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Research Article

Article Title: The Effect of Using a Program Enriched with Six Bricks Duplo Block Play-Based Technique on Pre-School Children's Visual Perception and Math Skills

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Abstract:

This study examined the effects of "Six Bricks (LEGO® Duplo)" play-based technique on preschoolers' early mathematics and visual perception skills. The study group consisted of children attending public kindergartens affiliated with the Ministry of National Education in the Meram district of Konya during the 2024–2025 academic year. A quasi-experimental design with experimental and control groups was employed. Data collection tools were "General Information Form," the "Test of Early Mathematics Ability–3 (TEMA–3)," and the "Frostig Visual Perception Test." 50 play-based "Six Bricks Duplo Block" activities was implemented with the experimental group over a 10-week period, while the control group continued with the current program. The posttest findings indicated a statistically significant improvement in favor of the experimental group on both measures. The results showed the effectiveness of integrating play-based approaches such as the "Six Bricks Duplo Block" into preschool curricula as a means of fostering early cognitive development.

Keywords: Six Brick Duplo Block, Math, Visual perceptual, Preschool.

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INTRODUCTION

Early childhood is a critical period as the fundamental building blocks are laid for an individual's cognitive, social, emotional, and physical development. It is one of the most rapid periods of mental and physical development. During this period, children rapidly develop the mathematical and visual perception skills they will need throughout their lives (Huntsinger, Jose, & Luo, 2016; Sarama & Clements, 2009). At the same time, their abilities to explore, learn, and interpret their environment also advance quickly. Visual perception and mathematical skills, in particular, form the foundation for children's problem-solving, analytical thinking, and adaptability to everyday situations. In this context, the educational approaches and material use implemented in early childhood play a significant role in children's development.

For children, play is one of the most effective ways to learn. It provides a natural learning environment that allows them to develop both cognitive and social-emotional skills. In recent years, play-based learning methods have been increasingly adopted to enable children to participate more actively in the learning process (Coşkun & Başgül, 2025). Among these methods, the "Six Bricks (LEGO® Duplo)" play-based tecnique developed by the LEGO Foundation, stands out as an innovative tool for supporting children's cognitive skills. It aims to equip children with new knowledge and skills using a play-based learning approach and implemented via using six different colors and sizes of LEGO Duplo bricks. It supports children's creativity, problem-solving skills, along with cognitive flexibility (Hutcheson, 2018). It is an easily applicable and flexible technique designed to develop children's cognitive and motor skills. Activities are generally short, fun, and interactive, allowing children to focus their attention and actively engage their cognitive processes. It supports children's development of a wide range of skills, from visual perception and spatial awareness to sequencing and basic math concepts (Zosh et al., 2017). Structured games like this help children achieve multifaceted outcomes such as creative thinking, problem-solving, increased attention span, and motor skill development. It also boosts children's social skills, such as cooperation, emotional regulation, and self-efficacy (Kaplan et al., 2022; Manessis, 2014; Petrovska et al., 2013).

Children's math skills encompass areas such as counting, basic arithmetic operations, shape recognition and ordering. During the preschool period, children learn abstract mathematical concepts through more concrete experiences. Games and daily activities help reinforce these skills. For instance, playing with blocks helps children understand shapes and sizes, while counting games facilitate number comprehension. Additionally, children gain direct experience by playing with concepts such as measurement, weight, and cubage. These types of activities develop problem-solving abilities and logical thinking skills (Björklund et al., 2020; Clements & Sarama, 2020; Mumcu & Aydoğan, 2020; Zippert & Rittle Johnson, 2020).

Research Problem and Its Importance

Visual perceptual skills in early childhood are associated with individuals' abilities to recognize and categorize objects, and organize information in their environment. Visual perception plays a critical role in the development of both cognitive and motor skills. When it is underdeveloped, children may experience difficulties in academic learning and social interactions. Math skills, on the other hand, encompass fundamental concepts such as number recognition, ordering, comparison, and calculation, and are a significant indicator of children's academic success. The close relationship between visual perception and mathematical skills is frequently emphasized in the literature, and the combined support of these skills contributes to children's overall cognitive development (Aladwan et al., 2023; Mix & Cheng, 2012; Pieters et al., 2012; van Veen et al., 2019). Furthermore, reinforcing these skills through play makes children's learning processes more fun and effective, making a crucial contribution to the development of their cognitive skills (Herzberg et al., 2022).

This study aims to examine the impact of the "Six Bricks Duplo Block" play-based technique on pre-school chilsren's visual perception and mathematical skills. The study aims to determine the role of this innovative method in children's development and in which areas it is most effective as the use of innovative techniques in early childhood education not only enhances children's individual skills but also provides effective guidance for educators and parents. In this context, the findings of this study are expected to provide evidence-based recommendations for integrating Six Bricks technique into early childhood education curricula. Furthermore, supporting visual perception and math skills at an early age will positively impact children's future academic success and life skills.

Mathematical and visual perception skills acquired in early childhood prepare individuals for the academic and social situations they will encounter later in life. Parents and educators using various educational games, activities, and interactive materials to support the development of these skills will strengthen children's mathematical thinking and their ability to interact with their environment. The support provided during this period will play a decisive role in children's future. Ultimately, this research aims to contribute to the literature on early childhood education at both theoretical and practical levels. A detailed examination of the effects of the Six Bricks Technique on visual perception and mathematical skills will be an important step toward identifying and developing effective methods in early childhood education. In this context, the study sought answers to the following questions:

- Is there a significant difference between the mathematical skills of children in the experimental group using the "Six Brick Technique" and the control group using the current program?

- Is there a significant difference between the visual perception levels of children in the experimental group using the "Six Brick Technique" and the control group using the current program?

METHOD

The current study, which aimed to examine the effects of a play-based "Six Brick Technique" on pre-school children's visual perception and mathematical skills, was designed using quantitative research methods. It is conducted within the framework of a Pretest-Posttest Control Group Experimental Design, a true experimental design. Experimental designs are used to measure the effects of programs aimed at improving children's awareness, learning outcomes, perceptions, and social-emotional skills. In an experimental research design, the *independent variable*(s) is manipulated while its effect on the *dependent variable* is tested (Creswell, 2014; Johnson & Onwuegbuzie, 2004). In the preschool period, this might mean, for example, measuring the effects of an educational program (independent variable) on children's or parents' attitudes, behaviors, or awareness (dependent variable). The dependent variables of the present study were *children's mathematical and visual perception skills*, while the independent variable was *the educational program developed using the Six Brick Technique*. The design used in the experimental model application phase of the study is given below in Table 1.

Table 1

Experimental Design

	Pretest	**Experimental Procedures**	**PostTest**
Experimental Group	FVPT MST	Application of the Six Brick technique	FVPT MST
Control Group	FVPT MST	Current Curriculum	FVPT MST

Frostig Visual Perception Test (FGAT) Math Skills Test (MBT)

Participants

The research was conducted with 5-6-year-old children attending kindergarten classes at a school affiliated with the Ministry of National Education in the provincial center of Konya, in accordance with the opinions of the kindergarten administrators. A total of 46 children from two kindergarten classes participated in the study. Experimental and control groups were formed via simple random sampling method. A total of 24 children were included in the experimental group, and 22 children were included in the control group. 52.17% of the children were girls, and 47.82% were boys. The proportion of girls and boys in the experimental group was 50%, while in the control group 54.54% were girls and 45.45% were boys. The average age of all participating children was 5.57. The average age in the experimental group was 5.58, and the control group was 5.55.

Data Collection Tools

In this study, the 'Frostig Developmental Visual Perception Test' and 'TEMA 3 Mathematics Ability Test' were used to measure preschool children's visual perception levels.

Frostig Developmental Visual Perception Test (FDVPT): This test was developed by Marianne Frostig in 1963 to determine the visual perception levels of children aged three to eight. It measures five perceptual skills: hand-eye coordination, figure-ground discrimination, shape constancy perception, perception of spatial relations, and perception of spatial relationships. The FDVPT is a performance test and can be administered in groups. There is no time limit and it lasts forty to fifty minutes (Wiederholt, 1971). (1994) conducted a reliability study of the Frostig Developmental Visual Perception Test (FDVPT) only for five-year-old children and found that the overall and subscale stability coefficients of the Frostig DVPT were all significant at the 0.01 level (Sökmen, 1994; Tuğrul et al., 2001). In Tepeli's (2013) study, reliability coefficients for children aged 54–59 months were calculated as .76 for the Visual-Motor Coordination subtest, .72 for the Figure-Ground Discrimination subtest, .78 for the Figure Constancy subtest, .79 for the Position in Space subtest, .69 for the Spatial Relations subtest, and .87 for the total test.

The Test of Early Mathematics Ability (TEMA-3): TEMA-3 was developed by Ginsburg and Baroody in 1983 to assess the mathematical abilities of children between the ages of three and eight years and eleven months. It was revised in 1990 and published as TEMA-2. The revised TEMA-2 test was later developed as TEMA-3 in 1993. Pictures, mathematical symbols, and small countable objects are used as materials in Forms A and B of TEMA-3. The test is administered children individually. Administration begins with the question corresponding to their age, calculating their chronological age. It is terminated when the child cannot answer five questions in a row. Each item is marked as correct or incorrect, and the number of correct answers provides the raw score (Ginsburg and Baroody 2003). The standardization and Turkish adaptation of TEMA-3 was conducted by Erdoğan (2006). As a result of the analyses, the test-retest Pearson correlation coefficient was found to be .90 for Form A and .86 for Form B. The internal consistency coefficient was also calculated regarding the reliability of the test in the study, and the KR-20 value was found to be .92 for Form A and .93 for Form B.

Data Analysis

In analyzing the data, the normal distribution assumptions of the scale applied to the experimental and control groups were first tested. The Shapiro-Wilk test analyses performed for this purpose revealed that the experimental and control groups did not meet the normal distribution assumptions in terms of visual perception and mathematical skills. In this context, the Mann-Whitney U test was used to compare the visual perception and mathematical skill scores of the children in the experimental and control groups. The Wilcoxon test was used to compare the pretest and posttest scores within the experimental and control groups.

Experimental Procedures

Prior to the implementation, a seminar on the Six Brick Technique was given to the classroom teachers and families of the children in the experimental group. The researcher participated in various activities with the children and the classroom teacher before data collection. After the children had adjusted to the researcher, the researcher administered the Frostig Developmental Visual Perception Test and the TEMA 3 Mathematical Ability Tests as pretests between February 12th-17th 2024. The tests were administered individually by the researcher in a quiet, well-lit environment, independent of the children's educational environment. The test was evaluated considering the rules in the user manual. Visual Perception and Mathematical Skills test scores were obtained for each child. The same tests were also administered to the participants as posttests at the end of the program.

In this phase, the children in the experimental group received an educational program including the Six Bricks technique play-based activities while the current curriculum was applied to the control group. The activities included in the program were structured according to the principle of "Simple to Complex" and were selected from activities in Hutcheson's (2020) book, "Returning to Basic Skills with Six Bricks." The experimental interventions lasted 10 weeks. The program, which implemented one activity per day, consisted of a total of 50 sessions with 50 activities. This program was designed to develop both the children's visual perception and mathematical skills. To provide a fun learning environment, play-oriented and exploration-oriented activities were emphasized, as well as social interaction.

Preschoolers participating in the study had "Six Bricks technique" play-based activities, in addition to their existing curriculum. It is an educational set developed in 2012 by Brent Hutcheson, Director of Care for Education which is designed to encourage learning. Consisting of six LEGO® DUPLO® bricks in different colors. This set encourages children to build, explore, and transform ideas and concepts. The foundations of this approach were laid in 2009, when the LEGO Foundation sought partners for projects that support learning through play. Hands on Technologies, a LEGO® Education partner in South Africa, became involved, and a project called "Developing Talent through Creative Play" was launched in a South African township. As part of this project, teachers received support, training, and LEGO® Education materials. However, evaluations after five years of implementation revealed that teachers struggled to use some complex LEGO® materials. Consequently, the "Six Bricks Duplo Block" play-based technique emerged as a more practical and accessible alternative.

In 2012, the LEGO Foundation decided that collaborating with a nonprofit organization to support education would be more effective. Therefore, Care for Education was established and took over the partnership with the LEGO Foundation. The mission of Care for Education is to encourage educators and children to learn by interacting with concrete and physical materials. The organization advocates that learning should occur through active participation and construction rather than rote memorization, and therefore emphasizes integrating tactile learning tools into educational processes. It helps children understand concepts more quickly while supporting the development of creativity, curiosity, and innovation skills. In 2013, a group of Danish teachers visiting South Africa discovered the Six Bricks Technique and brought it to Denmark, enabling its global expansion. Today, Care for Education collaborates with international organizations such as IRC (Play Matters), SOS Children's Villages, and UNICEF to support play-based learning. Programs with "Six Bricks Duplo Block" play-based activities are held in many countries, including Kenya, Ethiopia, Tanzania, Uganda, Egypt, Jordan, and Türkiye, (Yöndem, 2024).

The activities in the "Six Bricks technique" were selected from the simple-to-difficult principle and from Hutcheson's (2020) book, "Returning to Basic Skills with Six Bricks." This resource book contains activities designed to support children's cognitive, affective, and motor skills. It offers a variety of play-based activities using six LEGO DUPLO bricks to make children's learning more effective. The activities can be implemented both individually and in groups. Group activities support children's social skills and teamwork, while individual activities allow children to learn at their own pace. They are generally unstructured, play-based, and do not require preparation. The experimental implementations last 10 weeks. The program, which includes one activity per day, consists of a total of 50 activities and 50 sessions. It is designed to develop both children's visual perception and mathematical skills to provide a fun learning environment. The emphasis is placed on social interactions as well as play and exploration-oriented activities.

Sample Activity 1: "Notice the change!"

- The teacher arranges her six bricks in a random order on a shelf/cabinet high enough for the children to see from their seats.
- When the children enter the classroom, they try to find where the six bricks are arranged.
- Then, the children go to their desks and try to create the same arrangement as the teacher's bricks by using their own.

Guiding Questions:

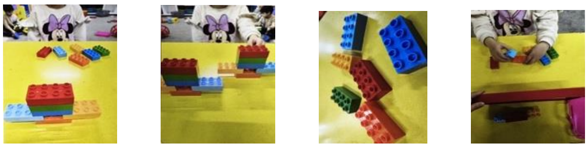
- What color is the first / second / third brick?
- Can you place your finger on the red / blue / green brick?

- Can you hold the first / third / fifth brick and show it to us?
- Can you lift your second brick and balance it on your right / left hand?
- The children leave their bricks on their desks in that order.
- The teacher changes their brick arrangement throughout the day without telling the children.
- The children notice the changes and try to adjust their arrangement accordingly.

Sample Activity 2: “Is there something missing?”

- The teacher arranges the six bricks as they wish. Children examine the arrangement for a few seconds.
- The teacher hides the arrangement or puts up a barrier.
- Asks the children to memorize the image and create the arrangement without seeing it.
- The barrier is removed, and they talk about the differences between the two images. How right it is? Which color is not right?

Guiding Question: The activity is evaluated by the child and the teacher with questions such as: How many correct bricks did you place? Which part did you have difficulty remembering?



Sample Activity Photos

Ethical Aspects

This study was conducted in strict accordance with the provisions of the “Higher Education Institutions Scientific Research and Publication Ethics Directive.” No instances of actions that could be considered violations under the “Actions Against Scientific Research and Publication Ethics” were encountered during the research process. Necmettin Erbakan University Social and Human Sciences Scientific Research Ethics Board gave the present study 2024/601 as Ethics Assessment Document Issue Number on 26/07/2024.

FINDINGS

The pretest results of the math skills scales applied to experimental and control group children before the experimental procedures are presented below in Tables 2 and 3.

Table 2

Descriptive Analysis of Pretest Scores of Math Skills of Children in Experimental and Control Groups

	Experimental Group			Control Group		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation
Math skills PRETEST	24	18.67	2.53	22	18.14	1.75

Table 2 shows descriptive statistics for the pretest math skills scores of children in the experimental and control groups during the experimental procedures. According to the analyses, the mean math skills pretest score for children in the experimental group was 18.67, with a standard deviation of 2.53. The mean pretest score for children in the control group was 18.14, with a standard deviation of 1.75. The results of the Mann Whitney U Test conducted between the two groups are presented in Table 3.

Table 3

Analysis of Math Skills Pretest Scores of Children in the Experimental and Control Groups via Mann Whitney U Test

	Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	P
Math Skills PRETEST	Experimental	24	24.42	586.00	242.00	-0.494	0.621
	Control	22	22.50	495.00			

Table 3 shows the mean rank of the pretest math-skill scores of the children in the experimental group was 24.42, while the mean rank of their peers in the control group was 22.50. The Mann Whitney U test Z value, calculated between the pretest score rankings of the groups, was found as 0.494. This value indicates that the pretest math skills of the children in both groups were equivalent before the experimental procedures. The pretest results of the visual perception scale administered to the children in the experimental and control groups before the experimental procedures are presented below in Tables 4 and 5.

Table 4

Descriptive Analysis of Visual Perception Scale Pretest Scores of Children in the Experimental and Control Groups

	Experimental Group			Control Group		
Visual Perception PRE-TEST	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Hand-Eye Coordination	24	15.83	1.86	22	15.59	1.68

Figure-Ground	24	4.83	0.70	22	4.91	0.92
Shape Constancy	24	5.96	1.00	22	5.95	1.00
Location in Space	24	5.08	0.88	22	5.27	0.83
Relationship of Shape to Space	24	4.96	0.95	22	5.05	1.13
Total	24	36.67	3.07	22	36.77	3.54

Table 4 shows the descriptive statistics for the experimental procedures performed on the pretest scores of the visual perception scale for children in the experimental and control groups. According to the analyses, the total mean pretest score on the visual perception scale for children in the experimental group was 36.67, with a standard deviation of 3.07. The mean pretest score for children in the control group was 36.77, with a standard deviation of 3.54. The results of the Mann Whitney U test conducted between the two groups are presented in Table 5.

Table 5

Analysis of Visual Perception Scale Pretest Scores of Children in the Experimental and Control Groups via Mann Whitney U Test

Visual Perception PRE-TEST	Group	N	Mean Rank	Sum of Ranks	Mann-Whitney U	Z	P
Hand-Eye Coordination	Experiment	24	24.21	581.00	247.00	-0.381	0.703
	Control	22	22.73	500.00			
Figure-Ground	Experiment	24	23.17	556.00	256.00	-0.195	0.846
	Control	22	23.86	525.00			
Shape Constancy	Experiment	24	23.52	564.50	263.50	-0.012	0.991
	Control	22	23.48	516.50			
Location in Space	Experiment	24	22.04	529.00	229.00	-0.838	0.402
	Control	22	25.09	552.00			
Relationship of Shape to Space	Experiment	24	23.25	558.00	258.00	-0.138	0.891
	Control	22	23.77	523.00			
Total	Experiment	24	23.71	569.00	259.00	-0.111	0.912
	Control	22	23.27	512.00			

According to Table 5, the mean rank of the experimental group children's pretest scores on the visual perception scale was 23.71, while the mean rank of their peers in the control group was 23.27. The Mann Whitney U test Z value, calculated between the groups' pretest score rankings, was 0.111. This value indicates that the visual perception levels of the children in both groups were equivalent before the experimental procedures. The results of the math skills posttests administered to the children in the experimental and control groups after the experimental procedures are presented below in Tables 6 and 7.

Table 6

Descriptive Analysis of Math Skills Posttest Scores of Children in the Experimental and Control Groups

	Experimental Group			**Control Group**		
	N	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**
Math Skills Posttest	24	21.46	1.89	22	18.73	1.75

Table 6 shows descriptive statistics performed on the posttest math skills scores of children in the experimental and control groups after the experimental procedures. According to the analyses, the total mean posttest mathematics skills score of children in the experimental group was 21.46, with a standard deviation of 1.89. The mean posttest score of children in the control group was 18.73, with a standard deviation of 1.75. The results of the Mann Whitney U Test conducted between the two groups are presented in Table 7.

Table 7

Analysis of Math Skills Posttest Scores of Children in the Experimental and Control Groups Using the Mann Whitney U Test

	Group	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	**Z**	**p**
Math Skills	Experimental	24	31.15	747.50	80.500	-4.083	0.000
FINESTEST	Control	22	15.16	333.50			

Table 7 shows the results of the Mann Whitney U Test calculated between the posttest math skills scores of the children in the experimental and control groups. The analysis revealed a Z value of 4.083 between the math skills scores of the two groups. This value indicates a significant difference in the posttest math skills of the children in both groups ($p<0.05$). As a result of the experimental procedures, children's math skills in the experimental group were found to be significantly higher than their peers in the control group. The results of the posttest math skills administered to children in the experimental and control groups after the experimental procedures are presented below in Tables 8 and 9.

Table 8

Descriptive Analysis of Visual Perception Scale Posttest Scores of Children in the Experimental and Control Groups

	Experimental Group			Control Group		
Visual Perception (PostTest)	**N**	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**
Hand-Eye Coordination	24	25.29	2.63	22	16.18	1.62
Figure-Ground	24	6.63	0.92	22	5.82	0.96
Shape Constancy	24	8.42	1.35	22	7.27	1.28
Location in Space	24	6.63	0.92	22	6.14	0.77
Relationship of Shape to Space	24	6.88	0.95	22	5.82	1.05
TOTAL	24	53.83	4.24	22	41.23	3.53

Table 8 shows descriptive statistics based on the posttest visual perception scale scores of children in the experimental and control groups after the experimental procedures. The analyses show that the total mean posttest visual perception scale score of children in the experimental group was 53.83, with a standard deviation of 4.24. The mean posttest score of children in the control group was 41.23, with a standard deviation of 3.53. The results of the Mann Whitney U Test, conducted between the visual perception scores of the two groups, are presented in Table 9.

Table 9

Analysis of Visual Perception Scale Posttest Scores of Children in the Experimental and Control Groups via Mann Whitney U Test

Visual Perception (PostTest)	**Group**	**N**	**Mean Rank**	**Sum of Ranks**	**Mann-Whitney U**	**Z**	**p**
Hand-Eye Coordination	Experiment	24	34.42	826.00	2.000	-5.802	0.000
	Control	22	11.59	255.00			
Pattern-Background	Experiment	24	28.42	682.00	146.000	-2.707	0.007
	Control	22	18.14	399.00			
Pattern Constancy	Experiment	24	28.46	683.00	145.000	-2.689	0.007

	Control	22	18.09	398.00			
Position-in-Space	Experiment	24	26.75	642.00	186.000	-1.816	0.069
	Control	22	19.95	439.00			
Relationship of Pattern to Space	Experiment	24	29.29	703.00	125.000	-3.158	0.002
	Control	22	17.18	378.00			
TOTAL	Experiment	24	34.27	822.50	5.500	-5.697	0.000
	Control	22	11.75	258.50			

Table 9 shows Mann Whitney U Test results calculated between the posttest scores of the visual perception scale in the experimental and control groups. A Z value of 4.083 was calculated for the hand-eye coordination subscale, a Z value of 2.707 for the pattern background perception subscale, a Z value of 2.683 for the pattern constancy subscale, a Z value of 1.816 for the position in space subscale, a Z value of 3.158 for the relationship of pattern to space subscale, and a Z value of 5.500 for the overall scale. According to these values, it is understood that the posttest visual perception levels of the children in both groups differed significantly ($p<0.05$) in terms of hand-eye coordination, pattern background perception, pattern constancy, relationship of pattern to space, and the overall scale. In terms of the position in space subscale, although the experimental group had a higher mean rank value compared to the control group, this difference was not statistically significant ($p = 0.069 > 0.05$). As a result of the experimental procedures, it was observed that the visual perception levels of the children in the experimental group were significantly higher than those in the control group. Table 10 presents the results of the Wilcoxon Test conducted between the pretest and posttest scores of the children in the experimental group on their math skills

Table 10

Analysis of Pretest-Posttest Math Skills Scores of Children in the Experimental Group via Wilcoxon Test

Math Skills		**N**	**Mean Rank**	**Sum of Ranks**	**Z**	**p**
POSTTEST- PRETEST	Negative Ranks	1	23.50	23.50	-3.648[c]	0.000
	Positive Ranks	23	12.02	276.50		
	Ties	0				
	Total	24				

According to the Wilcoxon Test results presented in Table 10, the differences between the pretest and posttest measurements of the experimental group's math skills were analyzed via Wilcoxon test. The analyses yielded a Z value of 3.648 between the pretest and posttest math skills of the experimental group. According to these values, a significant difference was found between the measurements in the experimental group's math skills at a significance level of 0.05. According to the mean ranks, the posttest math skill levels of the children in the experimental group were found to be significantly higher than the pretest results. Table 11 presents the results of the Wilcoxon test conducted between the pretest and posttest scores of the children in the experimental group on the Visual Perception Scale.

Table 11

Analysis of Visual Perception Scale Pretest-Posttest Scores of Children in the Experimental Group via Wilcoxon Test

Visual Perception PostTest-PreTest		**N**	**Mean Rank**	**Sum of Ranks**	**Z**	**p**
Hand-Eye-Coordination	Negative Ranks	0[e]	0.00	0.00	-4.307[c]	0.000
	Positive Ranks	24[f]	12.50	300.00		
	Ties	0[g]				
	Total	24				
Pattern-Background	Negative Ranks	1[h]	4.50	4.50	-4.007[c]	0.000
	Positive Ranks	21[i]	11.83	248.50		
	Ties	2[j]				
	Total	24				
Pattern Constancy	Negative Ranks	0[k]	0.00	0.00	-4.346[c]	0.000
	Positive Ranks	24[l]	12.50	300.00		
	Ties	0[m]				
	Total	24				
Position-in-Space	Negative Ranks	0[n]	0.00	0.00	-4.311[c]	0.000
	Positive Ranks	23[o]	12.00	276.00		
	Ties	1[p]				
	Total	24				
Relationship of Pattern to	Negative	0[q]	0.00	0.00	-4.399[c]	0.000

Space	Ranks					
	Positive Ranks	24[r]	12.50	300.00		
	Ties	0[s]				
	Total	24				
TOTAL	Negative Ranks	0[t]	0.00	0.00	-4.291[c]	0.000
	Positive Ranks	24[u]	12.50	300.00		
	Ties	0[v]				
	Total	24				

In Table 11 the pretest-posttest scores of the experimental group were as follows: a Z value of 4.307 for the hand-eye-coordination subscale, a Z value of 4.007 for the pattern-background perception subscale, a Z value of 4.346 for the pattern constancy subscale, a Z value of 4.311 for the position-in-space subscale, a Z value of 3.399 for the relationship of pattern to space subscale, and finally a Z value of 4.291 for the entire scale. A significant difference was found between measurements in the visual perception of the experimental group at a significance level of 0.05. According to the mean ranks, it was observed that the posttest visual perception levels of the children in the experimental group were significantly higher than the pretest results.

DISCUSSION

The present study show that a program enriched with "Six Bricks Duplo Block" activities has a significant impact on preschool children's visual perception and math skills. Findings revealed that children participating in the intervention program showed significant increases in their posttest scores on math and visual perception skills. These results are consistent with previous researches suggesting that the program supported with these activities has a positive impact on children's cognitive development, fosters active participation in learning process, and boosts the development of math and visual perception skills (Gilligan-Lee, et al., 2023; Jerrom, et al., 2023; Kaplan, et al., 2022).

Interaction with building blocks not only improves children's hand-eye-coordination but also significantly supports their spatial thinking skills (Verdine et al., 2014; Mix & Cheng, 2012). In this context, children's experience playing with blocks at an early age may be directly related to their math performance in later years (Wolfgang, Stannard, & Jones, 2001). Indeed, the findings of the current study support the critical role of this play-based approach in preschool education. Object interactions facilitate increasingly complex, flexible, and controlled motor actions (Libertus et al., 2016). In this context, play-based activities with building blocks, such as LEGO Duplo, make children's learning processes fun. While playing with these blocks, children explore the physical properties of objects and gain an important foundation for understanding their three-dimensional structure (Soska et al., 2010). Furthermore, these "Six Bricks Duplo Block" activities positively influences visual perception which enables children nor only remember and recall an image but also its sequence when they see. Visual perception is vital in learning. The activities fosters children's spatial thinking which is the ability of visualizing and reasoning. It is vital in achieving science, engineering and technology related subjects. The connection between motor and cognitive development is strengthened through experiences arising from children's interactions with objects (Libertus et al., 2016). In this regard, the tactile and visual experiences provided by "Six Bricks Duplo Block" activities facilitate children's understanding of the three-dimensional structure of objects and their grasp of spatial relationships (Soska et al., 2010; Rachwani et al., 2020). This is further confirmed by the improvements in visual perception and math performance found in the study. Manual interactions with objects support perceptual development, helping children better understand their environment. During this process, children discover that lids turn, latches open, and blocks match with appropriate shapes. Such interactions enable children to acquire the biomechanical skills necessary to develop motor skills (Rachwani et al., 2020) and also contribute to the internalization of mathematical concepts. Games like Six Bricks are more than just fun activities. They offer important opportunities for children's cognitive, motor, and visual perception development. These types of constructive play encourage children's imagination while developing problem-solving and math skills. This study found that the process of assembling blocks to create different structures reinforces children's spatial thinking skills and contributes to the development of visual perception. Therefore, construction games like this constitute an indispensable resource for cognitive development in early childhood.

These findings support and extend previous research examining the relationship between structured block play and play-based learning approaches and children's academic achievement and math performance across different age groups (Bower, et al., 2020; Nath and Szücs, 2014; Thomson et al., 2018; Richardson, et al., 2014; Verdine et al., 2014). Considering the age group included, the results reveal the relationship between visual perception and math measures in preschool children, drawing attention to the program's effectiveness in preparing children for elementary school.

Furthermore, within the context of Vygotsky's (1978) theory of sociocultural development, social interaction and learning through play are thought to play a critical role in cognitive development (cited in: Cole & Scribner, 1978). In line with this theory, the implementation of "Six Bricks Duplo Block" activities in individual and group work can support both individual and social cognitive development in children. Visual perception and math skills hold an important place among these cognitive abilities. The development of visual perception is associated with children's ability to mentally visualize a visual scene (Loikith, 1997). In this context, play promotes not only sensory association processes but also the development of visual perception (Brey, 2017; Kellman & Arterberry, 2006). The results contribute to the existing literature on learning through play and games, as well as offer important insights into the successful use of play methods to support academic learning goals in preschool classrooms in developing countries (Strasser et al., 2023).

In this context, it can be argued that the activities planned using the "Six Bricks Duplo Block" play-based technique can support children's observation, modeling, memorizing, and counting of bricks. Through these processes, they develop both visual perception and math skills. This is further confirmed by the increase observed in children's post-test scores. The program's potential to develop visual perception and math skills contributes to children's cognitive development, helping them become better prepared individuals during the preschool period.

LIMITATIONS OF THE STUDY

The present study has several limitations. First, the sample was restricted to a specific age group and a limited number of preschool institutions, which may limit the generalizability of the findings. In addition, the assessment tools primarily focused on mathematics and visual perception skills, leaving out the potential effects of the program on other cognitive and social domains. The relatively short duration of the study also prevented the evaluation of long-term effects. Finally, parental involvement and environmental factors were not included in the research design. Considering these limitations, future studies are recommended.

CONCLUSION AND RECOMMENDATIONS

The findings of this study show that a program enriched with "Six Bricks Duplo Block" activities significantly contributes to the development of preschool children's visual perception and math skills. Experiences gained through structured block play not only enhance fundamental cognitive processes such as hand-eye coordination and spatial thinking but also foster problem-solving, modeling, memory, and the internalization of mathematical concepts. The results highlight that play-based approaches constitute an indispensable resource for supporting cognitive development in early childhood. In this regard, incorporating Six Bricks activities into preschool curricula may facilitate children's preparedness for elementary school by equipping them with stronger academic and cognitive foundations. The results emphasize that integrating innovative, play-based approaches into the preschool curriculum offers a more holistic learning experience, thereby enhancing school readiness and contributing to broader discussions on innovative approaches in education. Employing larger and more diverse samples, extending the intervention period and examining additional developmental domains are recommended in future studies. Conducting studies that examine the effects of the program enriched with "Six Bricks Duplo Block" play-based activities in different age groups (e.g., 3-4 year-olds or first-grade primary school students) could be beneficial for expanding the program's reach. The program's effects on other areas could enable the program to be evaluated as a holistic educational method. It is recommended that the program be implemented in different cities, rural areas, or private preschools to compare its effects. Besides, the impact of parental involvement in children's learning processes on the effectiveness of such play-based programs can guide parent-child interactions. Moreover, when supported with technologies such as digital platforms or augmented reality it can significantly contribute to the modernization of education. To integrate the "Six Bricks Duplo Block" play-based activities into the preschool curriculum, regular training and seminars can be organized to ensure widespread use of play-based learning approaches not only for math and visual perception but also for other cognitive and social skills.

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Data Availability Declaration

Data Availability Upon Formal Request:

While the primary datasets utilized in this study are not publicly accessible due to certain constraints, they are available to researchers upon a formal request. The authors have emphasized maintaining the integrity of the data and its analytical rigor. To access the datasets or seek further clarifications, kindly reach out to the corresponding author. Our aim is to foster collaborative academic efforts while upholding the highest standards of research integrity.

Author Contributions

Both authors, Yasemin Yüzbaşıoğlu and Banu Uslu, contributed equally to this work. They collaboratively handled the conceptualization, methodology design, data acquisition, and analysis. Each author played a significant role in drafting and revising the manuscript, ensuring its intellectual depth and coherence. Both authors have thoroughly reviewed, provided critical feedback, and approved the final version of the manuscript. They jointly take responsibility for the accuracy and integrity of the research.

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