacher cooperative relationship, and 3-year-olds' mathematical ability. This study can make an important contribution to further research on the development of more practical home connection programs for improving a developmentally appropriate home environment to aid children's mathematics learning.

Keywords: home connection program, parents' mathematical interaction, parent-teacher cooperative relationship, young children's mathematical ability

Corresponding author, ¹⁾ jihyunkim@mju.ac.kr

Introduction

The goal of the “Mathematical Inquiry” domain of the national early childhood education standard in South Korea is to help children learn to inquire mathematically various problems in their daily lives. This standard emphasizes young children’s mathematical experiences in their daily lives rather than mathematical concepts as knowledge to be grasped through instruction; its goal is to develop children’s ability to actively solve everyday problems by constructing mathematical knowledge for themselves via inquiry and exploration (Ministry of Education & Ministry of Health and Welfare, 2019). However, Korean young children are exposed to a large amount of private tutoring; the most when compared with Japan, Taiwan, the U.S.A., and Finland (Kim et al., 2017). This is especially true for math: 17.3% of Korean 5-year-olds are exposed to private tutoring in math (Kim et al., 2016), and they started to experience private tutoring to get themselves ready for elementary school at 5.15 years of their age on an average (Yoon & Kim, 2017). In addition, 86.2% of private tutoring for young children is being implemented at home through parents’ choice as purchasing commercial learning materials (Lee et al., 2019). This reality makes us doubt whether Korean national math standard co-works at their home, and so we must make efforts to improve the Korean home learning environment as more developmentally appropriate practices for young children’s math development.

The age of three is a phase of initiative; an important time when children make plans, set goals, and try to achieve things for themselves (Erikson, 1950). During this phase, children’s cognitive abilities develop rapidly (Broberg et al., 1997). In this period, young children constantly express their curiosity about new things and cognitively develop by inquiring about and exploring their surroundings for themselves based on their curiosity (Bae & Kim, 2018). In addition, cognitive development during childhood significantly predicts children’s future school-age learning ability, academic achievement, problem-solving abilities (Fagan et al., 2007; Rivera-Batiz, 1992), and achievement in mathematics (Pajares, 1996).

The mathematical ability of young children is closely related to the important cognitive developments that take place during childhood (Lee & Park, 2010). Children’s mathematical ability is defined as an understanding of mathematics and the ability to

construct mathematical concepts through a variety of informal experiences in their daily life (Clements, 2001). Children who broaden their mathematical experiences in everyday life through conversations with their parents or teachers have been positively predicted to have more robust mathematical interactions with them, which in turn contributes to their cognitive development (Bae & Kim, 2018).

Here, we can focus on parental daily interaction with their young children for the children's mathematical development. Parents' mathematical interaction is defined as natural, verbal and non-verbal interactions between parents and their children regarding mathematical concepts and mathematical problem-solving in everyday life (Kim, 2015). When parents naturally interact with their children about mathematics-related content and elicit mathematical experiences through play or games in everyday life, the children gain the opportunity to deal with a variety of mathematical concepts and process skills. During mathematical interactions between parents and children, children can handle a variety of the informal mathematical concepts they experience by connecting them to situations and events that occur in their daily lives (Moon & Lee, 2008). Therefore, parents who value the informal mathematical knowledge experienced by their children and sensitively respond to mathematical experiences occurring in their daily lives should actively carry out mathematical interactions (Kim, 2015). Young children's mathematical activities at home proceed differently depending upon the physical and psychological environment constructed by their parents at home (Kim, 2002), and a greater variety of mathematical interactions between parents and their children has been shown to make a positive contribution to the improvement of children's mathematical abilities (Lee & Park, 2010).

Young children's mathematical development can be strengthened through the cooperation between family and educare centers. The parent-teacher cooperative relationship refers to a partnership in which parents and teachers assist one another toward a common purpose (Ahn, 2004; Bryan, 2005; Chung, 2011). According to ecological system theory, the home environment and the educare center in which children spend most of the day are microsystems that directly impact children – therefore, enhancing the mesosystem that connects these two microsystems can have a positive influence on children's development (Bronfenbrenner, 1979). The parent-teacher cooperative relationship, built as a partnership, becomes an important factor to provide good quality

educational experiences for children (Weiser, 1991). Parents' involvement and learning based on the home-center connection has a positive effect on young children's mathematical abilities (Kim & Ahn, 2008). Home connection education through home-center connection carried out by teachers and parents as equal partners is important in that it predicts young children's cognitive development and growth (Moon, 2017).

Thus, we adapted a home connection model in which young children's mathematical abilities can develop based on active parental mathematical interaction, which in turn can be enhanced through the family-center connection. Home connection activities are a series of processes in which parents and childcare centers share responsibility for children's education making common efforts toward a higher quality of education in a consistent, cooperative relationship that is based on a partnership (Chung et al., 2011). This takes places through coherently linked educational activities that extend experiences in the childcare center to the home and thereby reintegrate the experiences in the center through the cooperative relationship between the home and the center. Through this cooperation, parents and teachers provide various experience opportunities for children by sharing information about the skills and methods of child education (Bae & Kim, 2017), inducing appropriate interactions for children's development at home (Watson & Swim, 2008), and positively influencing the children's cognitive development, including the development of mathematical concepts through coherent education (Bae & Kim, 2017; Bryan, 2005; Choi, 2013; Galindo & Sheldon, 2012; Hughes & Macnaughton, 2001; Rentzou, 2011). Therefore, we can infer the importance of connecting young children's learning to various mathematical contexts in daily life.

According to previous research on home connection activities related to math and science, home connection activities can promote parents' mathematical interactions with their children (Bae & Kim, 2019; Lee et al., 2019), make positive contributions to the improvement of parents' scientific educational attitude, and promote scientific interactions between parents and their children (Chon & Lee, 2007; E. Lee, 2010). In addition, such experiences were found to positively predict children's understanding of basic mathematical and scientific concepts, improvement of mathematical ability (Kim & Ahn, 2008; Kim & Choi, 2006), mathematical process skills, and mathematical attitudes (Kim & Ahn, 2008; J. Lee, 2010). Given that home connection activities are much more likely to be

linked to the context of experiences in everyday life, they are expected to relate positively to the promotion of parents' interactions and young children's mathematical abilities.

Most of the existing research on the home connection program examined early childhood mathematics dealing with specific activities, such as cooking (Kim & Choi, 2006), or were only concerned about improving young children's mathematical abilities regardless of whether the children employed mathematical inquiry activities based on their daily experiences (Kim & Ahn, 2008). A few previous studies have targeted the parents of young children, and one Korean study showed that a parent education program had a positive effect on the enhancement of parents' mathematical teaching efficacy (Hur, 2012). In short, it is difficult to find research that focuses primarily on the improvement of parents' mathematical interactions with their children. In addition, these studies are substantially limited in terms of their methodology to identify their activities as belonging to a home connection program. For instance, some developed home connection programs that introduced to parents simple math activities to help their children acquire mathematical concepts (Kim & Ahn, 2008; Kim & Choi, 2006); others listed segmented activities between the childcare center and home because they were merely categorized under the same topic (Chon & Lee, 2007; Kim & Ahn, 2008). Therefore, the literature requires us to first link activities taking place first at the center with activities taking place in the children's homes, and then link activities taking place at home to a third set of activities taking place afterward, again in the childcare center, which integrate both sets of activities. Such organization of activities can motivate parents to engage in their own mathematical interactions and help their children improve their mathematical abilities.

In short, a home connection program for the promotion of mathematical interactions of three-year-olds' parents can be expected to contribute to improvements in parents' mathematical interactions with their children, parent-teacher cooperative relationship, and children's mathematical abilities. The present study aims to examine the soundness of these expectations. Its research questions are as follows:

1. Does a home connection program significantly promote parents' mathematical interactions?
2. Does a home connection program significantly improve the parent-teacher cooperative relationship?

3. Does a home connection program significantly enhance young children's mathematical abilities?

Methods

Research Participants

This study selected a total of 42 3-year-olds and one of their parents in B and D childcare centers in G-gu, S city, South Korea, as the research participants. The two childcare centers were located in the same administrative district (G-gu), and the parents' socio-economic backgrounds, community cultures, and the goals and contents of the main childcare programs were similar between the two. Twenty-one 3-year-olds and their parent from each of B and D childcare centers were selected as the experimental and comparison groups, respectively. Although we utilized purposive sampling, there were no differences in the ages and sex between the two groups. We selected three-year-olds as the participants because at this age, children build a foundation for their future mathematical abilities and improve their mathematical knowledge and conceptual understanding (Lee, 1999). It is also the time when the gaps between children's mathematical abilities begin to develop (Hong, 2009). This age can be seen as an important time in which early childhood has begun but private education has not yet begun; according to a study on the actual state of private education for children in South Korea, children receive their first private tutoring (Korean, English, Mathematics, etc.) at the age of about 46.9 months (Kim et al., 2016). Therefore, as three-year-olds have little experience of private education and are thus expected to receive little effect from it, we targeted this age group to examine the effects of parents' mathematical interactions with their children. The actual degree of exposure to private education of mathematics was 14.29% and 9.52% for the experimental and comparison groups, respectively, and overall, one out of 10 children had some experience of private mathematics tutoring. Before conducting the research examination, the researchers composed an explanatory note and a consent form and distributed them to the children's parents. The study was then conducted only with the children whose parents returned the

completed consent form. The researchers laid out the research purpose, procedures for the protection of personal information during the program participation process, methods for processing the collected data, and an outline of program procedures in the parent orientation session.

Research Instruments

Parents' Mathematical Interactions

This study used the scale of parents' mathematical interactions developed by Kim (2015). This scale includes four sub-factors and is constructed with a total of 24 question items: 10 for "interacting with numbers and arithmetic, measurements, and regularity", six for "interacting with space and figures", five for "interacting through storybooks", and three for "interacting by collecting data and showing results". Each item was measured with a 4-point Likert scale, in which answers ranged from "Never" (1) to "Very often" (4). The total scores range from 24 to 96, and higher scores indicate that parents' mathematical interactions are more active. The reliability coefficients (Cronbach's α) were .90 for "interacting with numbers and arithmetic, measurement, and regularity", .88 for "interacting with space and figures", .86 for "interacting through storybooks", and .86 for "interacting by collecting data and showing results", and the overall reliability coefficient was .95.

Parent-Teacher Cooperative Relationship

In order to measure the parent-teacher cooperative relationship, this study used the caregiver-parent partnership scale (for parents) developed by Owen, Ware, and Barfood (2000). The scale contains three sub-factors and is constructed with six items for "mutual relations", five for "information sharing", and three for "information seeking", totalling 14 items. The present study used a 5-point Likert scale; the responses to each item were from "Never" (1) to "Often" (5). The total scores range from 14 to 70, and higher scores mean that the parent-teacher cooperative relationship is more active. The Cronbach's α (reliability coefficients) were .78 for "mutual relations", .84 for "information sharing", and .78 for "information seeking", and the overall Cronbach's α was .74.

Young Children's Mathematical Ability

In order to measure young children's mathematical ability, the current study employed Choi and Hwang's (2007) pictorial math ability test instrument for children. The sub-factors are "algebra", "arithmetic", "geometry", and "measurement", and the total number of items is 60. The test method is to award 1 point if the young child gives the correct answer according to the instruction and award 0 points otherwise. Examples of items are "Judy has two candies, and her mom gives one more candy to her, how many candies does Judy have now?" for "algebra", and "What blocks do you need to make this shape?" for "geometry". The highest score possible is 60. The higher the score, the higher the mathematical ability the child has. At the time of the development of the instrument, the reliability coefficients (Cronbach's α) were .81 for "algebra", .85 for "numbers and arithmetic", .75 for "geometry", and .82 for "measurement", and the overall Cronbach's α was .94. In this study, the Cronbach's alphas of "algebra", "numbers and arithmetic", "geometry", and "measurement" were .68, .66, .65, and .66, respectively, and the overall Cronbach's α was .75.

Research Procedure

Pre-test

This study conducted a pre-test on the three-year-olds and parents in the experimental and comparison groups. The mathematical ability test for the young children was conducted by a trained research examiner as a one-on-one test with the children in an independent space of the childcare centers between June 25 and July 2, 2018. The total scores were calculated according to scoring standards. To measure parents' mathematical interactions and the parent-teacher cooperative relationship, a questionnaire was sent to each home between June 25 and June 30 that was completed by parents and then returned to the childcare centers.

Research Examiner and Teacher Training

To ensure consistent testing, we trained our examiners prior to testing the young

children's mathematical abilities. This training included background theory, the purpose and contents of the test, the test's method, recording method, test time, and advice (e.g., advising the examiner to conduct the test in a setting comfortable for the young children). The test was conducted as a one-on-one test between the examiner and each child in an independent space. The researchers are Ph.D. students who majored in child studies and have an average of 13 years of childcare field experience. Before the program began, one of the researchers educated the two homeroom teachers of the three-year-olds in the childcare centers where the home connection program would be conducted on the purpose, session structure, content components, activity contents, and activity methods of each session. In addition, prior to each week's session, this researcher also explained the goals, activity methods, and activity tasks of each topic to the teachers. The two teachers who conducted the home connection program had similar backgrounds, with postgraduate education and less than three years of work experience.

Program Implementation

The home connection program for the promotion of parents' mathematical interactions was implemented in the experimental group from July 4 to September 5, 2018, after the completion of the pre-test. After the first session, during free-choice activity time in the childcare centers, the children were sent home and freely conducted the activity of the second session with their parents on the weekend. The third session then integrated the activities, again using the free-choice activity time at the centers.

The activities of this program were designed to be conducted at home every weekend, and activities carried out at home were brought back to the centers and conducted again to integrate the prior two activities. In reality, it was difficult to smoothly proceed with home connection activities every week because this required parents' active cooperation. After activities with the children, teachers helped the children to facilitate their own activities with parents by explaining which activities the children were to conduct with their parents at home. Teachers tried to increase parents' participation in home connection activities by explaining these activities to the parents in detail, one-on-one, during parents' visits to the centers, and consistently provided guidance through a parent-teacher communication

notebook. As shown in <Figure 1> and <Figure 2>, a total of 26 sessions were held at the rate of three sessions per week. The first session provided an orientation to the program for the parents and teachers, and the final session was an exhibition with families. This study proceeded with each topic in the following steps: childcare center activities ➡ home connection activities ➡ home-center integrated activities. The mathematical activities in the childcare centers were connected to the home to facilitate parents' mathematical interactions, and the deepening and broadening of activities through cooperation between parents and teachers was reinforced through integrated activities in the centers. To guide parental mathematical interaction, childcare centers provided parents with detailed guidelines including the purpose and procedures of the activities, and math pouch containing worksheets and materials which can be dealt with easily by parents. For example, according to Figure 2, children found shapes in the classroom after reading a book <Shapes coming out the world> together in the phase of "childcare center activities"; at the second phase of "home connection activities", they interacted with their parents to go through reading books, finding shapes at home, and reconstructing new shape with basic shape in their worksheet (picture books and worksheet were contained in the math pouch); finally at the third phase of "home-center integrated activities", they shared their home activities with each other and re-reconstruct new shape with peers, based on their experience which had occurred at home before. The contents of each session were as follows: interacting through storybooks in the 2nd through 7th sessions, interacting with numbers and arithmetic, measurement, and regularity in the 8th through 13th sessions, interacting by collecting data and showing results in the 14th through 19th sessions, and interacting with space and figures in the 20th through 25th sessions, each of which was held for two weeks.

Meanwhile, the comparative group children experienced their usual math activities under the Korean national curriculum, without this home-connection program, during this period. These usual math activities generally mean that teacher-guided free choice or group activities focusing on children's math development under the class's monthly theme.

A Home Connection Program to Promote Mathematical Interactions of Parents: Effects on Parents' Mathematical Interactions, Parent-Teacher Cooperative Relationship, and Three-Year-Olds' Mathematical Ability

1 st session		Orientation for teachers and parents			
Parents' mathematical interactions	set		Childcare center	Home	Integrated
Interacting through storybooks	1	Session	2 nd	3 rd	4 th
		Activity name	Storybook 1 'Penguin la la la' →	Knowing the number of penguins	→ Knowing the locations of penguins
		Material		Math pouch: Storybook	Reorganized book
	2	Session	5 th	6 th	7 th
		Activity name	Storybook 2 'Shapes coming out of the world' →	Knowing the shapes in my house	→ Comparing shapes with friends
		Material		Math pouch: Storybook+ shape frames	Constructing with shapes that I found
Interacting with numbers and arithmetic, measurement, and regularity	3	Session	8 th	9 th	10 th
		Activity name	Knowing friends' shoe sizes →	Knowing family members' shoe sizes	→ Whose shoes are they?
		Material		Math pouch: Family members' shoes)	The picture of family members' shoes
	4	Session	11 th	12 th	13 th
		Activity name	Friends' spoons and forks →	Spoons and forks at my house	→ Spoons and forks in my class
		Material		Math pouch: Family members' spoons and forks	Family members' spoons and forks
Interacting by collecting data and showing results	5	Session	14 th	15 th	16 th
		Activity name	Classifying my stuff →	Classifying family members' stuff	→ Classifying stuff with friends
		Material		Math pouch: List of family members' stuffs	List of family members' stuffs
	6	Session	17 th	18 th	19 th
		Activity name	Cooking play with friends →	My home refrigerator	→ My home refrigerator story
		Material		Math pouch: My home refrigerator	The picture of my home refrigerator
Interacting about space and figures	7	Session	20 th	21 st	22 nd
		Activity name	Organizing my classroom →	Drawing my house & my room	→ Organizing my friends' rooms
		Material		Math pouch: Aerial view of my room	Aerial view of my room
	8	Session	23 rd	24 th	25 th
		Activity name	Knowing the shape of natural objects →	Making various shapes with natural objects	→ Introducing my work made of natural objects
		Material		Math pouch: Natural objects I found	Natural objects I found
26 th session		Overall evaluation and exhibition			

Figure 1. Home connection sessions

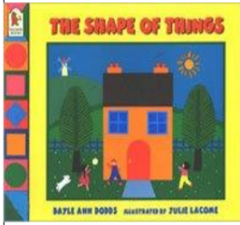
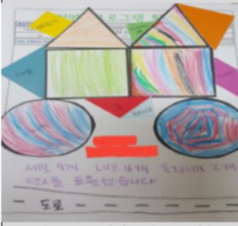
1st set		5 th session (Childcare center)	6 th session (Home)	7 th session (Integrated)
Activity name		'Shapes coming out the world'		
Material				
Stage	Inter-action			
[Stage1] Collect- ing thoughts	Participati ng and exploring	- Exploring in the language area : Have the young children freely read the storybooks.	- Reading books with parents : Read the book sent home with parents.	- Exploring friends' activities sheets and works : Observe the shapes friends found at home and reconstruct
[Stage 2] Sharing thoughts	Asking and acknowle dging	- What shapes are there? : Read storybooks with the teacher and friends. Experience changes in the shapes in storybooks. Talk about shapes and experience how they change naturally.	- Shapes the children found with parents. : Find the shapes in storybooks at home. *Home mission 1. Parents write mathematical stories, which are shared with their children at activity time, in the home activity sheet	- Introducing the activities sheet the children had with their parents : Tell friends which things are like the shapes in my house, and introduce my work reconstructed with shapes.
[Stage 3] Broaden- ing thoughts	Evaluatin g and supportin g	- Finding shapes in the classroom : Find the shapes in the books in the classroom and make shape figures. - Evaluating activities : Evaluate interesting and fun experiences during the activity time.  <A storybook related to shapes>	⇔ - Find the same shapes : Find things like the shapes in the book and take pictures of or draw them. Reconstruct basic shapes into a different one.  <A home activity sheet with a new shape reconstructed by using basic shapes with parents>	⇔ - Reconstructing my and friends' activities : Pair up with a friend who found something with the same shape as that I found, or group the children who found things of the same shape. (Go into circles, rectangles, and triangles drawn with tape on the floor). Also, reconstruct basic shapes into a different one together.  <Work reconstructed with friends>
com po ne nts	Parents' mathematical interactions	Interacting through storybooks	Interacting through storybooks	Interacting through storybooks
	Parent-teacher cooperative relationship	Information sharing, information seeking, and mutual relation	Information sharing, information seeking, and mutual relation	Information sharing, information seeking, and mutual relation
	young children's mathematical ability	Numbers and arithmetic, algebra	Numbers and arithmetic, algebra	Numbers and arithmetic, algebra

Figure 2. Home connection program: interacting through storybooks 2nd set (5th–7th Sessions).

Post-test

The post-test, conducted in the same manner as the pre-test, occurred between September 6 and September 10, 2018.

Data Analyses

The present study conducted its analyses using SPSS for WINDOWS 23.0. First, we carried out the descriptive statistics of the data to examine the socio-demographic characteristics of the research participants and calculated Cronbach's α to measure the reliability of the study's instruments. Second, we conducted *t*-tests for independent samples in order to test their pre-homogeneity and analyze the post differences between the experimental group and the comparison group. Third, we conducted paired-sample *t*-tests in order to examine whether there were any substantively significant changes in the experimental group after the implementation of the program, as compared to the comparison group.

Results

The results of analyzing whether the home connection program affected the promotion of parent-child mathematical interactions, the parent-teacher cooperative relationship, and children's mathematical abilities are as follows:

Effect on Parents' Mathematical Interactions

We conducted independent-sample *t*-tests to verify the homogeneity of the groups before examining the effect of the home connection program on parents' mathematical interactions (PMI). There was no statistically significant difference in the scores of PMI between the two groups before the program was conducted. Therefore, the pre-homogeneity between the two groups was verified.

On comparing the scores of PMI between the experimental and comparison groups after the program was conducted (see Figure 1), it was found that the scores were higher for the experimental group ($M = 72.29$, $SD = 8.46$) than for the comparison group ($M = 61.33$, SD

= 11.10), and the between-group difference was statistically significant ($t = 3.60, p < .01$). Looking at the sub-areas, we found statistically significant differences between the two groups in the post-program scores of the four sub-areas: interacting with numbers and arithmetic, measurement, and regularity ($t = 2.97, p < .01$), interacting with space and figures ($t = 2.55, p < .05$), interacting through storybooks ($t = 2.13, p < .05$), and interacting by collecting data and showing results ($t = 4.33, p < .001$). These results show that the home connection program had a significant effect on the promotion of PMI.

In order to identify whether there was a significant increase in the post-program scores of PMI within the experimental group, we conducted paired-sample t -tests (see Figure 3). In the experimental group, the scores of PMI were significantly higher ($t = -11.081, p < .001$) after the program ($M = 72.29, SD = 8.46$) than before the program ($M = 53.24, SD = 10.52$). Further, significant differences were also found in the four sub-areas of PMI: interacting about number and arithmetic, measurement, and regularity ($t = -10.30, p < .001$), interacting about space and figures ($t = -6.89, p < .001$), interacting through storybooks ($t = -7.20, p < .001$), and interacting about collecting data and showing results ($t = -8.19, p < .001$). However, in the comparison group, no significant difference in the scores were found before and after the program. Therefore, the experimental group experienced a statistically significant increase in the scores of PMI, but the comparison group did not.

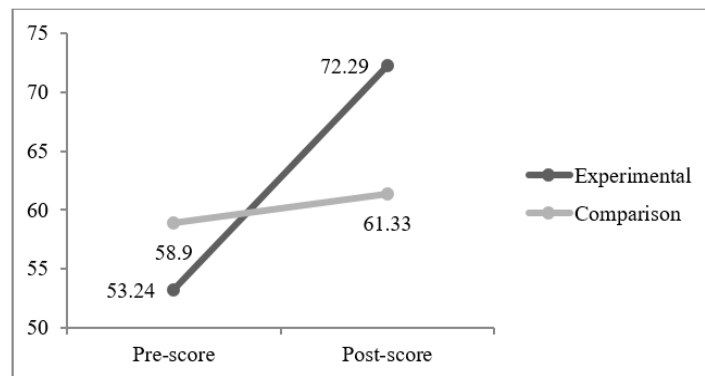


Figure 3. Parents' mathematical interactions in the experimental and comparison groups.

Effects on Parent-Teacher Cooperative Relationship

Prior to examining the effects of the home connection program on the parent-teacher cooperative relationship (PTCR), we performed independent-samples *t*-tests in order to identify the homogeneity of the two groups. The two groups did not show any statistically significant difference in the pre-scores of PTCR before the program. Accordingly, the two groups were analyzed as homogeneous.

The results of comparing the scores of PTCR between the experimental and comparison groups after the program (see Figure 2) revealed that the former's scores ($M = 55.71$, $SD = 3.64$) were higher than the latter's ($M = 48.42$, $SD = 5.47$), and the difference was statistically significant ($t = 5.28$, $p < .001$). In terms of the post-program scores in the sub-areas, the two groups showed statistically significant differences in mutual relation ($t = 2.22$, $p < .05$), information sharing ($t = 5.64$, $p < .001$), and information seeking ($t = 3.55$, $p < .01$). These results show that the home connection program exerted a statistically significant and positive effect on the PTCR.

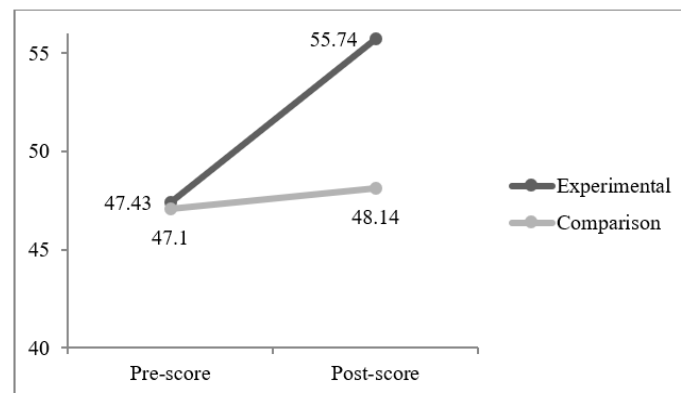


Figure 4. Parent-teacher cooperative relationship in the experimental and comparison groups.

With a view to investigating the effect of the program on PTCR within the experimental group, we carried out paired-sample *t*-tests to identify whether the program caused a substantive increase in PTCR scores (see Figure 4). It was found that in the experimental group, the scores of PTCR were higher after the program ($M = 55.71$, $SD = 3.64$) than before the program ($M = 47.43$, $SD = 7.37$). This difference achieved statistical

significance ($t = -5.72, p < .001$). Such statistically significant differences between the pre- and post-program scores were also found in all three sub-areas of the PTCR: mutual relation ($t = -4.26, p < .01$), information sharing ($t = -4.09, p < .01$), and information seeking ($t = -5.72, p < .001$). In contrast, the PTCR did not show a statistically significant increase even after the program in the comparison group. Therefore, we identified a positive effect of the home connection program on the PTCR.

Effect on Three-Year-Olds' Mathematical Ability

In order to examine the influence of the home connection program on three-year-olds' mathematical ability (3MA), we first conducted independent-sample t -tests to check the homogeneity between the two groups. There was no statistically significant difference in the 3MA scores between the two groups. This supports the pre-homogeneity of the groups.

After the program, we compared the scores of 3MA between the experimental and comparison groups (see Figure 3). First, the former's scores ($M = 19.47, SD = 6.37$) were greater than the latter's ($M = 14.67, SD = 4.19$) and the difference was statistically significant ($t = 2.89, p < .01$). Next, the results of the four sub-areas revealed that the two groups showed statistically significant differences in the post-program scores of numbers and arithmetic ($t = .62, p < .05$), geometry ($t = .11, p < .05$) and measurement ($t = .27, p < .05$), but not algebra. Overall, this indicates that the home connection program had a positive influence on the children's mathematical abilities.

In order to examine the effects of the home connection program on 3MA within the experiment, we identified whether there was a significant increase in the post-program scores compared to the pre-scores by conducting paired t -tests (see Figure 5). In the experimental group, the scores for 3MA were higher after the program ($M = 19.47, SD = 6.37$) than before the program ($M = 13.90, SD = 4.56$). The difference was found to be of statistical significance ($t = -6.22, p < .001$). Moreover, such statistically significant differences were also shown in all the four sub-areas of 3MA: algebra ($t = -5.45, p < .001$), numbers and arithmetic ($t = -3.25, p < .01$), geometry ($t = -2.53, p < .05$), and measurement ($t = -3.77, p < .01$). Notably, even in the sub-area of algebra, in which the between-group difference in the post-program scores was statistically nonsignificant, a statistically significant increase was found in the post-program scores, compared to the pre-scores. In

contrast, in the comparison group, children's mathematical abilities did not show a statistically significant increase. Therefore, the positive effects of the home connection program on 3MA were identified, as the scores increased more in the experimental group than in the comparison group.

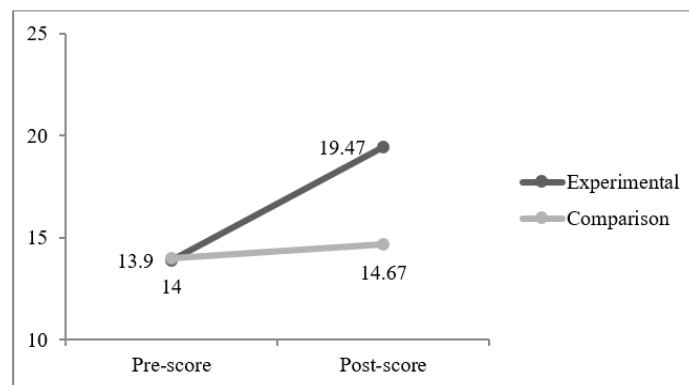


Figure 5. Young children's mathematical ability in the experimental and comparison groups.

Discussion

The effects of applying the program are as follows. First, the home connection program was found to exert a positive effect on the promotion of parents' mathematical interactions. In our research, the childcare centers first proceeded with mathematical activities that could be experienced in daily life and then these activities were connected to home activities. Through this arrangement, the childcare centers presented mathematical experiences that parents could share with their children and guided the parents regarding how they might conduct mathematical interactions, thus helping the children broaden their mathematical experiences. This is consistent with prior studies, that have shown that home connection programs have a positive influence on the frequency and depth of child-parent interactions (Lee et al., 2010) and, in the same context as previous findings, shows that childcare center-home connection activities promote parents' scientific interactions with their children (E. Lee, 2010). When teachers plan parents' involvement in their class activities, parents can

have more interactions with their children at home, feel positive about their ability to help their children, and improve the learning attitude and performance of their children (Epstein & Dauber, 1991). Through a home connection program, parents can respond properly to their children's developmental needs and provide support through various activities with them by knowing what kinds of experiences and learning their children face in childcare centers (Kim & Ahn, 2008). As a result, these programs promote parents' mathematical interactions with their children.

Second, the home connection program improved the parent-teacher cooperative relationship. This happened because, unlike in the existing home connection programs in which activities were sent from childcare centers to home and completed at home, here, home connection activities were returned to the childcare centers and completed there, thus enhancing parent-teacher communication and the parent-teacher cooperative relationship in general. During the home connection activities, the teachers shared information about mathematical activities in the childcare centers (e.g. technical and educational methods, children's reactions, learning situations) with the parents, and the latter shared the contents of mathematical activities at home (e.g. children's responses, parents' discoveries and difficulties, etc.). Accordingly, teachers and parents could communicate and cooperate with each other, regarding methods to help the children understand mathematical concepts. In addition, we could actually identify how, in the process of deepening and expanding the children's mathematical activities, the degree of the children's participation in the activities varied depending upon the level of the parent-teacher cooperative relationship. Home and childcare centers are the most important environmental systems that determine young children's growth and development, and therefore should build complementary and cooperative relationships (Lee & Moon, 2008). Parents who receive support from childcare centers through a home connection program can learn educational skills and methods (Swap, 1993) and help their children by showing greater interest in their education through cooperation with teachers. This can influence the educational achievement and positive behavior of children who spend whole days in childcare centers (Son, 2008). Teachers can also seek understanding and receive educational support from parents and perceive parents' interests in educating their children (Swap, 1993). Thus, activities related to information sharing and communication through home connection programs can improve the quality of

communication between teachers and parents (Jeynes, 2011) and enhance the parent-teacher cooperative relationship.

Third, the home connection program was found to positively influence the improvement of the three-year-olds' mathematical abilities. This happened because the young children were able to actively understand mathematical concepts through a variety of informal experiences in daily life. When the children's initial experiences in the childcare centers were connected to home, their parents' mathematical interactions help them naturally obtain mathematical concepts by problem-solving at their own pace in a comfortable environment. In addition, during the program, parents collaboratively supported the program by being interested in their children's lives in the childcare centers, communicating with the teachers, and actively participating. The results support the idea that when young children obtain insights into how to understand and use mathematical relations in their daily lives, their mathematical abilities improve (Clements, 2004). The findings of this study are consistent with the results of prior studies that show parents' involvement and home connection learning have a positive effect on young children's mathematical and problem-solving abilities (Han, 2003; Kim & Ahn, 2008; Kim & Choi, 2006) and that coherent education by home-childcare center cooperation improves young children's mathematical and cognitive abilities (Bae & Kim, 2017; Bryan, 2005; Choi, 2013; Galindo & Sheldon, 2012; Hughes & Macnaughton, 2001; Rentzou, 2011). Daily experiences of mathematics recurring through home connection activities exert a positive influence on young children's measurement ability, mathematical process and attitude (Lee, 2010), and mathematical ability and achievement level (Hill & Craft, 2003). In these processes, parents' positive interactions regarding mathematical experiences affect their children's cognitive development (Bae & Kim, 2017).

In conclusion, the home connection program increased mathematical interactions between three-year-olds and their parents, improved the parent-teacher cooperative relationship, and improved and developed the young children's mathematical abilities. The implications of this study are as follows. First, this study tried to apply the home connection method to enhance parental mathematical interactions of 3-year-olds. Parents can learn how to interact mathematically with their children by connecting their daily home-based interaction with childcare center's activities. Thereby, children can get integrated support

from their parents and teachers to improve their mathematical abilities and strongly root them in their daily lives. Second, this study is practical in that it presents various activities and specific activity methods to promote parent-child mathematical interactions. Teachers will, therefore, be able to present interesting activities to parents, and parents can easily connect the activities in childcare centers to home activities with their children. This study implies the importance of the parents' role at home through home connection activities and the need to connect the activities in childcare centers to home activities. Third, this study provides meaningful suggestions to the Korean society specially, focusing on young children's over-exposed private math tutoring for their future academic success at elementary school. We overcome this developmentally inappropriate home environment through the home-center connection to guide parental daily interaction with their children at home.

This study has three major limitations. First, we utilized purposive sampling to assign experimental and comparative groups; so, we have to interpret our research results with respect to this limitation. Second, this study collected data not by directly observing parent-child mathematical interactions but rather from parental reports about these interactions. We suggest conducting future studies to analyse the results of observing the process by which parent-child, child-child, and child-teacher interactions change. Third, this study used only a quantitative method to measure positive enhancement of the variables. Future qualitative studies are needed to determine which processes in the home connection program promote mathematical interactions between parents and their children and what parts of the parent-teacher cooperative relationship are influential.

Despite these limitations, the home connection program investigated in this study is expected to induce follow-up studies on the positive effects of daily-life-centered home connection programs on relevant variables such as parents' mathematical attitudes, mathematics learning perspectives, and the efficacy of mathematics guidance, and provide basic data for the development of future home connection programs relating to young children's mathematics. In addition, the program promoting parents' mathematical interactions is expected to contribute to activating interests in and studies on the qualitative aspects of the home environment that facilitate young children's cognitive development.

References

- Ahn, S. H. (2004). Early childhood teachers' perception and attitudes toward parent involvement. *Journal of Future Early Childhood Education*, 11(3), 27-49.
- Bae, J. H., & Kim, J. H. (2017). The effects of the parent-teacher cooperation on the cognitive development of 3-year-olds: Focusing on the mediating effect of the quality of home environment and the parental mathematical interaction. *Korean Journal of Childcare and Education*, 13(6), 143-161. <https://doi.org/10.14698/jkcce.2017.13.06.143>
- Bae, J. H., & Kim, J. H. (2018). Gajeonghwangyeongui jilgwa bumoui suhakjeok sanghojagyongi man 3se yuau injeunngnyeoge michineun yeonghyang [The effects of the quality of the home environment and parental mathematical interaction on the cognitive ability of 3-year-olds]. *The Korean Journal of the Human Development*, 25(1), 61-77. <https://doi.org/10.15284/kjhd.2018.25.1.61>
- Bae, J. H., & Kim, J. H. (2019). Man 3se yua bumoui suhakjeok sanghojagyong jeungjineul wihan gajeongyeongye peurogeuraemui gaebal mit jeogyong [Development and application of a home connection program on the improvement of mathematical interaction of parents of 3-year-olds]. *Korean Journal of Childcare and Education*, 15(3), 81-113. <https://doi.org/10.14698/jkcce.2019.15.03.083>
- Broberg, A. G., Wessels, H., Lamb, M. E., & Hwang, C. P. (1997). Effects of day care on the development of cognitive abilities in 8-years-olds: A longitudinal study. *Development Psychology*, 33(1), 62-69. <https://doi.org/10.1037/0012-1649.33.1.62>
- Bronfenbrenner, U. (1979). *The ecology of human development*. Harvard University Press.
- Bryan, J. (2005). Fostering educational resilience and achievement in urban schools through school-family-community partnerships. *Professional School Counseling*, 8(3), 219-227.
- Choi, H. J., & Hwang, H. I. (2007). Yuageurim suhangneungnyeokgeomsa gaebal yeongu [The development of a pictorial math ability test for young children]. *Early Childhood Education Research & Review*, 11(1), 157-180.
- Choi, J. H. (2013). Yua, eomeoni, gyosa teukseongi eomeoni-gyosa hyeomnyeokgwangye

- mit inji baldare michineun yeonghyang: Hoengdan mit jongdan yeongu* [The effects of child-, mother-, caregiver-characteristics on the mother-caregiver partnership and cognitive development: a cross-sectional and longitudinal analyses] [Unpublished doctoral dissertation]. University of Ulsan.
- Chon, Y. J., & Lee, J. S. (2007). Gajeongyeongye jayeontamgujungsim yuagwahakpeurogeuraem hyogwa yeongu [The effects of ‘take-home nature inquiry centered child science program’]. *The Korea Association of Child Care and Education*, 48, 1-17.
- Chung, K. S. (2011). A study on variables affecting teachers’ perception of communication difficulties with mothers. *Early Childhood Education Research & Review*, 15(3), 143-164.
- Chung, M. R., Kwon, J. Y., & Park, S. K. (2011). The relationships between the development of 12-month-infants and their home environment. *Korean Journal of Early Childhood Education*, 31(5), 371-390. <https://doi.org/10.18023/kjece.2011.31.5.016>
- Clements, D. H. (2001). Mathematics in the preschool. *Teaching Children Mathematics*, 7(5), 270-275. <https://doi.org/10.5951/TCM.7.5.0270>
- Clements, D. H. (2004). Geometric and spatial thinking in early childhood education. In D. H. Clements, A. DiBiase, & J. Sarama (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp. 267-297). Lawrence Erlbaum Associates.
- Epstein, J. L., & Dauber, S. L. (1991). School programs and teacher practices of parent involvement in inner-city elementary and middle Schools. *The Elementary School Journal*, 91(3), 289-305. <https://doi.org/10.1086/461656>
- Erikson, E. H. (1950). *Childhood and society*. Norton.
- Fagan, J. F., Holland, C. R., & Wheeler, K. (2007). The prediction, from infancy, of adult IQ and achievement. *Intelligence*, 35(3), 225-231.
- Galindo, C., & Sheldon, S. B. (2012). School and home connections and children’s kindergarten achievement gains: The mediating role of family involvement. *Early Childhood Research Quarterly*, 27(1), 90-103.
- Han, J. H. (2003). *Tamgujungsim yuasuhakgyoyuk peurogeuraemui guseong mit jeogyong*

- hyogwa* [A study of construction and effects on a inquiry based early childhood mathematics education program] [Unpublished doctoral dissertation]. Chung-Ang University.
- Hill, N. E., & Craft, S. A. (2003). *Separating ethnicity and SES in the relationship between parent-school involvement and academic achievement*. American Psychological Association. <https://doi.org/10.1037/e333872004-008>
- Hong, H. K. (2009). Suhakdonghwareul hwaryonghan iyagi nanugieseoui suhakjeok damhwabunseok [An analysis of math talk during story readings with young children]. *The Journal of Korea Open Association for Early Childhood Education*, 14(5), 175-203.
- Hughes, P., & MacNaughton, G. (2001). Building equitable staff-parent communication in early childhood setting: An Australian case study. *Early Childhood Research and Practice*, 3(2), 1-14.
- Hur, Y. M. (2012). *Yua suhakgyoyuk gwallyeon bumogyoyugi suhakgyoyuginsik mit gysuhyoneunggame michineun yeonghyang* [A study on the effects of parental education related to math education for young children on parents' perceptions of math education and math teaching efficacy] [Unpublished master's thesis]. Chung-Ang University.
- Jeynes, W. H. (2011). Parental involvement research: Moving to the next level. *School Community Journal*, 21(1), 9.
- Kim, E. Y., Choi, H. M, Choi, J. E., & Jang, M. K. (2016). *Yeongyua sagyoyuk siltaewa gaeseon bangan(II)* [A study on the current status and improvement of private education for young children II]. <https://doi.org/10.979.1185941/844>
- Kim, E. Y., Kim, G. J., Yoon, J. Y., Kim, M. J., Chiu, C. P., Jung, K. H., & Sajaniemi, N. K. (2017). *Yeongyua sagyoyuk siltaewa gaeseon bangan(III): Gukjebigyoreul jungsimeuro* [A study on the current status and improvement of private education for young children (III): A Study on the International Comparison]. https://www.nkis.re.kr:4445/subject_view1.do?otpId=KICCE00052827&otpSeq=0&popup=P
- Kim, H. R. (2003). *Yuagyoyukgigwanui jiljeok hwangyeonge ttareun bumo chamyeo* [Parent involvement according to the quality of kindergarten's environment] [Unpublished master's thesis]. Ewha Womans University.

- Kim, J. H. (2015). The development and validation of a scale to measure the mathematical interaction of young children's parents. *Korean Journal of Child Studies*, 36(5), 95-113. <https://doi.org/10.5723/kjcs.2015.36.5.95>
- Kim, J. W., & Choi, J. O. (2006). The effects of family related cooking programs on young children's basic science concepts and mathematics abilities. *Korean Journal of Child Studies*, 27(2), 39-53.
- Kim, S. M., & Ahn, J. K. (2008). The effects of family related mathematical inquiry activities based on daily experiences on the young children's mathematical abilities. *Korean Journal of Human Ecology*, 17(5), 821-833. <https://doi.org/10.5934/kjhe.2008.17.5.821>
- Lee, E. S. (2010). *Donghwareul hwaryonghan gajeongyeongye gwahak hwaldongi yuau gwahaktamguneungnyeok, bumoui gwahakgyoyuktaedo mit bumo-yuau gwahakjeok sanghojagyonge michineun yeonghyang* [The effect of take-home science activities through fairy tales on child scientific inquiry competence, parent attitudes toward science, and parent/child interactions toward science] [Unpublished master's thesis]. Chung-Ang University.
- Lee, H. K., & Park, H. S. (2010). The effects of a parent-child interaction and usability of mathematical media in home on children's number concept. *Korea Journal of Child Care and Education*, 6(1), 171-190.
- Lee, J. G. (2010). *Ilsangsaenghwalgwa yeongyehan yua cheukjeonghwaldong peurogeuraem gaebal mit hyogwa* [Development and effect of an early childhood measurement program associated with daily life] [Unpublished doctoral dissertation]. Chonnam National University.
- Lee, J. H. (1999). A study of content and methods used in number instruction for young children from a cultural psychology perspective. *Korean Journal of Early Childhood Education*, 19(1), 111-131.
- Lee, J. W., Lee, J. L., Do, N. H., Choi, H. M., Lee, J. H., Lee, Y. J., Yoon, J. Y., & Yeom, H. K. (2018). *2018nyeon jeongukboyuksiltaejosa: Gagujosa bogo* [2018 National Educare Survey: A report on the household survey]. Ministry of Health and Welfare & Korean Institute of Child Care and Education. <http://prism.go.kr/homepage/entire/retrieveEntireDetail.do;jsessionid=2C63C2D71FA>

520EED54E86F60CF3D3D3.node02?cond_research_name=&cond_research_start_date=&cond_research_end_date=&research_id=1351000-201800323&pageIndex=84&leftMenuLevel=160

- Lee, M. J., & Moon, H. J. (2008). Teacher-mother communication: Its effect on satisfaction with early childhood educational institutions and on parenting stress. *Korean Journal of Child Studies*, 29(1), 1-14.
- Lee, S. H., Hwang, S. H., & Nam, M. K. (2010). The effects of the child care center-family linked sensory activity on infant's physical development and infant-parent interaction. *Korean Journal of Childcare and Education*, 6(3), 103-125.
- Ministry of Education, & Ministry of Health and Welfare. (2019). *2019 Revised Nuri Curriculum Guide*. <https://www.moe.go.kr/boardCnts/view.do?boardID=312&boardSeq=79419&lev=0&searchType=null&statusYN=W&page=1&s=moe&m=0301&opType=N>
- Moon, H. W. (2017). *Gajeonggwa yeongyehan eoneojeondalhwaldongi man 3se yuau juuijipjungnyeok mit eoneopyohyeollyeoge michineun yeonghyang* [The effect of family-related message delivery program on 3-year-old children's development of attention ability and linguistic expression] [Unpublished master's thesis]. Chung-Ang University.
- Moon, Y. S., & Lee, W. Y. (2008). The effects of the project approach method on young children's measurement ability and mathematical attitudes: "Wheel" project activity. *The Korea Association of Child Care and Education*, 54, 141-161.
- Owen, M. T., Ware, A. M., & Barfood, B. (2000). Caregiver-mother partnership behavior and the quality of caregiver-child and mother-child interaction. *Early Child Childhood Research Quarterly*, 15(3), 413-428.
- Pajares, F. (1996). Self-efficacy beliefs and mathematical problem-solving of gifted students. *Contemporary Educational Psychology*, 21(4), 325-344.
- Rentzou, K. (2011). Parent-caregiver relationship dyad in Greek day care centers. *International Journal of Early Years Education*, 19(2), 163-177.
- Rivera-Batiz, F. L. (1992). Quantitative literacy and the likelihood of employment among young adults in the United States. *Journal of Human Resources*, 27(2), 313-328.
- Son, S. R. (2008). *Boyuksiseol man 1, 2, 3se hakgeubeseoui eomeoni-gyosa gwanggye*

daehan sanghoinsik bunseok [Analysis of mutual perception for relationship between mother and teacher in the classes for 1, 2, 3 years old children at day-care centers] [Unpublished master's thesis]. Ewha Womans University.

Swap, S. M. (1993). *Developing home-school partnerships: From concepts to practice*. Teachers College Press.

Watson, L., & Swim, T. (2008). *Infants & toddlers: Curriculum and teaching*. Thomson Delmar Learning.

Weiser, M. G. (1991). *Infant/toddler care and education*. Merrill Prentice Hall.

Yoon, S. J., & Kim, J. W. (2016). First grade elementary school children's early childhood private education experience and later school adjustment. *The Korean Journal of Human Development*, 23(4), 55-79. <https://doi.org/10.15284/kjhd.2016.23.4.55>