

A Study on the Effect of Mathematics Teaching Provided Through Drama on the Mathematics Ability of Six-Year-Old Children

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This study was conducted to examine the effect of mathematics teaching given through the drama method on the mathematical ability of six-year-old children. The research was conducted in Ankara on 105 children from the kindergarten classes of two different primary schools of the Ministry of National Education, which are at middle socio-economic level. Thirty-five of the 105 children were selected as the experimental group, 35 of them as the control group and finally 35 as the placebo control group. The placebo control group was formed in order to determine the differences resulting from group interaction. Data were collected by means of the "General Information Form" and the "Test of Early Mathematics Ability-3 (TEMA-3)" developed by Ginsburg and Baroody in 1983. Results showed that mathematic teaching based on the drama method has a positive effect on the mathematical ability of six year of children.

Keywords: Pre-school period, mathematics teaching, mathematics concepts, drama in education

THE DEVELOPMENT OF MATHEMATICS CONCEPTS

Early childhood period is a period when the child has the most rapid development and starts to learn basic concepts actively. Children in this period progress from pre-operation stage to concrete operations. In other words, the child passes from visual thinking to mental development during the early childhood period (Wortham, 1998; Yildiz, 1999; Frakes & Kline, 2000;

Jacobson, 2001).

Experiences regarding mathematics, which constitute a significant part of life, are realized in a long and difficult process following the initiation of learning the fundamental concepts. Children constantly face mathematical concepts in their daily lives. In the early childhood period, the initial experiences about mathematics are acquired generally through the experiences with objects, depending on the child's stage of development. Therefore, an active learning environment and methods are required in the early childhood period for the development of the mathematical concepts and abilities to be used in the future by the child. Children should be aware of the transition from concrete to abstract, simple to complicated, and from trial to making. Many studies have revealed that the information that the child learns

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in an active learning environment is retained (Graham, Nash, & Paul, 1997; Raida, 1999; Trisha, 1999; Bennet, 2000; Fleege, 2000; Young-Loveridge, 2004). Moreover, Peker and Mirasyedioglu (2008) stated that the use of concrete materials for a long time, especially in the primary education period, is positively related to increasing students' mathematics success.

The mathematical concepts to be used in the future are first formed in the first year of childhood. The child starts to acquire the initial mathematical abilities first physically, then mentally and finally by hand-counting via the experiences he/she gains during his/her interaction with his/her environment (Chao, Stigler, & Woodward, 2000; Frakes & Kline, 2000; Geist, 2001). There are various concepts in the field of mathematics. In addition to the basic concepts related with numbers, such as multiplicity, counting, numbers, sets, addition-subtraction, division-multiplication etc., the child also starts to learn concepts like shapes, weight, volume, length etc. in various stages in time beginning from the birth depending on his/her development. Mathematics is a continual education. In order to make a simple addition operation, numbers should be known and how they are used should be learned first. Concepts related with mathematics may be covered in all preschool education programs. Therefore, a mathematics program should be planned well. The program should be based on experiences which will improve the child's capability of expression and will enable him/her to have new experiences. The instruction methods and materials used in planning should be used in accordance with the objective. The program to be developed should also emphasize that mathematics is easy to learn, useful, practical and entertaining. In the study they conducted, Tudge and Doucet (2004) observed the children in their environment and recorded children's behavior in settings that particularly contained pre-formed mathematical materials. They reported that children dealt with mathematical concepts more easily in their natural settings. Many studies on this issue revealed the importance of the use of different techniques in mathematics education for children (Raida, 1999; Trisha, 1999; Young-Loveridge, 2004). Children should believe that they can learn mathematical concepts and they should not be afraid of mathematical studies. One of them will be enthusiastic to learn mathematics when he/she comprehends the way how he/she will learn mathematics and understands the reasons behind mathematical concepts. The child's self-confidence and his/her awareness of learning skills will improve his/her cognitive learning potential (Kline, 2000; Yildiz, 2002).

One of the basic objectives of pre-school education is raising children who are creative, problem-solving, and sensitive to themselves and to their environment, whose communication skills are developed and who can think in a scientific manner. The use of drama in

mathematics teaching courses started in the beginning of the twentieth century. In these courses, first a desire for learning mathematics is aroused in children, and then it is ensured that they get adapted to mathematics, and learn to enjoy it by thinking, understanding the relations and problem solving. In pre-school education, children have the chance of learning many mathematics concepts by imagining through drama studies. In drama studies, creating real situations, going to places where there are real situations and imagining these situations ensure that the effects of education are permanent. Imagining realized by seeing, hearing, tasting or smelling something that does not really exist requires mental processes, which improves the intellectual capacity of the child. Thus, many subjects become livelier and more life-related. Many concepts in mathematics subjects as well as descriptive and explanatory information related to these concepts are learnt faster through drama. For example, creating a shopping environment for children and counting vegetables and fruits in this medium are suitable mathematical settings for children. Mathematics teaching provided by means of drama changes abstract mathematical concepts in children's minds into concrete and attractive. Therefore, it is important that families and educators provide a creative environment for children in mathematics teaching (Tanriseven, 2000; Aral et al., 2003; Ozsoy, 2003a; Peterson, 2004; Erdogan & Baran 2006).

Rationale of the study: aims and hypotheses

Drama, which is used as an instruction method in pre-school educational institutions, can also be used for mathematics teaching. Children can learn best by experiencing and playing. Imagination is the most needed material when the child is playing. This requires mental processes such as seeing, hearing, feeling, touching, tasting or smelling, the implementation of which will develop the mental capacity of the child. The subject learnt will subsequently become more lively and livable. Topics related with mathematics can also be taught more quickly and permanently through drama. With the help of real objects or symbolic objects replacing them, the drama method may facilitate learning many concepts in various topics (size, weight, shape etc.) and complimentary, descriptive information about these concepts. The topics taught are comprehended faster as the child learns during games (Peterson, 2004). In terms of supporting mathematical abilities in the pre-school period, despite the studies made on cooperative learning, the use of physical materials, and the impacts of methods such as music, game etc. (Kaaland-Wells, 1994; Raida, 1999; Trisha, 1999; Rose, Parks, Androes, & McMohan, 2000; Karşal, 2004; Young-Loveridge, 2004), there are a few study related the impact of the drama method (Ozsoy, 2003a/2003b; Fleming, Merrell, & Tymms, 2004).

Based on this consideration, this study aims to analyze whether the mathematics teaching provided through drama for six-year-old children in kindergarten has any impact on their mathematical abilities or not.

METHOD

Participants

The study involves children who are six years old. In the study, there is one experimental and two control groups. The sampling consists of 105 children, 35 of whom are in the experimental group, while 35 are in the control and the remaining 35 are in the placebo control groups. The children in the experimental and control groups have been selected from the same school. The placebo control group has been selected from a different school in order to identify any difference that may arise from group interaction. Children to be covered under the experimental, control and placebo control groups were required not to have attended any preschool education institution previously, to have started kindergarten in that education year and not to have participated in drama activities at or after school.

Instruments

The Test of Early Mathematics Ability-3 (TEMA-3) was used in the study to evaluate the mathematics abilities of children. The Test of Early Mathematics Ability (TEMA) was developed by Ginsburg and Baroody to evaluate the mathematical abilities of children between three years and eight years eleven months old. It was reviewed and republished as TEMA – 2 in 1990. The TEMA-2 test, which was reviewed again, was developed as TEMA-3 in 1993 (Ginsburg&Baroody, 2003). The validity and reliability studies of TEMA-3 for Turkish six-year-old children were performed by Erdogan & Baran (2006). Within the scope of test-retest reliability study, TEMA-3 was administered to two hundred children, one hundred of whom were given Form A, while the remaining one hundred were given Form B. Three weeks after the first administration of TEMA-3, Form A and Form B were administered again to 120 children. The correlation results (reliability coefficients) of the scores in the first and second administration of the test were .90 from

Form A to Form A, .88 from Form A to Form B, .90 from Form B to Form B and .90 from Form B to Form A. The interior consistency coefficient was calculated in order to test the reliability of the test and KR-20 value and the internal consistency was found as .92 for Form A and as .93 for Form B.

The mathematics ability levels of six-year-old children were taken as the external criteria to analyze the criterion validity of TEMA-3. Form A and Form B were administered to thirty children, with the lowest and highest mathematics abilities according to their teachers' viewpoints. The results of Mann Whitney U-Test showed that Form A and Form B scores of thirty children with the highest mathematics ability according to the teacher were significantly higher than the Form A and Form B scores of thirty children with the lowest mathematics ability. This reveals that TEMA – 3 can distinguish between children with strong and weak mathematical abilities.

The test consisting of seventy two items evaluates the areas of informal mathematics such as less-more, counting, informal calculation etc. as well as the areas of formal mathematics such as numbers, relations between numbers, calculation and decimal concepts. TEMA – 3 consists of two separate forms as Form A and Form B. Form A and Form B are two parallel forms which are mostly similar and which measure the mathematical abilities of children. The forms are suggested to be used as pretest and posttest in experimental studies (Ginsburg & Baroody, 2003).

Pictures, mathematical symbols, countable small objects are used as materials in Forms A and B of TEMA-3. The increase in mathematics score acquired as a result of the evaluation of the test administered individually to the children points to an improvement in the mathematics ability of the child (Ginsburg & Baroody, 2003). The administration of the test takes an average of half an hour for each child.

Procedure

First, a “Mathematics Teaching Program Based on Drama Method” was developed in the study in order to support the mathematics ability of children in the experimental group. The program covered activities based on drama to develop the abilities of counting, corresponding objects equivalent to numbers, arranging

Table 1. The distribution of the participants in the experimental, control and placebo control groups by their schools

Schools	Experimental Group Control Group				Placebo Control Group	
	N	%	N	%	N	%
Dikmen Central Elementary School	-		-		35	100.00
Province General Council Elementary School	35	100.00	35	100.00	-	
Total	35	100.00	35	100.00	35	100.00

objects according to their numbers, recognizing numbers, pointing at objects at a given number, knowing the following number, and the concept of operations for children at the six age group.

Twenty-four education situations of the Mathematics Teaching Program Based on Drama Method were presented to seven experts who are specialized in drama, programme development in education and pre-school education, to take their viewpoints. The experts were asked to evaluate the program against seventeen criteria such as the adequacy of the education situations and the appropriateness of the mathematics teaching, the adequacy and appropriateness of the materials used, the appropriateness of the distribution of the objectives, the appropriateness of the drama studies and the clarity of the instructions. The experts have also specified their points of view on the Mathematics Teaching Program Based on Drama Method (twenty-four activities) given to them in more details.

The researcher, then, determined the schools where the study would be conducted. The sampling of the research consisted of six-year-old children attending, in the 2005-2006 instruction year, the kindergarten classes of formal elementary schools affiliated to the Ministry of Education, in the province of Ankara.

One hundred and five children, attending the kindergarten classes of two elementary schools determined by randomly selection, constituted the research sample. The schools were selected from among the schools, in the province of Ankara and affiliated to the Ministry of Education, which are at middle socio-economic levels as per data from the State Statistics Institute. The schools from which the samples were selected are presented.

The Test of Early Mathematics Ability – 3 (TEMA-3) Form A was administered as a pre-test to the experimental, control and placebo control groups. TEMA-3 was administered individually to the children in a silent environment independent from the education environment. Following the tests, the teacher prepared some materials for the setting where the program would be implemented for the experimental group (35). The materials, such as cards with objects that the program involved, number symbols, large and small boxes, books, cassettes, beads, blocks, costumes suitable for the program, and paper and pencils, were prepared before the children came to the area of implementation. Role play, dramatization, and pantomime, which take place in drama, were all considered in designing the activities in the education program. After the implementation, it was ensured that an assessment was made and children's views were taken. The duration of treatment in a day lasted for about 45-50 minutes for one group. Mathematics activities based on the drama method were conducted with children for two days a week, for twelve weeks.

The educational situations for the placebo control group, on the other hand, involved “placebo” activities, i.e. activities that did not support the development of mathematics ability and mathematics concepts. In addition, activities such as music, games, and story reading, which are irrelevant to mathematics, were organized for the children in the placebo control group (one day in two weeks). The educator planned the activities by discussing them with the group teachers one week before the implementation.

The children in the control group (35), selected from the same school with the experimental group, continued to attend their education program in the kindergarten. Following the implementation of the Teaching Program based on Drama Method with the experimental group (for twelve weeks after the pre-test), TEMA-3 Form B was administered as a post-test to the children in the experimental, control and placebo control groups.

Finally, TEMA-3 Form B was administered again to the experimental group in order to identify whether the teaching was retained four weeks after the administration of the posttest (retention test).

Analysis of the Data

A mixed pattern of 3x3 was used in the study (experimental group, control group, placebo control group x pre-test, post-test and retention test). In the pattern, the dependent variable is the mathematics abilities of the children while mathematics teaching program is the independent variable, whose effect on mathematics abilities of the children is studied.

In the analysis of the data collected by means of the Test of Early Mathematics Ability–3 (TEMA-3), the Analysis of Covariance (ANCOVA) was used to test the effect of the Mathematics Teaching based on Drama on the mathematics abilities of children. The Bonferroni Test was administered to identify the group with a difference according to ANCOVA. Also, the effect of Mathematics Teaching based on Drama Method on mathematics abilities of children, immediately after and four weeks after the experiment, were evaluated. The T-test for correlated samplings was used to evaluate the posttest and retention test correlation of the experimental study.

RESULTS

The findings of this study, which reveal the effect of mathematics teaching based on drama on the mathematics ability of six-years-old children, are presented in the following tables.

Pretest–posttest score means of TEMA-3 in Table 2 show that there is a meaningful difference between pretest and posttest score averages of the experimental group (pretest mean: 86.06, posttest mean: 96.43). When the pretest scores of the groups are checked, the

Table 2. Descriptive statistics for six-year old children’s TEMA-3 scores

Group	N	Pretest		Posttest	
		Mean	SD	Mean	SD
Experimental	35	86.06	11.59	93.34	11.59
Control	35	95.88	11.94	98.60	11.94
Placebo Control	35	87.77	14.08	87.34	14.08

Table 3. Summary of ANCOVA for six-year old children’s TEMA-3 scores

Source of Variance	Sum of Squares	df	Mean Squares	F	p
Experimental	11804.11	35	337.26	5.183	.000
Group	367.26	2	144.38	2.822	.005
Error	4360.05	67	65.07		
Total	18385.00	105			

Table 4. The t-test results of posttest and retention test mean scores of TEMA-3 in experimental group (n=35, df=34)

		Mean	SD	t	p
TEMA-3 Scores	Posttest	93.34	11.59		
	Retention test	94.05	11.38	-.671	.507

estimated means of the posttest scores are observed as mean = 96.43 in the experimental group, mean = 94.18 in the control group and mean = 90.64 in the placebo control group. It is also noted that there is a decrease in the estimated means of the posttest scores according to the pretest scores of the control group and the difference between the pretest and posttest is more obvious in the experimental group. It is further observed that the experimental group has the highest mean, followed by the control group and the placebo control group.

The ANCOVA analysis revealed that there was a significant difference between the estimated posttest mean scores according to the pretest mean scores of TEMA-3 [$F_{2,67}=2.822, p<.01$]. The Bonferroni Test applied in order to identify the reason for the difference showed that there was a significant difference between the experimental group and the placebo control and control groups, as well as the placebo control group and the control group. This result was due to the high score of the experimental group. High scores of the children in the experimental group revealed the influence of the instruction method followed. On the other hand, the difference between the placebo control group and control group was considered to be arising from the selection of the children in the control group and the experimental group from the same school. Despite the fact that the children in the experimental and control groups were not selected from the same grade or the

children in the control group were not subject to any program implementation was in line with the objective of the study, they might get higher scores than the children in the placebo control group due to the interaction between the children and teachers.

According to Table 4; the posttest score mean was 93.34, the retention test score mean was 94.05 for TEMA-3 of children in the experimental group. The results of the t-test showed that there was no significant difference between TEMA-3 posttest and retention test scores ($t_{(34)} = -.671, p>.05$). However, the score means revealed that the mathematics ability scores of children in the experimental group in the posttest were maintained in the retention test given one month later and the effect of the experimental study was consequently maintained.

DISCUSSION

Drama is a child-centered method which creates an independent learning environment since the child is constantly active and enabled to express his/her ideas freely in drama. The child is involved in more activities during this process and may enjoy this environment as he/she enjoys playing games. The child learns various concepts about life while he/she is enjoying game processes. Mathematical concepts are among these concepts with vital importance. Mathematical concepts are taught to children through the use of the drama

method may become enjoyable activities which are easy to learn for children (McCaslin, 1990; Ozsoy, 2003a; Peterson, 2004). These results explain the high scores of the children in experimental group since the mathematics teaching provided through drama ensures the active participation of children and aims to improve the mathematics abilities of children in an enjoyable environment.

Urkun's (1992) study intends to reveal the effect of an education model based on supportive mathematics concepts for children at the age group of four-five. The findings of this study note that the education given supports the mathematical concept development of children. Chao *et al.* (2000) studied the impact of using structured blocks in teaching numbers to the children in kindergarten and children showing each number with various objects in various ways. The findings of the study concluded that the relation between physical materials and abstract numerical concepts is not easy to comprehend unless it is gradual and takes place in steps. Raida (1999) studied the impact of mathematics education given through books of mathematical concepts to one hundred and twenty-eight children at the age group of six on the mathematics abilities of children. The findings of the study revealed that the mathematics abilities of children are significantly affected by the mathematics education given to the experimental group.

Tarim-Gozubatık and Deretarla-Gul (2004) studied to identify the subtraction-addition abilities of children and strategies that followed. The Test of Early Mathematics Ability -2 (TEMA-2) has been used in the study as a measurement tool. Test forms involving three types of problems, namely, non-verbal problems, verbal problems and subtraction-addition operations, were administered to children. The study concluded a linear relation between the scores of the children in TEMA-2 test and the answers they gave, depending on the type of the problem.

Young-Loveridge (2004) carried out a study to design an effective program to improve the counting abilities of children at the age group of five. This program was based on numerical concepts, books and games. The study was conducted on one hundred and six children. The mathematical knowledge of children was evaluated by means of a test covering topics such as counting, subtraction-addition, enumeration, recognizing shapes etc. As the children in the control group continued to attend the daily education program, a program covering stories of numbers, rhythm and games was implemented to the children in the experimental group. At the end of the study, a significant rate of increase was observed in the mathematics knowledge of the children in the experimental group.

These studies, suggesting the impacts of the support of mathematics abilities with education, further support the positive effects of the mathematics teaching given through the drama method in this study.

Drama provides the multilateral development of the child. The child learns to share and cooperate with his/her friends during activities since drama is a group activity while (s)he also learns to consider cases in various dimensions and aspects as (s)he acts and watches his/her friends act. Learning is much easier and it has retainable impacts as the child learns via trial and error in drama process (Girgin, 1999; Peterson, 2004).

CONCLUSION

The study revealed an increase at a significant rate at the end of the education process in the TEMA-3 scores of the children in the experimental group in relation with the impact of the mathematics teaching based on the drama method. The scores of the children in the experimental group were found to be higher than those of the children in the control groups ($p < .01$). No significant difference was observed between the scores of TEMA-3 posttest and retention test scores of children in the experimental group ($p > .05$).

This study concludes that the mathematical abilities of six-year-old children can be supported with education. Mathematics education in the early childhood period is not the direct transfer of knowledge to the child, but it is based on child's learning by directly performing and experiencing the knowledge. How to teach the mathematics concepts to the children in early childhood period is a significant issue.

As the mathematics world of adults is generally filled with abstract concepts, the world of children is more related with concrete concepts and realities. Therefore, mathematics activities of the early childhood should cover activities that can be implemented by the child in real world and should be based on learning with making- living. It is possible to teach many things by means of drama activities in the preschool period. This is due to the fact that the child can learn various concepts through drama activities while improving his/her potential of creativity. An entertaining and enjoyable environment can be created by including mathematics concepts in the drama education program, introducing mathematics concepts to the children, which is one of the objectives of the program.

Teaching of the mathematical concepts through entertaining activities, in which children want to participate and can be active, will be more appropriate since these concepts are abstract and relatively hard to learn in the preschool period. Therefore, due to its features, the drama method should be used in teaching mathematical concepts in pre-school education institutions.

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