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THE EFFECT OF THE SPATIAL SKILLS EDUCATION PROGRAM ON THE SPATIAL SKILLS OF PRESCHOOL CHILDREN

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ABSTRACT

Spatial skills have a central place in humans' process of adaptation to their environment. Gaining of spatial experiences in the early childhood constitutes the basis for children's learning experiences in the following periods. Preschool learning environments provide important opportunities to children (games and communication with friends and teachers) with regards to the discovery of space and learning of spatial skills. This study will therefore focus on the impact of the "Spatial Skills Education Program" on the spatial skills of preschool children. Pretest-posttest control group experimental design will be used for measuring the impact of Spatial Skills Education Program on preschool children. The sample group of the study is construed of 31 children (of ages 60-67 months) attending a kindergarten located in the Üsküdar district of Istanbul. The data for the research has been collected by using the Spatial Perception Scale, Bracken Basic Concept Test, and Spatial Ability Form.

The experimental group is construed of the goals and gains defined in the 2006 Preschool Education Program of the Ministry of National Education, the goals and gains defined by the researcher so as to fulfill those of the Ministry of National Education, as well as the 12-week-long Spatial Skills Education Program that consists of activities designed to reach these aims and gains. The Spatial Skills Education Program has been conducted for 12 weeks, two days of the week by the researcher (Tuesdays and Thursdays), and two days (Wednesdays and Fridays) by the classroom teacher. Whereas the Preschool Education Program of the Ministry of National Education has been applied on the control group.

For all independent variables, the posttest results show meaningful differences in favor of the children in the experimental group. The research results show that the Spatial Skills Education Program has positive impact on the spatial skills of the preschool children.

Key Words: Spatial skills, preschool children, educational program.

INTRODUCTION

Space is where a human executes all his actions and lives all his experiences (Tümertekin and Özgüç, 2009); and is therefore effective in helping people structure their ideas (Plumert & Spencer, 2007). Spatial skills, on the other hand, have a central role in the process of human's adaptation to his environment (Newcombe & Huttenlocher, 2000). This central role has caused the concept to be considered and discussed as part of different disciplines.

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Different features of spatial skills have been the subject of numerous studies (Lehnung, Leplow, Friege, Herzog, Ferstl and Mehdorn, 1998). In the literature, spatial skills have changing decriptions in different disciplines, and the researchers who conduct research on this subject focus on different aspects (Bayrak, 2008). Different aspects researched on this subject include spatial ability (Linn & Petersen, 1985), spatial skill (Tartre, 1990), spatial intelligence (Gardner, 2000), spatial visualization (Olkun and Altun, 2003), and spatial thinking (Newcombe, 2010).

Spatial-thinking is functional in the brain even at early ages (Gersmehl & Gersmehl, 2007). Children develop spatial concepts as the result of their interaction with their environment (Blades, Sowden, Spencer, 1995). Spatial learning begins at infancy, and the child's control over space increases as the child begins to walk. As children's ability to move increases, they begin to play games that include spatial experiences either by using their own body (hiding, stepping on objects, crawling) or by using particular objects (Legos, or different objects) (Güven, 2004). Gaining of spatial skills at early ages constitutes the basis for learning experiences in the later years (Gersmehl & Gersmehl, 2007). Preschool learning environments provide children significant opportunities (games, communication with friends and teachers) to children with regards to space and spatial discovery (Thorpe, 2011).

Tzuriel and Egozi (2010) state the significance of teaching spatial skills as part of school curriculum. Beginning from the preschool ages, children's spatial abilities (Turgut, Günhan and Yılmaz, 2009; Ertekin and İrioğlu, 2011) and spatial awareness (Abravel, 1973) can be improved via proper educational practices. According to Levine, Vasilyeva, Lourenco, Newcombe and Huttenlocher (2005), a proper educational program can allow both the development of spatial skills, and the decreasing of spatial-skill differences among children. Mohler (2006) also emphasizes preschool education, and state that children can gain such skills easier at early ages.

In the literature, spatial thinking is defined as a basis for subjects such as science and mathematics (Pollman, 2010). Spatial skills are related to the mathematical skills of early ages, such as geometry, measurements and graphics (Kersh, Casey & Young, 2008; Markey, 2009). Moreover, spatial skills have a significant role in solving problems in mathematics and geometry (Casey, Erkut, Ceder & Young, 2008). According to Williamson (2008), various spatial skills in children are related to their performance in mathematics.

The literature includes varying studies that focus on the relationship between spatial skills and other disciplines, including spatial skills and sex, as well as spatial skills and age. Nevertheless, the suggestions as to how spatial skills can be improved by education seem to be limited (Lajoie, 2003). In light of the data provided above, this study has aimed to develop a Spatial Skills Education Program, and to determine its impact on the spatial skills of preschool children.

Spatial Ability

In order to survive and produce, all living things have to organize their actions in a spatial world (Newcombe and Huttenlocher, 2000). People carry out evaluations regarding these relations between space and themselves. Estimating the distance between two objects, or guessing whether an object would fit into a particular space, or defining a pattern are all actions realized in space, and include evaluations on objects' relations between themselves or space (Melendez, Beck & Fletcher, 2000).

Spatial information carries different levels of significance with regards to all actions, may them be simple or complex. We use spatial skills in our daily conversations; we map the given space, and invent tools to find our way in that given space (Plumert & Spencer, 2007). Finding directions to a particular place, placing objects, packing luggages, catching a ball are all actions that require the representation and processing of these information (Hegarty & Waller, 2005).

Despite some pioneering works, studies that place spatial ability at its focus do not appear in the literature up until the 1920s (Mohler, 2008). The period 1920-1960 includes studies in psychometrics with varying focuses, such as whether spatial ability is different than intelligence, as well as factor structure. In 1921, Thorndike has defined space as the basic factor of human intelligence. The results of researches conducted in this period have

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shown the multiple factors of spatial ability. Accordingly, tests have been developed to measure this ability. While studies in psychometrics on spatial ability have continued between 1960-1980, developmental and other studies have also been conducted in this period. The point of focus in developmental studies have been the development of spatial ability in children and adults. The first studies in this field have been conducted by Piaget and Inhelder (Mohler, 2008).

While spatial ability is a subject that is discussed in a variety of fields including education, psychology and neurology, what spatial skill really is, which term should be used to identify it, how it can be described, and what spatial skill is in reality, or shortly, the nature of spatial skill, has not yet gained clarity (Linn & Petersen, 1985). Different terms used to describe this ability in the literature include spatial ability, visualisation, spatial skill, visual spatial skill, spatial intelligence, spatial reasoning, spatial orientation, and spatial thinking (Işık, 2008; Çakmak, 2009).

Researches in the literature focusing on spatial ability focus on four major topics. These skills are as follows:

- Description of particular spatial abilities
- Gender differences regarding spatial ability
- The impact of spatial skills on predicting profession
- Gaining of spatial skills via education

The most clear result of century-long research experiences on spatial skills is that spatial ability is a complex cognitive process, and that each and every one of research conducted on this topic will provide significant contributions to the field (Mohler, 2008).

Elements of Spatial Ability

In the literature, spatial skills are analyzed in varying dimensions. In this regard, researches having different perspectives have defined spatial skills in different ways (Yang and Chen, 2010). According to the definition of Kersh, Casey and Young (2008), spatial skills cover individuals' capacity to compare, manipulate and transform the non-verbal, visual information.

Using the term "spatial ability", Grande (1990) has presented seven components of spatial ability, that are eye-body coordination, figure-ground perception, perceptional continuity, perception of location in space, spatial relations, visual distinction, and visual memory (Tekin, 2007).

Tartre (1990) has defined spatial skills as the mental skills such as understanding, directing, interpreting and reorganizing visual relations. Lohman (1988, 1996) has defined spatial ability as the production, preservation and recalling of well-structured visual images, and has presented three sub-factors in relation to this ability, that are spatial visualization, speeded rotation, and spatial orientation.

Zavotka classifies spatial abilities in four main titles (Allen, 2010):

- Mental visualisation of two-dimensional objects in a three-dimensional space
- Three-dimensional visualization of two-dimensional drawings
- Mental twirling of an object in a different plane
- Visualisation of a scaled down object

Linn and Petersen (1985) have defined spatial ability as a set of skills including remembering, production, transformation and representation of symbolic and non-verbal information. Additionally, based on a meta-analysis study they have conducted, Linn and Petersen have stated that spatial ability covers multiple components, including spatial perception, spatial visualisation, and mental rotation.

When the above-mentioned definitions of spatial abilities are analyzed, one can see that this ability covers a set of different components. Three of these elements will be covered in this study, that are spatial visualisation, spatial perception and perspective.

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Mental Rotation

Mental rotation covers the mental visualization of a particular object's or the picture of an object's appearance when that object is rotated in a three dimensional or two dimensional space (Casey, Andrews, Schindler, Kersh, Samper and Copley, 2008). Linn and Peterson (1985) define mental rotation as individuals' ability to quickly and correctly visualize the rotated versions of two dimensional and three dimensional figures. Newcombe and Frick (2010) define mental rotation skill as the ability to visualize the new appearance of an object after it is rotated, scaled down or up, sliced into two, or folded. According to these researchers, mental rotation is the mental visualization of the movement of an object.

Mental rotation covers four sub-processes. These processes are coding of the stimulus to be rotated, mental visualization of the stimulant's appearance, planning and implementation of the rotation, and comparison of the mentally rotated stimulant to the present stimulant (Lamm, Windischberger, Moser and Bauer, 2007; cited in Richter, Brenner & Karnath, 2009). The simple form of mental rotation skills can be seen in infancy, and these skills keep developing in the early childhood (Newcombe & Frick, 2010). The results of a research conducted by Kosslyn, Margolis, Barrett, Goldknopf and Daly (1990) show that five-year-old children are capable of mental rotation. The results of certain developmental researches focusing on mental rotation show that children of ages 4-5 are capable of both mental rotation and of utilizing mental rotation strategies, and that the processing speed increases with age (Frick, Daum, Walser & Mast, 2009). Moreover, certain other researchers have also expressed the opinion that mental rotation can be learnt by education (Tzuriel & Egozi, 2010).

Spatial Visualization

Spatial visualization covers a process wherein spatial data is used in multiple phases, including retention of figures, detecting a figure among many other complex figures, or forming a new figure by bringing two figures together (Linn & Peterson, 1985).

Creating cognitive maps related to one's environment, utilization of these maps, and spatial relations are covered within the scope of spatial visualization (Gilmartin & Patton, 1984). Data acquired from the experimental research by Rafi, Samsudin and Said (2008) show that spatial visualization skill can be developed with education.

Spatial Perception

Spatial perception is defined as an individual's determination of the relationship between objects based on the direction his/her body faces (Linn & Petersen, 1985). According to Heddens and Speer (2006), spatial perception includes skills such as hand-eye coordination, figure-ground perception, perceptional continuity, positioning in space, visual distinction, visual memory, and perception of spatial relations. Hand-eye coordination means integrating visual stimulants and motor responses. Children use this ability while stacking blocks on top of each other. Similar to a jigsaw puzzle, figure-ground perception is the ability to find a particular figure in a given ground. Perceptional continuity is the ability to recognize figures even when their size, orientation or color-shade features change. Positioning in space is the associating the position of the object with one's own position in the given space. Finally, spatial relations is both associating one's own position with the positions of objects, and to associate positions of different figures with each other (Heddens & Speer, 2006).

Perspective Taking

The initial researches on taking perspective have been conducted by Piaget. Known in the literature as the "three mountain task", Piaget has attempted to determine whether children of different ages were able to understand the appearance of mountains from different angles. As the result of these researches, Piaget has concluded that children were not able to percieve different perspectives before the ages 9-10 (Newcombe and Huttenlocher, 2000). Perspective taking includes an individual's imagining of oneself as the observer, moving

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and taking perspective according to the figure and the order of the figure. In perspective taking, the observer mentally designs his/her own movement (Newcombe & Frick, 2010).

Piaget and Inhelder (1956) define spatial perspective as increasing decentration, as well as the ability to draw distinctions between left and right, or front and back (Salatas & Flavell, 1976).

In certain studies, the development of spatial perspective has been analyzed within three rules (Flavell, Favell, Green & Wilcox, 1981). These rules are:

- When two people share the same position, the appearance of an object is the same to both of them.
- When objects that have different features are rotated on their own vertical axis, they appear differently; different individuals at different locations also have different views of the object.
- When single-sided objects such as a sphere or a cylinder are rotated on their vertical axis, they will appear the same; different individuals at different locations will also have different views of these objects as well.

Based on their research, Flavell, Favell, Green and Wilcox (1981) have argued that children of ages 4-5 are able to comprehend all three of the above-mentioned rules.

Before comprehending that objects can be viewed differently to different people, children first realize that objects have different appearances. In ages 3-5, children's ability to understand others' perspective develops; they begin to accept that someone else that sits opposite to them may have a different view of the given object (Bigelow & Dugas, 2008).

Silvern, Waterman, Sobesky and Ryan (1979) have stated that perspective taking develops in four levels. The first level is level zero (0). At this level, children cannot realize that others may have different views than themselves. At level one, they realize that people may have different points of view. At level two, they realize that one can be able understand the point of view of both themselves and others; and at level three, they become capable of understanding the point of view of both themselves and others.

Research shows that perspective taking in children begins to develop at earlier ages than what is indicated (Flavell, Flavell, Green & Wilcox, 1981). These research findings show an increase in preschool children's success on the perspective-taking-related tasks. When suitable tasks and options are provided, even three-year-old children have very little difficulty in determining others' perspective (Ives, 1980). The research with five-year-old children conducted by Newcombe and Huttenlocher (1992) show that five-year-olds have the capability to comprehend others' perspective. Another study by Rosser (1983) conducted with children of ages 4, 6 and shows that even four-year-old children are aware of different perspectives.

Learning of Space and Development of Spatial Skills among Children

Children begin to conceptualize space from very early ages onwards (Melendez, Beck & Fletcher, 2000). They begin discovering their surroundings beginning from their moment of birth; the actions they execute throughout this process constitute one of the resources for spatial information. The first spatial figure that babies come across is the face of their mother. As the mother lies down on the bed, holds the baby in her arms, or sits upright, the baby views the mother's face at different angles each time (Smith, 1997). Developmental changes cause babies' ability to move in a particular space to increase. With the increase in their movement ability (crawling, standing, walking etc.), they begin to learn new information about their surroundings, which eventually impacts their process of understanding space (Siegler & Alibali, 2005). In this process, they feel the need to define objects and position them in space. Defining and positioning are two important steps for them to reach objects, or orient themselves towards those objects (Siegler & Alibali, 2005). As babies reach a toy, crawl towards an object, or pull themselves upwards, they build relations with their surroundings (Stiles, 2001). Children's awareness of space and their surroundings begin with their awareness of their own bodies. Realization of the space other than the body begins by understanding directions, perceiving the position of his/herself in a given space, and understanding the distance between objects (Pollman, 2010).

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Development of Spatial Ability

The first theoretical approach with regards to the development of spatial abilities in children belongs to Piaget. Piaget has argued that children make only limited use of basic spatial skills, that they begin to use projective and metric features in coordination only from ages 9-10 onwards, and that this development continue in the mid-childhood ages. While some of the studies conducted after Piaget's have supported his theory, many other studies in the following years have shown that children are able to make use of topological, projective and metric features either all together or one by one (Blaut, 1997). Moreover, the results of many researches show that basic spatial skills among children begin to appear before the ages nine or ten (Newcomce & Sluzenski, 2004; Lourenco & Huttenlocher, 2007; Boardman, 1990; Rosser, Campbell & Horan, 2001; Malofeeva, 2005; Blades, Sowden & Spencer, 1995; Somerville & Bryant, 1985; Bremner, Bryant, Mareschal & Volein, 2007; Michaelidou, Filippakopoulou & Nakos, 2007).

While some researchers argue that spatial skills can be improved by training and experience (Lohman, 1996), other place particular emphasis on a systematic and structured education for improving spatial skills (Holliday-Darr, Blasko & Dwyer, 2000). In the literature, studies conducted with preschool and first-grade children appear to be quite limited (Mohler, 2006). In addition to particular training programs, spatial skills can also be supported with traditional in-class methods (Gagnon, 1985).

In light of the information provided above, this study aims to analyze the impact of Spatial Skills Education Program on the spatial skills of preschool children.

METHOD

Research Model

In line with the aim stated for the research, the experimental design is construed of pretest, posttest and control group pattern (Büyüköztürk, 2007).

The Sample Group

At the implementation stage of this research, it is highly significant to have teachers at schools to contribute to the implementation in classrooms. The fact that the administration of Halil Rüştü Elementary School (located in the Üsküdar district of Istanbul province) has agreed to the conditions of implementation, and that the teachers at this school have agreed to participate in the project voluntarily have been the factors that enabled the selection of this school. At this school, dual education is being practiced. Group matching technique is used for the formation of experimental and control groups in the research. In this technique, two equal groups are being formed based on group averages of related variables (Büyüköztürk, 2007).

The working group for this research consists of the children attending the kindergarten at Üsküdar Halil Rüştü Elementary School. Following the formation of experimental and control groups, studies have begun with 20 children in the experimental group (morning) and 23 children in the control group (noon). However, due to reasons such as changing of groups by children, leaving school, absence during the test period, or unwillingness to respond to the tests, the statistical analyses have been realized based on the data provided by 16 children in the experimental group, and 15 children in the control group.

Demographic Information on the Workgroups

The experimental group has included 7 girls (43.8%) and 9 boys (56.2%), adding up to 16 children in total; and the control group has included 9 girls (60%) and 6 boys (40%), adding up to 15 children in total. The age of the children in the experimental and control groups change between 60-67 months.

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Information on the Equilibrium of the Workgroups

In order to determine whether both groups are equal with regards to spatial perception, spatial concept development and spatial abilities, three different measurement tools have been applied on both of the groups simultaneously. These tools were Spatial Measurement Scale, Bracken Basic Concept Test and Spatial Ability Form.

The Mann Whitney U-Test has been applied upon the direction-position sub-aspect of the Bracken Basic Concept Test of the experimental and control groups, as well as the pretest scores of the Spatial Perception Scale and Spatial Ability Form. The scores reached have showed that the children in the experiment and control groups do not have a meaningful difference with regards to their direction-position subaspect scores at Bracken Basic Concept Test ($U=119,5$ $p>.05$). Moreover, no significant difference has been found between the Spatial Perception Scale ($U=86,5$ $p>.05$) and Spatial Ability Form ($U=114$, $p>.05$) score gradings of the experimental and control groups.

When all pretest findings have been evaluated, it can be said that prior to the implementation the spatial perception, spatial ability and direction-position concept scores of all children in the experimental and control groups have been close to each other.

Data Collection

Data Collection Tools

Within the scope of this research, the measurement tools below has been used to determine the spatial perception, spatial concept development, and spatial abilities of the children in the experimental and control groups both at the beginning and end of the study.

Personal Information Form

The personal information form used in the research covers the the child's age, sex, whether the child has received any prior preschool education, the educational background of parents, and the employment status of the parents. The classroom teachers have provided assistance in the collection of the data in the form.

Spatial Perception Scale

In order to observe the in-group and inter-group differences, the "Spatial Perception Scale" has been implemented to both groups both prior to and after the experimental study. The scale had been developed by Tığcı and Güven (2003) so as to measure the spatial abilities of 6 year-old children. The scale consists of 49 articles. The coefficient of internal consistency in the scale has been calculated as .82. The Raven Progressive Matrice Group Intelligence Test has shown positive correlation in criterion validity. The scale has been applied to the children on an individual basis and in a silent environment. The articles in the scale are graded based on two choices, that are 'right' or 'wrong'. The practitioner codes the right answers as '1', and the wrong answers as '0'. A large number of right answers show that the children's spatial perception development level is high, while a large number of wrong answers show that the children's spatial perception development level is low.

Bracken Basic Concept Scale

Prior to the experimental implementation, the Bracken Basic Concept Scale-Expressive has been applied to the children in both the experimental and the control groups. The scale had been previously developed by Bracken, and was revised in the year 2006. The scale has been developed so as to measure the basic concept development of children of ages 2 years and 6 months to seven years and 11 months. The Revised Form of the Bracken Basic Concept Scale consists of 11 sub-tests and 308 articles (Bracken, 1998; cited in Bütün-Ayhan and Aral, 2007).

Each sub-aspect can be evaluated within itself. The scores received from the first five aspects constitute the preparation to school aspect. The test is marked as right (1) and wrong (0). If the total score of the first six tests is the total score of the School Readiness Composite (SRC) Test, then it would be entitled as Expressive TC. The concept development level of each child is determined by comparing his/her test score to the standard score

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stated in the scale. Based on the test scores, the concept development level of the child is evaluated as advanced, good, intermediate, low, and very low. The retest reliability of the original test has been calculated as .95, the coefficient of internal consistency of the direction-position sub-aspect has been calculated as .92, and the coefficient of consistency of Expressive TC has been calculated as .97 (Bracken, 2006). The scale has been adapted to Turkish by Yoleri (2010). The retest reliability of the scale for children of ages 3-6 has been calculated as .99, and the KR 20 internal reliability coefficient has been calculated as .89. The KR 20 value for the direction-position sub-aspect has been calculated as .89 (Yoleri, 2010).

Spatial Ability Form

The Spatial Ability Form used in the study so as to measure the spatial abilities of the children in the experimental and control groups has been developed by the researcher. A set of related research has been used as resources for the preparation of the articles in the form, as well as its implementation (Gzesh & Surber, 1985; Petty & Rule, 2008; Frick, Daum, Walser & Mast, 2009; Estes, 1998; Lehnung, Leplow, Haaland & Mehdorn, 2003; Blumberg & Torenberg, 2005; Sorby, 2009; Plumert & Hawkins, 2001). The draft form had been prepared as 23 articles.

The validity and reliability studies of the form has been implemented based on the phases found in the literature (Tavşancıl, 2005; Büyüköztürk, 2005). The reliability studies of the Spatial Ability Form has primarily covered the reliability of scope. For this aim, advice has been taken from five Pre-School Education Experts and one Mathematics Expert. As part of the reliability studies of the Spatial Ability Form, the Cronback Alpha coefficient of internal consistency and test-retest coefficients of reliability have been analyzed.

The Spatial Ability Form has been applied to 35 children (60-72 months) attending the Şehit Öğretmen Nuriye Ak Kindergarten located in the Ataşehir district of Istanbul twice, each application being three weeks apart. The test-retest reliability of the gathered data have been conducted by using the Pearson Product-Moment Correlation Coefficient formula. This way, the reliability coefficient has been found to be $r=.85$ ($p<0.01$). KR-20 calculation is recommended for dual-category evaluation tools consisting of two answering options as right or wrong (Büyüköztürk, 2005). Therefore the results of the data gathered from the 50 children (60-72 months) attending the Şehit Öğretmen Nuriye Ak Kindergarten located at the Ataşehir District of Istanbul has been corrected using the article analysis statistical program, and the article-total score correlation and KR-20 value (.79) has been calculated by using Excel software.

According to the article-total correlation, in order to have an item to be considered reliable, it has to have a weight value of .30 or higher. If need be, articles of weight values such as .20-.30 may also be kept in the scale (Büyüköztürk, 2005). Nevertheless, in this study, the articles that have a weight value below .25 (articles 1,2,4,6,7,12,13) has not been covered in the form. Other applications and analyses in the research has been realized by using 16 articles.

The articles in the Spatial Ability Form are applied to the children on an individual basis, and in a quiet room. The duration of implementation of the Spatial Ability Form is 20-30 minutes per child. Due to the qualifications of this age group, the speed factor or time limit in responding to the questions has not been taken into consideration. Based on the individual difference between the children, the necessary sensibility has been shown with regards to their use of time. The form aims to measure the spatial abilities of 60-72 month-old children (preschool), such as mental rotation, perspective taking, mapping, model design, and finding the hidden object in the design. The right answers in the form have been graded as '1', while the wrong answers have been graded as '0'. The highest score that can be achieved from the Spatial Ability Form has been 16, and the lowest score has been 0. A large number of right answers reflects high spatial ability performance, whereas a large number of wrong answers reflect low spatial ability performance.

Spatial Skills Education Program

The establishment of the Spatial Skills Education Program has first began with a literature review. The literature review has been conducted in two frameworks; these two frameworks were space and definition of space, and spatial ability. As the second step for the formation of the program, the aims and gains of the program has

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been established. The 2006 Preschool Education Program of the Ministry of National Education has been studied for this aim; the space-related aims and goals have been identified; and in line with the literature studied, additional goals and gains have been established by considering the developmental features of children.

Afterwards, a set of activities have been designed in light of the aims and goals identified. The general structure of the educational environment and the preschool education program have also been considered for the preparation of activities. The factors considered for the selection of the materials used in the activities were the familiarity of children with these materials, how much attention they attracted with regards to color and appearance, and ease of accessibility. The activities have been planned as individual as well as small and big group activities, thereby enabling all children to participate in the activities.

In the research, the Spatial Skills Education Program designed for developing the spatial abilities of children has been implemented by integrating it into the preschool education program. Games have been used as the primary method in the activities. In addition to games as the primary method of activities, question-answer and problem solving techniques have also been used in the activities.

The primary aim of the program has been developing children's ability of understanding and using the direction-position words, mental rotation, understanding different perspectives, being able to recognize objects in different positions, interrelating spaces depending on their different features, and spatial representation.

The Operation

The experimental group is construed of the goals and gains defined in the 2006 Preschool Education Program of the Ministry of National Education, the goals and gains defined by the researcher so as to fulfill those of the Ministry of National Education, as well as the 12-week-long Spatial Skills Education Program that consists of activities designed to reach these aims and gains.

The Spatial Skills Education Program has been conducted for 12 weeks, two days of the week by the researcher (Tuesdays and Thursdays), and two days (Wednesdays and Fridays) by the classroom teacher. The classroom teacher has participated in the program by either repeating and consolidating a particular activity previously applied by the researcher, or by applying the worksheets provided by the researcher. The worksheets completed in the classroom under the guidance of the classroom teacher had been delivered back to the researcher.

Data Analysis

Prior to the experimental study, a non-parametric test Mann-Whitney U Test (MWU) had been given to the children so as to determine whether there were any meaningful differences between their scores in the Bracken Basic Concept Scale Total and Direction-Position SubTest, Spatial Perception Scale, and the Spatial Ability Form. The Wilcoxon Signed Rank Test has been used to determine the difference between the pretest and posttest score averages between each group.

RESULTS

The results of the Mann Whitney U-Test has been provided in tables 1-3. The results of the Mann Whitney U-Test are based on the comparison of the post-implementation scores of those children who have attended the Spatial Skills Education Program and those who have not. The scores reflect children's performance in the Bracken Basic Concept Test Direction-Position SubAspect, Spatial Perception Test, and Spatial Ability Form.

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Table 1: The Mann Whitney U Test Results Regarding the Bracken Basic Concept Scale Direction-Position Sub-Test Scores of the Experimental and Control Groups

	Group	N	Rank Average	Rank Total	U	z	p
Direction-Position Sub-Test	Control	15	10,13	152,00	32	3,57	,001
	Experimental	16	21,50	344,00			
	Total	31					

When Table 1 is analyzed, one can see a significant difference between the Bracken Basic Concept Test Direction-Position SubAspect scores of the children who have participated in the Spatial Skill Education Program, and the students who have not (U=32, p<.05). When the rank averages are analyzed, one can see that the children who have participated in the Spatial Skill Education Program have higher scores in the direction-position subtest, in comparison to those who have not.

Table 2: The Mann Whitney U Test Results Regarding the Spatial Perception Scale Scores of the Experimental and Control Groups

	Group	N	Rank Average	Rank Total	U	z	p
Spatial Perception Scale	Control	15	11,73	176,00	56	2.55	,011
	Experimental	16	20,00	320,00			
	Total	31					

When Table 2 is analyzed, one can see a significant difference between the Spatial Perception Scale scores of the children who have participated in the Spatial Skill Education Program, and the students who have not (U=56, p<.05). When the rank averages are analyzed, one can see that the children who have participated in the Spatial Skill Education Program have higher posttest scores in the Spatial Perception Scale, in comparison to those who have not.

Table 2: The Mann Whitney U Test Results Regarding the "Spatial Ability Form" Posttest Scores of the Experimental and Control Groups

	Group	N	Rank Average	Rank Total	U	z	p
Spatial Ability Form	Control	15	8,87	133,00	13	4.25	,001
	Experimental	16	22,69	363,00			
	Total	31					

When Table 3 is analyzed, one can see a significant difference between the Spatial-Skill-Requiring Tasks Form scores of the children who have participated in the Spatial Skill Education Program, and the students who have not (U=13, p<.05). When the rank averages are analyzed, one can see that the children who have participated in the Spatial Skill Education Program have higher posttest scores in the Spatial Skill Form, in comparison to those who have not.

DISCUSSION

Results of this research show that the children in the experimental group have scored higher in the Bracken Basic Concept Scale Direction-Position subtest and the Spatial Ability Form, in comparison to the children in the control group. These findings can be interpreted as follows: the implementation of the Spatial Skill Education Program alongside the 2006 Preschool Education Program of the Ministry of National Education develops children's spatial skills better than the 2006 Preschool Education Program of the Ministry of National Education does by itself.

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The results of the research in the literature conducted to develop spatial skills also tend to support the results of this research.

The results of the research conducted by Gabrielli, Rogers, and Scaife (2000) show that the activities conducted by using technology have a positive impact on the spatial-task-performances and spatial abilities of six-year-old children. The findings of a research by Fenna and Doorman (2011) have shown that the implemented education program has been effective in 4-6 year-old children's ability to recognize spatial arrangements.

The results of an experimental research conducted by Tzuriel and Egozi (2010) on 116 children of ages 6-7 have shown that the gender-based difference between the performances of the children in the experimental and control groups has disappeared following the implementation of an education program on the representation and transformation of visual-spatial information.

The results of an experimental research conducted by Tığcı (2003) with 6-year-old children have shown that the spatial perception level of the children who have attended a spatial perception education program develop more than those who have not.

In their experimental study, Petty and Rule (2008) have applied a 10-week-long spatial skill program to children in the experimental group, while the children in the control group have continued with their curriculum-based education. At the end of the research, a significant increase has been found in the spatial skills of the children who have participated in the spatial skill education program. According to the results of a research conducted by Casey, Andrews, Schindler, Kersh, Samper and Copley (2008), an intervention program prepared for spatial skills have given rise to the spatial visualisation skills of the children in the experimental group.

A research conducted by Davis and Hyun (2005) show that establishment of an educationally-rich environment, encouraging children to speak, cooperation with children, providing children with constructivist discussion and reflection, support children's ability to use the concepts related to projective and metric space in an integrated way. In the research, jigsaw puzzles had been used as educational materials. The results of the research have shown that the use of this material for education has positively impacted 5-7 age children's reasoning skills of in visual space (Verhaegh, Resing, Jacobs & Fontijin, 2009). In a research where the impact of the right and left relational concept training has been studied, a meaningful difference has been seen between the spatial-skill-related pretest and posttest averages of preschool children (Wilmshurst ve Rubin, 1974).

Researches show that spatial skills are related to particular activities and that they can be improved by proper education. There are no obligations to incorporate spatial skills into educational programs. As a consequence, individuals' participation in spatial-ability-related activities and gaining of experiences in this regard are left to chance (Tang, 2006). The Spatial Skill Education Program used in this research, as well as the other education programs for improving spatial abilities developed in other studies, develop spatial abilities within a systematic program, rather than mere coincidences. Such programs provide children with the opportunity to repeat the spatial-skill-related activities more often. This situation allows them to gain such experiences wherein abstract (concepts) and solid (materials) stimulants are harmonized in a systematic structure. At the basis of the positive impact of spatial skill education programs on the spatial skills of children lay the awareness, opportunity for repetition, and the opportunity for transfer, all acquired as results of planned activities and active participation.

Spatial skills impact many fields and disciplines, and can impact success in various areas of life (Mohler, 2008). The results of developmental studies, as well as the findings regarding the individuals' differences in spatial thinking as presented in the research, all show that spatial skills can be improved by effective and well-structured education and/or technology (Newcombe & Frick, 2010). As the result of a meta-analysis study, Baenninger ve Newcombe (1989) have shown that participation in spatial activities are effective on the spatial skills of children, and that the spatial skill performance of children can be developed via education. While spatial skills can be observed in the early childhood, development in this area continues until mid-childhood, and this development includes significant personal differences. This situation places great significance on the

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educational programs that aim to develop this skill in the preschool era (Newcombe & Frick, 2010). Blades, Sowden and Spencer (1995) state that the education of certain spatial skills have to begin in the preschool age. In light of the findings in this research, the relationship between development of spatial concept in children and spatial skill can be recommended as a further study with regards to preschool education and new researches in the area. Moreover, the impact of this education program and similar programs on the later education lives of children can be researched as well.

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