A Study on the Relationship between Six-Year-Old Children's Creativity and Mathematical Ability

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Abstract

Creativity is defined as a totality of processes and a way of attitude and behavior which exists in every child to a different extent. Every child is creative owing to their nature and their perspective on life. Offering children creative environments, especially during early childhood education, affects their mathematical abilities and supports their creative thinking. The aim of this study is to investigate whether children's creativity and mathematical abilities vary with respect to their gender and whether there is a relationship between creativity and mathematical ability. The study population includes six-year-old children attending independent kindergartens affiliated with the Ministry of Education in Ankara city center. The sampling consists of 80 six-year-old children in total, attending Sevgi Kindergarten, which was chosen randomly from among the kindergartens in the population. Data were gathered by using several instruments. These included a "General Information Form" prepared by the researchers to gather information about the children, "Torrance Test of Creative Thinking – Figural Form A" to assess children's creativity, and the "Test of Early Mathematics Ability- 3 (TEMA-3)" to assess children's mathematical ability. While t-test was used to determine whether children's creativity and mathematics scores differed with respect to gender, Pearson Product-Moment Correlation Coefficient was used to analyze whether there was a relationship between creativity and mathematical ability. The results showed that children's creativity scores differed significantly with respect to gender, but not their mathematics scores. Also, it has been found that there is no relationship between the creativity and mathematical ability of children.

Keywords: Creativity, Mathematical ability, Early childhood education, Mathematic skill

1.Introduction

Creativity, which has an important role in the development of societies and humanity and expresses an important ability of the individual, can be defined as an inherent latent power. It is a process that involves certain characteristics such as flexibility, multidimensional thinking, sensitivity, alertness and interest in people and the environment, fluency, being able to think and act comfortably, quickly and independently, originality, and being able to arrive at different and diverse conclusions (Aral 1990, Tuna 2000, Çakmak and Baran 2005).

Isenberg and Jalongo (1997) define creativity as making and creating what has not been made before. In addition, they state that it is a way of responding to objects, symbols, ideas and situations by drawing on previous experiences. According to Gartenhaus (1997), on the other hand, creativity is not a secret. It is a concept known by everyone; however, very few people develop and strengthen it. Creativity is not a special gift that very few people possess by chance, but an ability and type of behavior that can be developed through practice. Creativity is an ability that exists in all human beings and is used to solve and interpret the problems that life poses. There can be differences in the

continuity and degree of creativity at different ages. Creativity is not an ability that is acquired later in life, but one that comes from birth. However, in order for it to develop and flourish, it is necessary to provide appropriate settings and environmental factors, and to support, direct and guide creativity in this environment (San 1985, Ulcay 1985, Artut 2001). The environment that a child has in early childhood is one that nourishes his creative and cognitive potential. In order to develop this potential in the child, it is necessary to start education at an early age, and train and develop the senses which have an active role in creativity. The child explores, hears and perceives his environment through his senses. He should be given opportunities to perceive, observe his environment and to evaluate his observations.The development of creativity should be helped by talking with the child and by presenting environments where he can learn by exploring. Individuals become more creative in environments where they are encouraged to solve problems through exploration and by using creative solutions (Gürsoy 2001, Higginson 2000, Sonmaz 2002, Korkmaz 2002, Meissner 2006).

While creativity is viewed as the ability to solve problems in the literature, in reality it necessitates creative performance, recognizing the problem, thinking differently and developing solutions. Recognizing the problem plays a particularly important role in the creative process. Creative thinking necessitates children to constantly seek answers to questions such as What?, Why?, How?, How much?. Creative individuals are, at the same time, good problem solvers because creativity and problem solution are linked to each other. Children should learn to research, think of a problem as a whole, develop their own techniques, listen and discuss, and cooperate. They should be presented with educational environments where they can become active individuals who explore, analyze and see mistakes. Another way of developing creative thinking is to provide the development of these abilities (Aktamış and Ergin 2006, Grai 2000, Aslan 2002).

In order to develop the mathematical abilities which will be necessary in future school years, the basis for mathematical concepts should be established in the pre-school period and appropriate educational experiences should be organized. In such environments, children firstly adapt to mathematics, and then learn to enjoy it by thinking, understanding relationships and solving problems. When play and problem solution is used in children's daily lives, cognitive development will be supported. In this way, mathematics can be made meaningful and useful for children. Mathematical activities in line with children's experiences ensure that children approach the solution of the problem in a creative way (Güven 1995, Gönen and Dalkılıç 1998, Özsoy 2003b). Creative problem solution exercises in pre-school curricula, which are designed to develop creativity, can help children consider events from different perspectives. All children are creative owing to their nature and perspective on life. Creative environments offered to children especially during their early childhood education can affect their creativity and mathematical ability. Considering these facts, the present study aimed to investigate whether six-year-old children's creativity and mathematical abilities varied by gender and whether there was a relationship between creativity and mathematical ability.

2. Materials and methods

The population in this study was six-year-old children attending independent kindergartens affiliated with the Ministry of Education in Ankara city center. For the sampling of the study, a total of 80 six-year-old children attending Sevgi Kindergarten were selected randomly. Data were gathered by using a General Information Form, the "Test of Early Mathematics Ability-3 (TEMA-3)" and "Torrance Test of Creative Thinking – Figural Form A".

2.1.Test of early mathematics ability-3 (TEMA-3)

Test of Early Mathematics Ability (TEMA) was developed by Ginsburg and Baroody in 1983 in order to test the mathematical ability of children aged 3 through 8 years and 11 months. The test was revised in 1990 and published again under the name TEMA- 2. The reliability and validity studies of TEMA-2 in Turkey were carried out by Güven (1997) and it was concluded to be a valid and reliable instrument. TEMA-2, which was revised again later on, was developed as TEMA-3 in 1993 (Ginsburg and Baroody 2003). Made of a total of 72 items, the test measures the aspects of informal mathematics such as fewer-more, counting, and informal calculation. In addition, the test also measures aspects of formal mathematics such as numbers, relations among numbers, calculation and decimal concepts. TEMA-3 consists of two forms, Forms A and B. These are two parallel forms that measure children's mathematical abilities and are similar to a great extent. It is suggested that these forms are used in experimental studies as pre and post tests. In Forms A and B of TEMA-3, pictures, mathematical symbols and small countable objects were used as materials (Ginsburg and Baroody 2003).

Reliability and validity studies of TEMA-3 for six-year-old children were carried out by Erdoğan and Baran (2006). For its test-retest reliability, TEMA-3 Form A was administered to 100 children and Form B was administered to another 100 children. The correlation results (reliability coefficient) between the scores obtained from the first and second administration of the test were as follows: from Form A to Form A .90; from Form A to Form B .88; from

Form B to Form B .90; and from Form B to Form A .90. Internal consistency coefficient of the test was computed in order to test its reliability and internal consistency KR-20 value was found to be .92 for Form A and .93 for Form B. In order to analyze the criterion validity of TEMA-3, six-year-old children's mathematical ability level was taken as the criterion. Judged by the opinions of teachers, Form A and Form B were administered to 30 children with the best and 30 children with the least mathematical ability. According to the results of Mann Whitney U-Test, Form A and Form B scores of the 30 children with the best mathematical ability according to the opinions of their teachers were significantly higher than the scores of the 30 children with the lowest level of mathematical ability. This result suggested that TEMA-3 can differentiate between children with low and high levels of mathematical ability. The results of the individually administered test showed that the increase in mathematics score indicated an increase in the child's mathematical ability (Ginsburg and Baroody, 2003). The implementation of the test lasted approximately half an hour for each child.

2.2.Torrance test of creative thinking – Figural form A

The study utilized the *"Test of Creative Thinking- Figural Form A"*, which was developed by Torrance (1966) in order to determine children's level of creativity and adapted to Turkish by Aslan (1999). The test consists of the three sub-tests of picture formation, picture completion and parallel figures. The score of creativity was calculated by taking the mean of scores obtained from the subcategories of *fluency*, *originality, abstractness of title, resistance to premature closure and elaboration.* The number of answers given was interpreted as the fluency score; answers being extraordinary as the originality score; the titles that enable viewers see the picture in a deeper and richer way as the abstractness of title score; every relevant detail added to the borders of the picture or in the periphery as the elaboration score; and the delay in closing the picture as the resistance to premature closure score. The "Torrance Test of Creative Thinking – Figural Form A" was translated by three translators who were competent in both Turkish and English. The test was given in both languages to 30 university students with 15-day intervals to ensure language equivalence. Pearson product-moment was calculated for analysis and t-test was used on the same scores. The correlation between the English and Turkish tests was found to be high for overall figural creativity. In Aslan's (1999) adaptation study to Turkish, it was found regarding the validity of the "Torrance Test of Creative Thinking – Figural Form A" that the total creativity score internal consistency coefficient varied between.74 and .38 with Guttman, Spearman Brown and Cronbach Alpha techniques. As a result, the test was concluded to be reliable and applicable with pre-school, primary school, high school and university students (Çakmak and Baran 2005). In the study, creativity and mathematical ability scores for each child was computed. T-test was used to determine whether these varied with respect to gender, and Pearson Correlation Coefficient Significance Test was used to analyze the relation between them.

3.Findings and discussion

Conducted in order to determine whether there is a relationship between the mathematical ability and creativity of six-year-old children, this study reports demographic information regarding gender, order of birth, number of siblings, parents' level of education, parents' age, and mother's work status, as well as the relation between creativity and mathematics scores, the relationship between gender and creativity and mathematics scores in tables, and discusses them in light of the literature.

As can be seen in Table 1, 55% of the participating children were girls, 45% were boys, and the distribution of the children according to gender was similar. The majority of the children were first born (52.5%) , 77.5% were single children, 20% had one sibling and 2.5% had two or more siblings. When the distribution of the children was considered according to their mother's level of education, it was seen that 31.3% of the mothers were high school graduates and 62.5% were university graduates. Similarly, most fathers were high school and university graduates. It was observed that 75% of the children's mothers were aged between 26-35 and 51.2% of the fathers between 26-35. In addition, it was noted that 73.8% of the mothers were working.

Table 2 shows that the scores of girls (Mean: 96.3) and boys (Mean: 96.1) according to mathematical ability were very similar. However, it is worth noting that the average score of girls (Mean (47.2) in the test of creativity was higher when compared to boys. In addition, the t-test revealed that there was a meaningful difference [$t_{(78)} = 3.349$] between girls' and boys' creativity scores. It may thus be claimed that girls enjoyed drawing activities more and their attention span was longer than that of boys.

Çakmak and Baran (2005) analyzed the creativity of kindergarten children in villages and cities using different variables, and found that girls had higher mean scores than boys.

However, it was observed in this study that girls' and boys' mathematical ability scores did not vary meaningfully ($p>.05$). It may thus suggest that, regardless of their gender, children reflected their thoughts in their behavior, were able to do research, and experienced an environment in which they could enrich their lives through positive stimuli.

Mangır and Çağatay (1990) investigated whether kindergarten was helpful in visual perception and whether visual perception had any effect on gender, and found that children attending kindergarten were more successful in visual perception compared to those that did not attend kindergarten, and that gender was not significant in visual perception. Gönen et al. (1991) conducted a study to investigate creative thinking in five-year-old kindergarten children, and found no meaningful difference between the creativity scores of five-year-old girls and boys.

When Table 3 is analyzed, it has been found out that there is no relationship between the creativity and mathematical ability of children. This is because Test of Early Mathematics Ability applied for the children focuses on measuring the formal mathematical skills of children. When the items of the questionnaires are examined, it can be seen that some of the items are about informal mathematical skills which measures problem solving ability of children. On the other hand, it draws the attention that majority of the items on the questionnaire measures formal mathematical skills.

Erdoğan et al. (2009) explored the effects of the Van Hiele model in mathematics education on creative thinking. Children's creativity before and after mathematics education using traditional methods and the Van Hiele method was assessed by using the Torrance Test of Creative Thinking – Figural Form A. It was found that traditional mathematics education did not create a meaningful difference in children's creativity scores. Chamberlin and Moon (2005) showed that the environment presented to children during problem solution affects their creative thinking positively. Grai (2000) pointed out that children must make use of their creativity in order to be able to solve a problem successfully. He indicated that by presenting children with problems and giving them time to solve them, their creative abilities may emerge.

4.Results and implications

In this study conducted with six-year-old kindergarten children, a significant difference was found in children's creativity scores with respect to gender, whereas no meaningful difference was found in their mathematical ability scores. It was also found in the present study that a meaningful relationship did not exist between the sub categories of creativity and mathematics test scores. However, a negative relationship was noted in the sub-category of resistance to premature closure. These results suggest that formal educational practices are observed more in pre-school education. In the traditional approach, the goal is to make children reach the correct answer in the shortest and fastest way possible. However, the right thing to do should be to confront children with different problems, to support them in developing various solutions, and to give them the opportunity to display their creative thinking.At this point, in the next studies, an experimental study focusing on problem solving should be planned for the children and the search of relationship between mathematical and creativity scores of children will be able to give better results. Early childhood environments where children can learn by exploration and problem solution will be more effective in developing their creative thinking and creative ideas. A curriculum in which children are asked open-ended questions and which aims to have them reach a conclusion by themselves can develop their mathematical abilities.

It is essential that pre-school teachers present their pupils with opportunities to learn by exploring. Thus, they should prepare programs which include activities whereby children can produce new ideas, see different points of view and explore what is different. In addition, in mathematical activities carried out with children, there should not only be the teaching of numbers but also problem situations with problem statements, which can develop children's creativity. Open-ended problems should be combined with the children's daily experiences and should involve their areas of interest and experience. Children should be encouraged to approach problems as a whole, develop their own techniques or change the ones given to them. In addition, appropriate environmental arrangements should be made in order to ensure the development of these abilities.

In the light of the research results, it can be concluded that children's creativity may affect the mathematical environments provided to them. Thinking what is different existing in the nature of creativity, can be transferred to children by true implementation of mathematical activities by the teachers. The results of this study are important, in that it indicates the key role of mathematics in developing creativity.

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Table 1. The distribution of children and parents according to their demographics

Demographic Characteristics		
	N	%
Gender		
Girl	44	55.0
Boy	36	45.0
Total	80	100.0
Order of Birth		
First-born Child	42	52.5
Middle Child	34	42.5
Last Child	4	5.0
Total	80	100.0
Number of Siblings		
Only Child	62	77.5
1 Sibling	16	20.0
2 or more Siblings	2	2.5
Total	80	100.0
Level of Mother's Education		
Primary School	1	1.2
Secondary School	4	5.0
High School	25	31.3
University	50	62.5
Total	80	100.0
Level of Father's Education		
Primary School	1	1.2
Secondary School	2	2.5
High School	28	35.0
University	49	61.3
Total	80	100.0
Mother's Age		
26-35 years	60	75.0
36 years and older	20	25.0
Total	80	100.0
Father's Age		
26-35 years	41	51.2
36 years and older	39	48.8
Total	80	100.0
Mother's Work Status		
Unemployed	21	26.2
Employed	59	73.8
Total	80	100.0

Table 2. T-Test results of children's creativity and mathematical ability scores with respect to gender

	Gender	N	Mean	S	df	t	p
Mathematics	Girls	44	96.3	15.98	78	.066	. 948
	Boys	36	96.1	14.17			
Creativity	Girls	44	47.2	18.5	78	3.349	. 001**
	Boys	36	34.0	16.2			

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Table 3. Results of Pearson Correlation Coefficient Significance Test conducted to find out the relationship between children's creativity and mathematics scores

Creativity		Mathematics
Fluency	Pearson Correlation	.176
	Sig. (2-tailed)	.120
	N	79
Originality	Pearson Correlation	.003
	Sig. (2-tailed)	.979
	N	79
Abstractness of Titles	Pearson Correlation	.029
	Sig. (2-tailed)	.657
	N	79
Elaboration	Pearson Correlation	.207
	Sig. (2-tailed)	.065
	N	80
Resistance to Premature Closure	Pearson Correlation	*-.079*
	Sig. (2-tailed)	.674
	N	31
Creativity	Pearson Correlation	.141
	Sig. (2-tailed)	.213
	N	80