Educational Research (ISSN: 2141-5161) Vol. 2(6) pp. 1210-1218 June 2011
Available online@ http://www.interesjournals.org/ER

Full Length Research paper

The effects of drama in helping five-year-old children acquire the concepts of number and operation

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Accepted 22 June, 2011

This study aims to investigate the effects of the drama method in helping five year-old pre-school children acquire the concepts of number and operation. In order to form the study sample, 20 out of 45 five-year-old children attending a public kindergarten in Turkey were randomly selected. Of these 20 children, 10 were assigned randomly to the experimental group and the remaining 10 to the control group. The experiment group undertook a "Drama Based Number and Operation Education Program". The control group, on the other hand, followed the regular kindergarten curriculum. The results showed that experimental children were significantly more successful than the control group concerning the concepts of number and operation. In other words, it was observed that drama has an important effect in helping children acquire the concepts of number and operation and in supporting these concepts. The results also revealed that gender and the number of siblings did not create a meaningful difference in experimental children's achievement of the concepts of number and operation.

Keywords: Number, operation, drama, preschool education.

INTRODUCTION

During preschool, children are taught skills and concepts in various fields according to their age group, through kindergarten curricula. Mathematics is one of these fields. It has an important role in making children become aware of their own physical and social environment (Clements and Sarama, 2003). Children start pre-school education institutions with a pre-existing knowledge of various concepts and skills related to mathematics. In other words, children gain concepts related to mathematics through informal means before they start their formal education at preschools (Akman, 2002; Carrasumada et al., 2006; Clements and Sarama, 2003). Studies and programs organized to develop children's mathematical concepts and skills may affect their future learning and life positively. Since the acquisition of mathematical competencies shape people's future, children should be presented with a life full of mathematics at very early ages (Varol and Farran, 2006). In order for children to be able to understand the mathematical concepts that they will learn and use in the future, certain ways of thinking and skills should be developed during the pre-school period (Metin and Daglıoglu, 2006; Charlesworth and Lind, 2003). It is crucial that children develop mathematical skills themselves by playing with objects, learn concepts through experiences with concrete methods, and establish these concepts and skills correctly (Maxim, 1989). Perhaps the very first fundamental concept and skill expected to be developed through mathematical activities with young children is counting objects by being aware of numbers. In addition, it is also important that children develop an understanding of correspondence and

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sequencing (NCTM, 2006).

Children develop an initial understanding of numbers by making use of concrete objects. When they understand the features of numbers, they enter into a new world and once they start using the symbols, they have made a crucial achievement for their future mathematics education (Zhou and Wang, 2004). While it is indicated in the literature that studies on children's mathematical development usually focus on their conceptual development, early mathematical knowledge and skill areas, one common result that has emerged from these studies is that preschool children start their education equipped with critical knowledge of counting (Anderson, 1997; Tucker et al., 2002).

Development of the Concepts of Number and Operation in Pre-school Children

Preschool mathematics education consists of the concepts and skills of number, shape, time, measurement, data analysis and problem solution (Dinçer and Ulutaş, 1999; NCTM, 2006). An important concept that children should gain in mathematics education is number sense. It enables children to attach meaning to numbers through the use of physical materials and the experiences they have in their environment, and forms a basis for other skills such as grouping and sequencing (Ktoridou et al., 2005). Making children count the objects used in everyday life and mentioning the quantity of objects helps the development of one-to-one correspondence skills in children (Olkun and Toluk, 2003). Considering the fact that number sense is formed through encounters with objects, it is evident that sequencing through one-to-one correspondence or sharing toys and candies maintains the development of the concept of numbers (Butterworth, 2005). Children start counting verbally by the age of three, which manifests itself through songs or rhythms (Van de Rijt and Van Luit, 1998). Baroody and Price (1983) held a study with three-year-old children to investigate whether they have the ability to sequence numbers-words, and the results showed that children in this age group use the skill of sequencing numbers-words while counting objects. When children reach the age of four, although they are aware that numbers are used to count objects, they may not always realize that each object represents a number and they either skip one object or count the same object twice (Van de Rijt and Van Luit, 1998). For four-year-old children, counting is not an easy endeavor and before they understand that the number of objects in a group they are counting corresponds to the last number, they learn how to count. Children develop ideas about quantity in early ages and at the age of four and a half, they start to understand the relation of quantity (Van de Walle, 2004).

Around the age of five or six, children start counting numbers from 1 to 20 rhythmically and do so by knowing the meaning of numbers. Children at this age can sequence numbers from 1 to 10. In addition, they can write and recognize numbers from 1 to 9. Moreover, they can add and subtract numbers up to 5 (Metin, 1992). After mastering how to count, children learn another strategy for counting. This is known as shortened counting and is used by six-year-old children as a strategy. When children can count in a flexible way, they cognitively gain the concept of ordinal numbers. This concept is gained throughout the development of counting (Van de Rijt and Van Luit, 1998). All these developments have an important place in the formation of the knowledge of arithmetic in children. Arithmetic has a far more complex structure than children simply thinking of two numerical values and generalizing, combining and differentiating them (Saxe et al., 1987). Educators may help children understand the meaning of operations such as addition and subtraction by presenting them with various problem situations (Ktoridou et al., 2005). In preschool, children can perform the operations of addition and subtraction by the help of concrete objects. They can understand that combining (an increase in the number of objects) the two sets of objects presented to them means addition and separating (a decrease in the number of objects) some of the objects from the group means subtraction (Gelman and Gallistel, 1979; Butterworth, 2005).

Mathematics Education and Drama for Preschool Children

The experiences that children have in mathematics and the information they gain during preschool education form the basis for their primary school experiences. That is why children need learning environments where they will be active and learn the methods-techniques to develop mathematical concepts and skills for the future (Erdoğan, 2006; Yıldız, 1999). In order to ensure mathematical development, teachers should provide rich learning opportunities for children, lead them to think, and encourage them to explore. In addition, by drawing their attention on the mathematical concepts during play, teachers can support children's efforts in order for them to solve problems. Johansson (2005) studied the role of the skill of sequencing numbers-words in children in arithmetic performance. The results showed that sequencing numbers-words is an important skill in order to make guesses in solving arithmetic problems. In the same study, children were presented with problems of addition (e.g., 2+2=?) and the results suggested a relation between the skill of sequencing numbers-words and arithmetic performance. Moreover, the findings also supported the fact that the development of the skill of

sequencing numbers-words in children is a determinant of using correct strategies in solving arithmetic problems. According to National Council of Teachers of Mathematics (2007) children's mathematical development should be supported through experiences, appropriate developmental ways, and practices that support early mathematical development. Previous studies about children's learning in the first six years of life emphasized that mathematics success in later stages of their life is closely related to early childhood education (Güven and Balat, 2006; Wolfgang et al., 2003). A wide range of sources and materials should be used for the teaching of numbers to children, using key concepts, activities based on approaches that target perception, audio and video technologies and active learning. That is why both free activities and drama activities may be utilized while presenting mathematical concepts to children. With the drama technique, which uses real life situations and concrete objects, children can be made to explore on their own. In this way, they can enjoy education and develop positive attitudes towards mathematics. Since drama encourages the use of all senses, employing drama in mathematics education makes learning permanent and more enjoyable. By activating the senses, instruction becomes more effective, efficient and successful (Adıgüzel, 1993).

Drama has an important role in children's adaptation to life. Drama studies carried out with preschool children contribute greatly to turning abstract situations into concrete ones, giving meaning to life, and learning concepts and skills. Drama is a technique which makes children think in different perspectives, assume an active role in their education, express themselves clearly, and be creative by putting themselves in the place of another person (Dirim, 1999; Holden, 2002). Drama as an teaching method ensures that children actively ponder different situations and their roles, and learn relations, events and subjects by exploring them (O'Neill and Lambert, 1990). Drama in education also supports the effective development of an emotional, fictional point of view and creative expression in children (O'Hara, 1984). In addition, it is a group activity that makes children develop self-expression through movement, mimicry and the techniques of role play. According to Johnson (2002), drama is a learning tool which makes it possible for children to discover concepts, gain knowledge and develop thinking skills. Used as an educational method, creative drama aims to increase the interest of the participants in the teaching of different subjects and concepts. It also aims to make the participants analyze real-life situations through imagery and make them understand various subjects and concepts (Adıgüzel, 1993).

As mentioned above, considering that drama helps particularly children learn permanently and easily through associations with their own lives, its place in education gains a greater importance (Aral et al., 1981). Drama in the preschool period is effective in making children acquire not only socio-emotional and psychomotor skills, but also cognitive ones. For this reason, drama can be used to develop children's creativity, prepare them for life, and also teach them various concepts and skills including mathematics and science (Erdoğan, 2006; Akyol, 2003; Morgül, 1999**;** Holden, 2002). Various mathematical concepts and skills can be presented to children, such as counting the number of children that will join a game, matching them, comparing them, subtracting as losers leave the game, adding as new ones join in, and grouping. During drama activities, children become exposed to new lives, concepts and experiences owing to the roles they play. By making use of appropriate roles, drama games can be used to teach mathematics. The number of studies focusing on the use of drama in mathematics education is rather limited. However, the results of these studies have shown that using drama in mathematics education positively affects the development of mathematical skill in children (Erdoğan, 2006; Sözer, 2006; Soner, 2005; Fleming et al., 2004; Jackson, 1997).

The Purpose of the Study

The purpose of this study is to investigate the effects of the drama method in making five-year-old preschool children gain the concepts of numbers and operations. The study also aims to determine whether there is a meaningful difference between children who receive drama education and those who do not, in terms of the total scores obtained before and after the experiment in favor of those who have received drama education. Another aim of the study is to investigate whether there is a meaningful difference between the experimental children's number and operation achievement scores according to gender and the presence of a sibling.

METHOD

Research Design

This study has adopted the pre and post test control group model (Karasar, 2004). In this model, one of the two groups is selected randomly and assigned as the experimental group, and the other one is used as the control group. In order to determine the effectiveness of the "Drama Based Number and Operation Education Program", pre and post tests were administered to both groups.

Participants

The sample of this study consisted of five-year-old

children attending a public kindergarten in Turkey.

There were two sections in the kindergarten with five-year-old children. In order to form the study group, all of the 53 children in these two sections were examined in terms of gender, presence of a sibling, order of birth, mother's employment status, socio-economic level, and parents' level of education. As a result of this analysis, 20 children were selected randomly out of the 45 who had similar qualities. Ten of these children were girls and the other 10 were boys. Ten children were assigned to the experimental group and the other 10 were assigned to the control group.

Materials

Drama Based Number and Operation Education Program

In order to support children's acquisition of the concepts of number and operation, a "Drama Based Number and Operation Education Program" was designed by the researchers. During the preparation of this program, the Preschool Curriculum (2006) developed by the Turkish Ministry of Education to be applied in public kindergartens was used (MEB, 2006). In designing the education program, those objectives relating to the concepts of number and operation in the cognitive domain of the Preschool Curriculum (2006) were chosen, and the program was developed in line with these objectives. Since the activities in the education program are drama based, unity in these activities was achieved by choosing objectives from the Preschool Curriculum (2006) related to psychomotor, socio-emotional and language development. In the preparation of the education program, the contents of the "Test of Numbers and Operations for 48-86 Month-Old Children", developed by Aktaş et al (2003) and used as pre and post test, was also taken into consideration. The "Test of Numbers and Operations" involves rhythmic counting, writing numbers, recognizing numbers, matching numbers, invariance of quantity, ordinal numbers, the value of the last number in an object group (cardinal number), and addition and subtraction. Taking into consideration this sequencing in the test, drama activities were designed to achieve the objectives chosen from the Preschool Curriculum (2006) related to the acquisition of the concepts of number and operation. While preparing the activities in the education program, the various stages of drama were taken into consideration and each activity was designed to include the stages of warm-up, play, and evaluation. In this way, an education program with a total of 24 drama activities was designed. The draft education program was presented for the review of several professionals in the fields of curriculum development, mathematics education, and drama education. They analyzed the draft program in terms of its aims, mathematical appropriateness of the concepts of number and operation, and the potential of combining these concepts with drama activities. Their feedback was used to make the necessary revisions. The program was then reevaluated and finalized.

Test of Numbers and Operations for 48-86 Month-Old Children

The "Test of Numbers and Operations for 48-86 Month-Old Children" was administered as pre and post test in the study in order to determine the efficiency of the Drama Based Number and Operation Education Program which was designed by the researcher. The test was prepared by Aktaş et al (2003) in order to assess 48-86 month-old children's knowledge of the concepts of number and operation. It consisted of 88 items based on the Denver Developmental Screening Test, Portage Early Childhood Education Program, mathematics test books for preschool children, and various sources used in mathematics instruction. The KR-20 internal consistency coefficient for the overall test was 0.98. In addition, internal consistency was computed for age groups and it was observed that KR-20 values ranged between 0.97 and 0.98. These results show that the test has high internal consistency. In another study carried out for the reliability of the test, the Pearson Product-Moment Correlation Coefficient was computed as 0.97. For the criterion validity of the test, the "Test of Early Mathematics Ability 2" was used as a criterion. In the study, both tests were administered to 188 children and the Pearson Product-Moment Correlation Coefficient was computed based on the results obtained. A relationship of 0.31 was found between the two tests (Aktaş et al., 2003).

Inquiry Form

The inquiry form used in the study was prepared by Erdoğan (2006). The form contained five questions about children's date of birth, gender, number of siblings and order of birth, as well as the age and level of education of their parents, and the work status of their mothers.

Procedure

Initially, the "Test of Numbers and Operations" was administered to the experimental and control groups as a pre test. Then, the Drama Based Number and Operation Education Program was implemented on the experimental group three days weekly, for a duration of six weeks. These implementations were in the form of sessions averaging one hour in length, between 9:00-10:00 in the mornings. After each implementation, evaluation studies were carried out and children's opinions concerning the

Table 1. Arithmetic Means And Standard Deviations Of The Numbers And Operations Pre And Post Test Results For Experimental And Control Groups

Groups	Pre test		Post test	
	$\bar{X}$	S	$\bar{X}$	S
Experimental (n=10)	27.80	11.53	56.70	7.41
Control (n=10)	26.20	11.14	43.80	13.20

Table 2. ANOVA Results Of Pre And Post Test Scores Received From The Numbers And Operations Test

Source of Variance	Sum of Squares	Sd	Average of Squares	F	*p*	η^2
Intergroups						
Group (Experiment/Control)	5405.625	1	5405.625	94.68	**.000****	.840
Error	3347.250	18	185.958			
Intragroups						
Measurement (Pre test, Post test)	525.625	1	525.625	2.82	.110	.136
Group*Measurement	319.225	1	319.225	5.59	**.029***	.237
Error	1027.650	18	57.092			
Total	4374.90	36				

*p<0.05 **p<0.01

implementation were obtained. The control group, on the other hand, followed the regular kindergarten curriculum. After the education program was complete, both groups were given the “Test of Numbers and Operations” as a post-test.

RESULTS

The Success of the Education Program and the Concepts of Number and Operation

As can be seen in Table 1 above, while the mean pre test score for the experimental group was 27.80, this score increased to 56.70 in the post test. In the control group, on the other hand, while this score was 26.20 in the pre test, it increased to 43.80 in the post test. After the experiment, it was observed that the mean scores increased more in the experimental group compared to the control group. In order to analyze whether this observed difference is meaningful or not, the results were evaluated by using two-factor analysis of variance for repetitive measurements repeated on a single factor, whose results are presented in Table 2.

As can be seen in Table 2 above, there is a meaningful difference between the experimental and control groups in terms of the scores obtained from the pre and post tests (F^{1}_{18} = 94.68, p<0.05). According to this finding, the success of children in both groups concerning the concepts of number and operation differs irrespective of being before or after the experiment. When the children’s group and their pre and post test results were analyzed together, it was observed that its common effect on children’s concepts of number and operation was meaningful (F^{1}_{18} = 5.59, p<0.05). This demonstrates that the number and operation achievement of children in the Drama Based Number and Operation Education Program was different from the observed number and operation achievement of children in the control group who did not receive this education. In other words, the number and operation achievement of children in the experimental and control groups varied with drama education. Undergoing the education program caused an increase in the achievement of the concepts of number and operation. There is a wide range of influence for the analysis (η^2=0.24). According to this influence range, 24% of the variance observed in the number and operation achievement scores of the experimental and control groups in pre and post tests can be explained by the experimental conditions. Since the common effect size is meaningful, the source of this difference was examined on the basis of row (p, A)

Table 3. q Values For The Differences Between Cell Averages

Factor	Level	Pre test- Post test[a] Q	Experiment- Control[b] q
Group (A)	Experimental	12.09*	-
	Control	7.37	-
Measurement (B)	Pre-test	-	0.09*
	Post-test	-	0.73*

[a]q table value, 2.98 for α=,05, r=2 and sd=18.
[b]q^1 critical value was calculated as 2.98 for α=.05.
*p<0.05.

Table 4. Mann-Whitney-U Test Results Of The Experimental Group According To Gender-Based Pre And Post Test Scores

Gender	N	Pre-test				Post-test			
		Rank order Av.	Sum of Rank order	U	p	Rank order Av.	Sum of Rank order	U	p
Female	5	4.60	23.00	8.00	.347	4.20	21.00	6.00	.175
Male	5	6.40	32.00			6.80	34.00		

and column (q, B) with Tukey q statistics and the results are presented in Table 3.

The mean scores presented in Table 3 above show that the mean achievement scores of the experimental group was meaningfully higher than the control group both before and after the treatment. While the mean post test scores of participants in the experimental group increased meaningfully, such a difference was not observed in the post test scores of participants in the control group.

The Effects of Gender on Number and Operation Achievement

According to Table 4 above, when the Mann-Whitney U Test was conducted on the pre test mean rank scores of experimental boys and girls, no statistically meaningful difference between the two genders was found (U=8.00 p>0.05). Similarly, when the mean rank of experimental girls' and boys' post test achievement scores were considered, no meaningful difference was found (U= 6.00, p>0.05). It was thus concluded that gender did not have a significant effect on the numbers and operations achievement scores of girls and boys in the experimental group. It can be said that the success of number and operation concepts is independent of the variable of gender. The education given to the experimental group did not create a meaningful difference between the developmental levels of participants according to their gender.

The Effects of the Presence of a Sibling on Number and Operation Achievement

As presented in Table 5 below, the results of the Mann-Whitney U Test conducted on the pre test mean rank orders of the experimental children who did and did not have siblings showed no statistically meaningful difference between these two groups (U=8.00 p>0.05). Table 5 also shows that there is not a meaningful difference in the mean rank order of the post test scores of the two groups (U= 6.00, p>0.05). The analysis results thus revealed that the presence of a sibling does not have a significant effect on the number and operation achievement scores of children in the experimental group. According to these findings, it can be said that number and operations success is independent of the variable of the presence of a sibling. The education given to the experiment group did not create a meaningful difference in the developmental level of participants with and without a sibling.

DISCUSSION

The aim of this study was to analyze the effects of using the drama method in helping five-year-old pre-

Table 5. Mann-Whitney U Test Results Of The Experimental Group According To Pre And Post Test Scores Based On The Presence Of A Sibling

Presence of a Sibling	N	Pre test				Post test			
		Rank-Aver.	Rank-Sum	U	p	Rank-Aver.	Rank-Sum	U	p
Single Child	4	6.50	26.00	8.00	.394	7.00	28.00	6.00	.201
Child with a sibling	6	4.83	29.00			4.50	27.00		

school children gain the concepts of number and operation. The results of the study showed that mathematical activities taught through drama were more effective in making children gain these concepts when compared to traditional education. This finding is similar to the results of an earlier study which involved the use of a drama education program with preschool children, carried out by Erdoğan (2006). In addition, the results of the present study also show similarities to those of previous studies conducted in different levels of education (Sözer, 2006; Soner, 2005; Fleming et al., 2004; Jackson, 1997). This study and others in the literature emphasize the benefits of using effective methods and techniques such as drama in making preschool children gain mathematical concepts and skills. Since concept and skill education through drama encourages children to explore on their own, learn things first hand, and become actively involved in the process, learning becomes permanent and more effective. Drama presents abstract concepts in a concrete way, supports children's learning by building new concepts on their intuitive experiences, and makes learning fun. While implementing drama techniques in this study, it was observed that children did not grow tired of learning abstract concepts such as numbers and operations, and they enjoyed participating in the activities. This may be attributed to the inherent game-like structure of drama. Making children gain mathematical concepts and skills in preschool through the use of appropriate methods and techniques is important for their future success, as it prevents mathematics anxiety and overcomes deficiencies which stem from various socio-economic drawbacks (Starkey et al., 2004; Botha et al., 2005; Wolfgang et.al., 2003; Güven and Balat, 2006).

The results showed that there was not a meaningful difference in the number and operation pre and post test mean scores of children who were attending the Drama Based Number and Operation Education Program with respect to gender and the presence of a sibling. A review of the literature also suggests that the variable of gender does not have an important effect on children's mathematics success or on using methods such as drama or cooperative learning (Erdoğan, 2006; Aunio et al., 2004; Benigno and Ellis, 2004; Yıldız, 1998). However, it may be believed in this study that the variable of gender did not create a meaningful difference as the drama activities were not implemented with only one gender, and the participation of both sexes and a group dynamic was encouraged.

Family support is crucial as children study mathematics at home after school. In this study, it was thought that the number of children within a family might affect the family's involvement with their children, and it was therefore assumed that the mathematical skills of children with and without any siblings may be different. There are, after all, previous studies which assert that the number of children and family support determine children's mathematics success (Benigno and Ellis, 2004; Güven, 1997). In this study, however, the variable of a sibling did not cause a meaningful difference in the outcomes of the drama based number and operation education program. In other words, it can be said that children with and without siblings benefit equally from the drama based number and operation education.

As mentioned before, research has shown that various methods and techniques used in mathematics education are effective in making children learn mathematical concepts and skills (Wolfgang et al., 2003; Sancak, 2003; Starkey et al., 2004; Bermejo et al., 2004). It is a well-established fact that when children are presented with activities based on their nature and in situations where their five senses are active and a rich environmental context is offered, learning becomes enjoyable, easy and permanent. Thus, choosing effective methods and techniques in making preschool children gain mathematical concepts and skills is of utmost importance. This study has shown that drama, an alternative practice in mathematics education, is a largely appropriate method for young children to acquire mathematical concepts and skills. Considering that drama helps build new knowledge and skills on top of existing ones, presents first hand

experiences to children, and supports learning through exploration, it would be helpful to teach children mathematical concepts and skills by using this method. In addition, supporting children's existing knowledge with experiential drama activities provides positive results. However, it is important to have teachers who are able to design activities which combine mathematics and drama, and are appropriate to the children's age.

CONCLUSION

In this study, which was designed to determine the effectiveness of the drama technique in conveying the concepts of number and operation to preschool children, it was determined that drama has an important effect on making five-year-old children learn numbers and operations. Although drama is not a widely preferred method in mathematics education, the few number of studies in this field and this study in particular, has shown that drama education is considerably successful in making children gain mathematical concepts and skills. In addition, the use of drama based mathematics activities may prevent children from developing negative attitudes and anxiety related to this field. In this study, the gender of the participants in the Drama Based Number and Operation Education Program and the presence of a sibling in their families did not have a meaningful effect on the benefits these children derived from the program. To sum up, the drama method helps preschool children in the pre-operational stage turn abstract concepts into concrete ones; allows them to explore, gain firsthand experience, and become actively involved in the process; and makes learning fun. Therefore, it can be safely used in the education of abstract concepts such as numbers and operations. Such abstract concepts should be presented by making use of various methods and techniques in preschool institutions. This study reveals that presenting the concepts of number and operation through drama supports the development of these concepts. In light of these findings, it is evident that methods and techniques that involve concrete learning experiences should be used and promoted in preschool institutions.

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