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Research into the Effect of Mathematics Education Based on the Theory of Multiple Intelligences on the Mathematics Ability of 6-Years Age Group

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Abstract: This study proposed to examine the effect of mathematics education based on the theory of multiple intelligences on the mathematics ability of 6-years-old children attending Kindergarten and to determine the permanence of mathematics education provided in this way. The research sample was composed of 60 children. In this study, test of early mathematics ability-TEMA-3 form A and B were used. Results of the research was determined that the mathematics ability test scores of children significantly changed, depending on the experimental procedure applied ($p<0.001$). The results of the t-test showed that the effect of mathematics education based on the theory of multiple intelligences continued after 1 month ($p<0.01$). In the mathematics, education program based on the theory of multiple intelligences, dealing with >1 area of intelligence through one activity and having children involved in the activities as much as they want and in the direction of their interests make children willing to get involved in the program.

Key words: Pre-school education, mathematics education, multiple intelligence theory

INTRODUCTION

Mathematics is about developing concepts and its foundation is the experience of children (Akman *et al*., 2000). The research results indicate that starting mathematics education at an early age is developmentally appropriate (Baroody, 1993). In the pre-school period, when the basics of mathematics is provided, math education is taught formally and informally (Aktas, 2005; Lind, 1999).

In addition to the basic concepts related to numbers, such as multitude, counting, sets, addition-subtraction and division-multiplication, concepts such as shapes, weight, volume, spatial position (location, distance), measurements, time and money are taught within mathematical concepts (Güven, 1997, 1999). In teaching math concepts, math activities appropriate for supporting the mathematical development of the child should be planned (Maxim, 1989). Studies have emphasized that systematic mathematics education and the enrichment of the program in this direction, regardless of children's readiness, has a significant consequence (Metin and Sahin, 1996; Pagani *et al*., 2006).

Howard Gardner, who introduced the theory of Multiple Intelligences, established that intelligence has multi aspects and there are 8 types of intelligence (verbal/linguistics, logical/mathematical, bodily/ kinesthetic, visual/spatial, musical/rhythmic, social/ interpersonal, intrapersonal and naturalistic). Each child has these 8 types of intelligences at different levels and they can be developed all through the life starting from early ages (Yavuz, 2001; Saban, 2005). Individuals with different types of intelligences have different learning traits (Akarsu, 2001). Research results also established that the level of intelligence areas differed according to individuals and their gender and that the dominant intelligence area was different for each individual (Elibol, 2000). While, the visual learning of 1student is dominant, another can learn only by involving her/his body in the task (Boydak, 2001). Therefore, the best way of using the theory of multiple intelligences in program development is considering how the topic to be taught can be adapted from one intelligence to another (Ekici, 2003). Research results support that behaviour, skills and concepts are developed by conducting activities related to the intelligence power of children through the use of multiple intelligences areas (Highland *et al*., 1999; Lowe *et al*., 2001; Tugrul and Çatli, 2005).

Instructional activities carried out through teaching settings that are in compliance with the intelligence type

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of each student are called education based on the theory of multiple intelligences (Demirel, 2003). Children in the pre-school period learn best by experiencing and playing. Seeing, touching, feeling, tasting or smelling while playing requires different mental procedures, which expands the mental capacity of the child. Thus, topics become more vivid and lively (Elibol, 2000; Akarsu, 2001; Boydak, 2001).

By means of education based on the theory of multiple intelligences, all such learning opportunities can be presented to children in the pre-school period. A lot of math concepts and explanatory information about these concepts can be communicated by using real objects or symbolic objects that can replace them (Lind, 1999). Children can discover their superior and creative sides and strengthen them. Since, 8 different intelligence areas involve the functions of both the right and the left brains, the rate of using the brain increases and thus, the thinking ability increases and positive attitudes towards learning are developed, which consequently enhances the efficacy of learning (Tugrul and Duran, 2003). Considering that the individual differences of children in pre-school period and the lives around them are determining factors for their development, it can be asserted that maths, for children in that period, can be a process that can easily be learned, is not something far from real life and is permanent and fun (Kansu, 2004).

Our research was aimed to examine the effect of mathematics education based on the ke mathematics ability of 6-years-old children attending Kindergarten and to determine the permanence of mathematics education provided in this way.

MATERIALS AND METHODS

Participants: The research sampling consists of 6-years-old children attending the Kindergarten of elementary schools affiliated to the Ministry of Education, in the province of Edirne in Turkey.

The research was restricted to those samples who were between 60-72 months old, who did not attend any pre-school education institute before and started Kindergarten in that instruction term. Sixty children, who complied with the defined conditions constituted the sample. Twenty of the children forming the sample were identified as the experiment group, while 20 were in the control and 20 were in the placebo group. The experiment and the control groups were in the same school. Placebo group, on the other hand, was taken from a different school in case teachers in both control and placebo control groups exchanged knowledge about the programme in the duration of the implementation of mathematics education based on multiple intelligence theory and there were individual differences in the application of the usual education programme. It was believed that the individual teaching differences of teachers would be influential in assessing the effect of mathematics education based on the theory of multiple intelligences.

The test of early mathematics ability-TEMA-3 form A and B were used as data collecting instruments. The Test of Early Mathematics Ability (TEMA) was 1st developed in 1983 by Ginsburg and Baroody (2003) to measure the math abilities of children between 2 and 8 years and 11 months old. It was revised in 1990 and published as TEMA-2. Later, TEMA-2 was revised again and improved as TEMA-3 in 1993 (Ginsburg and Baroody, 2003). TEMA-3 is composed of 2 separate forms, namely Form A and B. The test, which consists of 72 items totally, measures ability in informal mathematical areas such as few/little-a lot, counting and informal calculations, as well as formal mathematical areas such as numbers, relations between numbers, calculations and decimal concepts. In forms A and B of TEMA-3, illustrations, mathematical symbols and countable small objects are used as materials. Erdogan and Baran (2006) checked the validity and reliability of the test on 200 nursery school children between 60-72 months old. When the criterion validity of the Test of Early Mathematics Ability-3 (TEMA-3) was assessed, it was seen that the highest and the lowest scores that the children received from their teachers assessment, considered as external criterion and the scores they received from TEMA-3 differed significantly. While the test/retest reliability coefficient measured by Pearson Correlation Coefficient was $r = 0.90$ for form A and $r = 0.86$ for form B, the KR-20 internal consistency coefficient was found as 0.92 for form A and 0.93 for form B.

The test of early mathematics ability-3 forms A and B were administered to both control group and the experiment group as a pre-test and a post-test, obtaining raw scores for each child.

Data collection: The dependent variable in the design was the mathematics ability of children attending Kindergarten under elementary schools, while the independent variable was the program of mathematics education based on the Theory Multiple Intelligences. In the study, the children selected for the experiment group received mathematics education based on the theory of multiple intelligences 2 half days a week in addition to their normal school program; whereas, in the placebo control group, some activities prepared within the normal education program were conducted once a week, one activity each time and the control group students continued with their normal program in the Kindergarten.

Implementation and preparation of the mathematics education program based on the theory of multiple intelligences: In the study, a mathematics education program based on the theory of multiple intelligences was prepared to support the mathematics abilities of children in the experiment group. Twenty-four mathematics education activities based on the theory of multiple intelligences were developed to be conducted in 12 weeks, towards the prepared educational objectives and the behaviours expected to be acquired. The activities prepared were composed of art, Turkish language, play, music, science and nature, child's corner and routine activities, all of which involved the use of the verbal/linguistic, logical/mathematical, bodily/kinesthetic, musical/rhythmic, visual/spatial, interpersonal/social and intrapersonal intelligence areas. Moreover, as part of the mathematics education program based on the theory of multiple intelligences, family studies were included. The family studies involved activities for parents to experience with their children in their daily lives, as well as play and math concept activity sheets. The family studies were sent home every 2 weeks.

For the children in the placebo control group, activities that are not supportive of mathematical ability were established. The placebo education activities were arranged for 12 weeks and involved concept studies, art, Turkish language, music, preparation for literacy and play activities. They were implemented for the duration of 12 weeks for once a week, one activity each time.

The test of early mathematics ability-TEMA-3 Form A was administered as a pre-test to the children in experiment and control groups before implementing the mathematics education program based on the theory of multiple intelligences to the experiment group.

The Mathematics education program based on the theory of multiple intelligences were applied to the experiment group, while the activities prepared within the usual education programme were conducted with the placebo control group. The children in the control group continued with their usual education programme in the Kindergarten.

Upon the completion of the education, the test of early mathematics ability-TEMA-3 form B was administered to experiment, control and placebo control groups as the post-test. The test of early mathematics ability-TEMA-3 was administered to the experiment group 1 month after administering the post-test, to check whether the maths education based on multiple intelligence theory was permanent or not.

Data analyses: In order to test the effect of mathematics education based on the theory of multiple intelligences on mathematics ability, the Analysis of Covariance (ANCOVA) was used. For the cases in which the difference was significant as per ANCOVA results, Bonferrini Test was used to determine the groups in which there were differences. The post-test permanence test correlation was tested by means of the t-test for Correlated Samples in order to test the effect of the experiment of mathematics education based on the theory of multiple intelligences, immediately after and 4 weeks after the experiment, on math ability and permanence.

RESULTS

ANCOVA was used to determine whether the mathematics education based on the theory of multiple intelligences influenced the mathematics ability of those in the experiment group or not and to test whether there was a significant difference between the groups.

The math ability levels of groups prior to the experiment were 84.70, 81.45 and 78.50 for the experiment, control and placebo control groups, respectively (Table 1). Although, the math ability test scores of the groups were close to each other's before the implementation, as there were significant differences between the pre-test and post-test scores, ANCOVA was used to examine whether the implemented experimental procedure had a significant effect on the math abilities or not by checking the pre-test scores. The results of ANCOVA, which was conducted to test whether the difference observed between the corrected post-test mean scores of the groups was significant or not, are presented in Table 2.

The examination of Table 2 reveals that there are significant differences between the post-test math ability mean scores of groups, which were corrected according to the pre-test math ability scores ($F_{(2-56)} = 24.67$, $p<0.001$). This finding shows that the math ability test scores of the children changed significantly depending on the experimental procedure implemented.

The results of the Bonferrini Multiple Comparisons Test, which was conducted to interpret this difference between the post-test math ability mean scores of groups, which were corrected according to the pre-test math ability scores, are presented in Table 3.

Table 1: Post-test mean scores of children, corrected according to the math ability pre-test scores and standard deviations

		Pre-test		Post-test		
Groups	N	$\bar{X}$	S	$\bar{X}$	S	Corrected $\bar{X}$
Experiment	20	84.70	15.05	107.75	13.77	105.42
Control	20	81.45	13.09	87.50	13.43	87.57
Placebo control	20	78.50	13.12	85.20	13.75	87.45

Table 2: ANCOVA results of post-test mean scores of children, corrected according to the math ability pre-test scores, by groups

Source of variance	Sum of squares	SD	Mean of squares	F	p-value	Eta-square
Pre-test	5908.020	1	5908.020	70.03	0.000	0.55
Group	4163.565	2	2081.782	24.67	0.000	0.46
Error	4723.930	56	84.356	-	-	-
Total	16790.983	59	-	-	-	-

Table 3: Results of significance difference between the post-test scores of children as per math ability pre-test scores

Groups (I-J)	Significance difference (I-J)
Experiment-control	17.850*
Placebo-control	17.972*
Control-experiment	-17.850*
Placebo-control	0.122
Placebo control-experiment	-17.972*
Control	-0.122

Table 4: T-test results of the math ability post-test and permanence test mean scores of children in experiment group

Early mathematics ability test	N	$\bar{X}$	SD	S	t	p-value
Post-test	20	107.75	19	13.779	-8.41	0.000
Permanence test	20	121.70	19	14.868	-	-

According to the result of the Bonferroni test, it was determined that there is a significant difference between the experiment group and the control and placebo groups, while there is not a significant difference between the control group and the placebo group.

In Table 4, the t-test results of the mean scores that the children in the experiment group received from the math ability post-test and permanence test are introduced.

As shown in Table 4, there is a meaningful difference between the post-test math ability scores ($\bar{X}$ = 107.75) and the permanence test math ability scores ($\bar{X}$ = 121.70) of the children in the experiment group. An increase in the permanence test results is observed when compared with the post-test (t_{19} = -8.41, $p<0.001$).

DISCUSSION

The ANCOVA results, show that the math ability test scores changed significantly depending on the experimental procedure implemented.

In the mathematics, education program based on the theory of multiple intelligences, dealing with >1 area of intelligence through one activity and having children involved in the activities as much as they want and in the direction of their interests make children willing to get involved in the program. It is believed that this situation facilitates learning, in addition to leading to an increase in their math ability scores due to the use of materials in the activities, children's interest in these materials, the repetition of the concepts learnt in previous activities in different intelligence areas and children's carrying out family activities at home with their parents.

In their research conducted on elementary and middle school students, Baldes *et al*. (2000) integrated learning through positive discipline and cooperation with learning through the theory of multiple intelligences and they studied its effect on the learning motivation of children. The study proved that the learning motivation was increased and in their individual development, children applied what they learnt from school in their lives more.

Janes *et al*. (2000) stated in their study on elementary school students that education based on the theory of multiple intelligences has a positive effect on student motivation and success.

Kaçar (2004) specified in the study, which examined the effects of lesson plans based on the theory of multiple intelligences in the 2nd grades of elementary schools that the mathematical success of students were positively affected.

Bayhan (2003) conducted a study on the effect of a preparation education program based on the theory of multiple intelligences on the readiness of 6-years-old children for school. He/she determined that in the literacy education that has an important place in pre-school education although, it is not math ability, such a program was influential on the Kindergarten children's readiness levels.

Having no significant difference between the control and placebo control groups may indicate that the teachers continued their normal education programs, which did not involve multiple intelligences applications, as they believed in the importance of the research. Actually, this was proposed by the educator to the teachers before the research.

The mathematics education programme based on the theory of multiple intelligences, which was implemented for the children in the experiment group, was prepared in line with the objectives of mathematics education for pre-school children. The differences observed in the scores after the experiment show that mathematics education was supported by enriching the programme with the theory of multiple intelligences and the time allocated for the programme was adequate.

The t-test results of the mean scores that the children in the experiment group received from the math ability post-test and permanence test show that they maintain their math ability post-test scores in the permanence test administered 1 month later and the effect of the experimental study still lasts.

The inclusion of activities towards promoting the math abilities of children by mathematics education programme based on the theory of multiple intelligences, fun and pleasing activities that involve children and in which various cognitive styles are used with repetition and the inclusion of families to the programme will contribute to long lasting effects of the programme, providing permanence.

Coskungönüllü (1998) conducted a study in which the effects of multiple intelligence theory on math achievement of grade 5 students were examined and it was determined that the theory of multiple intelligences created a significant difference in math achievement.

In their research studying, the strategies of increasing the mathematical motivation and success of kindergarten children by way of multiple intelligences theory, Bednar *et al.* (2002) observed increased mathematical motivation and success in addition to the increase in involvement in mathematics.

Yilmaz and Fer (2003) carried out a study among 5th grade students to determine their views and academic achievements regarding the multiple intelligence areas, which concluded that teaching activities arranged according to multiple intelligence areas were positively influential on children.

In their study on the applicability of example, guidance materials on probability for the 8th grade level, which were developed applying the theory of multiple intelligences, Gürbüz and Çatlioglu (2004) highlighted that such materials not only helped learning but also made it permanent.

Oral and Öner (2005) conducted research on the teaching of science. They applied full learning supported multiple intelligence theory, multiple intelligence theory, full learning and the conventional method on 4 groups to determine whether there was any significant differences in the achievements, permanence of knowledge and attitudes towards the lesson. They found that the attitudes acquired in the science class did not have significant differences in terms of permanence levels. Researchers interpreted this finding in terms of the standard instruments used, which comply to the conventional system and emphasized that within the multiple intelligence theory activities, measurement should be made in an original way. In view of this, it can be asserted that an appropriate measurement scale was selected in the research to measure the permanence levels of the children and the required evaluations were made within the education program.

All findings indicate that the mathematics education programme based on the theory of multiple intelligences makes thinking styles different, makes student impressions positive, which is required for efficient education and increases mathematical motivation and involvement; the findings also show that all the intelligence areas as well as the areas of interest of the children in the class are covered within the program.

CONCLUSION

In this study, it was revealed that mathematics education based on the theory of multiple intelligences influences the math ability of children. The results of the t-test showed that the effect of mathematics education based on the theory of multiple intelligences continued after 1 month.

Although, the theory of multiple intelligences is a theory used as a basis for pre-school education programmes, it is observed that teachers have difficulty in making the necessary arrangements in practice. The teacher should 1st get to know her/his own intelligence areas and should be able to combine them with teaching techniques. If the teacher believes in the importance of education based on the theory of multiple intelligences, she/he will be a role model for children to use their intelligences and offer them opportunities. Children learn better when their teacher likes mathematics and approach mathematical activities positively. Mathematics can be made an area of interest for children by preparing and presenting educational experiences that promote mathematical skills and that are appropriate for their intelligences by a teacher who has knowledge on the theory of multiple intelligences.

Failure in learning adversely affects the feelings of the child about her/his place in society. Therefore, in addition to the attitude of the teacher who will provide math education, that of the family is also important. Instead of disaffecting their children from mathematics and making them worried in early ages, in direction of their own negative experiences, parents should become aware of the fact that education based on the theory of multiple intelligences contribute to them in fulfilling their responsibility of introducing their children to mathematics and the relationships they establish in other areas are equally important. Education based on the theory of multiple intelligences ensure that parents spend time effectively with their children.

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