

Analyzing Efficiency of Two Different Methods involving Acquisition of Operational Skills by Preschool Children

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This study, an education program was developed to improve addition-subtraction skills of 6-year old children using educational toys and smart boards. The program was implemented with children, and its effects on their operational skills were analysed. The study group of the research is composed of 90 children who attended preschool classes in Konya during the 2011-2012 academic year; 30 of them (13 females and 17 males) attended an educational program using smart boards, 30 of them (16 females and 14 males) attended a program using educational toys and 30 of them attended an educational program using traditional methods. The results of the study suggest that children acquire operational skills at a higher degree through using the smart boards and educational toys methods when compared to traditional teaching. On the other hand, there is no meaningful difference between the smart boards and educational toys methods in terms of acquiring addition skills. Yet, in terms of acquisition of subtraction skills, there is a meaningful difference in favour of the educational toys method.

Keywords: preschool mathematics education, addition-subtraction skills, smart boards, educational toys

INTRODUCTION

All over the world, the importance given to preschool education and especially to mathematics education in preschool has been gradually increasing. Particularly, in the reports and standards introduced in international studies, the emphasis on the importance of mathematics education during the preschool period is gradually increasing. NCTM (2000) which is one of the most influential mathematics education institutions in the world included preschool period in the standards it

set out for school mathematics. This is one of the indications that preschool age mathematics education is now gaining more attention. Furthermore, while there was a widespread understanding in the past that simple activities such as counting should be included in activities which young children can easily learn in mathematics education, recently program comprising many mathematical concepts that would make children more prepared for the years ahead have been developed (Griffin, 2004). For example, in the British program, counting, addition and subtraction operations are introduced at the age of 1, and counting, addition and subtraction operations are repeated at the age of 2; fractions are introduced at the age of 3, and dividing and multiplying are completed at the age of 4 (Butterworth, 2005).

It has become accepted that as people improve themselves in acquiring mathematical knowledge and skills and have a liking for mathematics beginning from

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State of the literature

- The literature concerning math education in preschool, suggests that the effects of various methods and approaches on improving mathematical skills of children have been investigated.
- However there is a gap in the literature on using educational toys and smart boards to help 6-years old children to acquire their operational skills.

Contribution of this paper to the literature

- The aforementioned gap in the literature is addressed in this paper by examining how new math education methods influence the success of 6-years old children in pre-school.
- This study explores the effect of a new educational program which includes educational toys and smart boards on childrens' operational skills
- The main assumption of the current research is educational toys and smart boards cause a meaningful increase in children's success scores compared to the traditional methods.
- The study aims to lead pre-school teachers to utilize modern and techological methods such as educational toys and smart boards instead of traditional and repetitive methods which are used for math education.

childhood years, they have an advantage in advancing the development of their mathematics proficiency. For this reason it is very important to support children beginning from the first time they encounter formal mathematics education so that they will enjoy mathematics while learning, and not be scared of mathematics exercises. As a result we hope they will like and be excited about mathematics and form a positive attitude towards the subject.

This goal can be achieved by integrating rich educational experiences that are provided during early childhood with modern learning approaches. In other words, there is a necessity for efficient learning environments where preschool children can have convenient educational experiences in order to improve mathematical terms and skills that they will use in the following years. Therefore, mathematical activities in preschool program should be carefully planned. Teaching methods and materials that are to be used should be determined in compliance with the objectives.

Furthermore, children should be provided with experiences (Charlesworth, 2005; Butterworth, 2005; Peker and Mirasyedioğlu, 2008; Tucker, Singleton and Weaver, 2002) involving addition and subtraction operations using tangible objects. They should be provided with experiences and processes where they can

enjoy learning mathematics, show interest and feel excited about the subject (Poyraz and Turhan, 2006). The use of educational toys and smart boards are among the most efficient methods which give children the opportunity to enjoy the subject while they are learning mathematics with tangible objects.

A literature search suggests that in the studies carried out for the purpose of determining teaching methods and materials which are efficient in improving mathematical skills of children in preschool age, the use of drama (Sezer, 2008; Erdoğan, 2009), games (Young-Loveridge, 2004, Şirin, 2011; Türkmenoğlu, 2005), cooperative learning (Yıldız, 1999), music education (Karsal, 2004), story technique (Raida, 1999), computers (Trisha, 1999), the constructivist approach (Kırlar, 2006) and Montessori method (Yiğit, 2008) have been analysed. It was noted that no study has been carried out on the efficiency of educational toys and smart boards in improving children's mathematical skills.

In this study, therefore, an educational program has been developed by researchers where educational toys and smart boards are used to help 6-year old children to acquire operational skills efficiently. This program was implemented with children attending preschool education institutions to examine their effects on their operational skills.

METHOD

The study group of the research was composed of 90 children attending preschool classes in Konya during the 2011-2012 academic year; 30 of them (13 females and 17 males) attended an educational program using smart boards, 30 of them (16 females and 14 males) by using educational toys and 30 of them attended an educational program that used traditional methods. While determining the schools to be part of the study group, the similarity of socio-economic levels, similarity between school success and opportunities, easy access and time factors were taken into consideration. In choosing classes in the schools, teachers' opinions, student traits and structure of the classes were also taken into consideration. In line with these data, without disturbing the structure of the classes, available intact classes were chosen using the cluster sampling method. Moreover, which group would be the control group or experimental group was decided with impartially. In order to determine whether input behaviours differed in terms of operational skills of the groups, the "Scale for Operational Skill of Preschool Children (6-year olds)" was administered as pre-test. Table1 provides values of pre-test average scores and standard deviations of the children who were involved in the empirical pre-operational smart boards technique, educational toys technique and traditional education.

Table 1. Arithmetic average and standard deviation values related with pre-test scores of addition and subtraction skills of the groups

Methods	N	Addition X	Addition Ss	Subtraction X	Subtraction Ss
1- Smart Board	30	10.33	7.64	9.16	7.26
2- Educational Toy	30	9.46	3.63	7.63	3.76
3- Traditional Methods	30	9.80	2.41	6.70	2.23

Table 2: ANOVA results on pre-test scores related with addition skills of groups

Source of Variance	Sum of Squares	Sd	Mean Squares	F	P	Significant difference
Between Groups	11.467	2	5.733			
Within Groups	2248.933	87	25.850	.222	0.80	-
Total	2260.400	89				

Table 3: ANOVA results on pre-test scores related with subtraction skills of groups

Source of Variance	Sum of Squares	Sd	Mean Squares	F	P	Significant difference
Between Groups	93.067	2	46.533			
Within Groups	2087.433	87	23.993	1.939	0.15	-
Total	2180.500	89				

In order to determine if there was a significant difference between the pre-test scores of the groups and among which groups there were differences, a One-Way Analysis of Variance was carried out. The results are summarised in Tables 2 and 3.

As can be seen from Tables 2 and 3, according to the results of one-way analysis of variance, no significant difference has been obtained among arithmetic average scores on the pre-test scores of the children who were to be provided education in environments with smart boards, educational toys and traditional learning ($F(0.222) = .080$; $F(1.939) = 0.15$, $p > 0.05$). In view of this finding, it can be said that the academic successes of the groups are similar before the experiment and are not significantly different from each other. In other words, assuming that uncontrollable independent variables will affect the groups in the same way, it can be said that the differences in children's acquisition of operational skills can be attributed to the procedures to be implemented on the groups.

Assessment Instrument

The scale has been developed by the researcher. The draft scale which was developed after studying the extant literature was submitted to ten experts to solicit their opinions. These experts had carried out studies on preschool mathematics education in particular and on preschool education in general. During the pre-test phase, the scale consisting of 20 items was administered to 50 preschool students. Necessary changes were made based on the feedbacks from students and draft scale was modified to obtain its final form. During the next

phase, the scale was administered and analyses were performed to determine the distribution of scale scores.

The results of the analyses indicated that the KMO value of the scale was .95 and also the Bartlett Test was significant (Chi-square=4.12, $df=19$, $p=0.00$, $p < .05$). These results indicate that the data are suitable for carrying out a factor analysis. Varimax Rotation and Rotated Component Matrix that was carried out indicate that the loading of the first factor of the Operational Skills Scale for Preschool Children varied between 0.72 and 0.81; and loading of the second factor varied between 0.54 and 0.83. Examining the total variance obtained as a result of Components Analysis, the two factors explained 72.66% of the total variance. The findings indicate that the first factor explains 39.68% of the total variance while the second factor explains 32.98% of total variance. These results show that the scale developed to determine operational skills of 60-72 month-old children fully assessed this structure and achieved the goal. It is observed in the results of analysis that correlation coefficients associated with items of the scale varied between .81 and .89 in the first subscale and between .80 and .85 in the second subscale.

Reliability results of the scale suggest that the Spearman Brown reliability coefficient is .91 and Cronbach's alpha reliability coefficient is .97. Accordingly, it can be said that the scale has internal consistency. A t-test, as an indication of reliability of the scale, was carried out to compare the upper and lower 27%. The statistical analysis suggests that the difference between upper and lower 27% is significant ($p < 0.001$). Moreover, the split-half reliability of the scale was found to be 0.84. The item discrimination analysis indicated that for the first factor, the factor correlation

coefficients varied between 0.78 and 0.85; for the second factor they varied between 0.64 and 0.81. Each item was in a positive and meaningful relationship with the general factor ($p < 0.001$). These coefficients indicate that the level of factors were found to serve its general objective.

Procedure

Before preparing addition-subtraction programs using smart boards and educational toys, the researchers carried out a literature review related with mathematics education in preschool period and technology in preschool education. In this literature review, theoretical grounds were first established with regards to the acquisition process of operational skills (addition-subtraction skills) by 60-72 month-old children. In the sources within the literature, it is mentioned that preschool children could achieve addition and subtraction operations related to verbal problem cases with tangible objects between numbers 1-10 which were presented to them, for example, "I had two balls and I bought another one, now how many balls do I have in total?" instead of asking "What is two plus one?" (Butterworth, 2005; Diaz et al., 2009; Gifford, 2005; Gilmore and Braynt, 2006; Greenberg 1994, Kamii and Housmann, 2000; Lansdell 1999, McCrink & Wynn, 2004, Slaughter, Kamppi, & Paynter, 2006; Tucker, Singleton and Weaver, 2002; Zhou and Wang, 2004; Zur and Gelman, 2004;). In the course of researches into addition-subtraction operations with children, it is advised that the meanings of symbols such as "+" "-" "=" should be explained (Nair and Pool, 1991); that the teacher should urge the children to realize the order of numbers after adding one to the total number of given object group, and afterwards to carry out operations of adding zero (0) to the total number where the children should be made to realize that adding zero does not change value of the total number; and the fact that changing places of numbers which are added to each other does not affect the result ($2+3=5$, $3+2=5$ etc.) should be also indicated (Butterworth, 2005).

It was determined that there are four different problems cases suitable for the subtraction operation with children in preschool age. These can be listed as problems of casting, equalizing, separating and comparing (Hatfield, Edwards and Bitter, 1997; Kamii, 2000). Also, in the Ministry of National Education Preschool Education Programme booklet, operational skills that 60-72 month-old children in preschool period should acquire are stated as "doing simple addition and subtraction operations using objects".

In the light of this information, the researcher prepared an education program to be implemented with smart boards. In the program, a software which allows

the children to do addition between numbers 1-10 was designed. Figure 1 illustrates the computer screen of the first part related to the addition operation. In this computer game, daisies are used to give the children the opportunity to do operations with tangible objects. The daisies are lined up side by side and the children are expected to realize that number 1 is small while number 9 is larger. "+" and "=" signs are also included in the operation part on the screen. Children are required to drag by hand into the empty box two of numbered daisies they like. Since the sum of the operation must not exceed 10, only ten empty boxes are provided. When the child drags 7 daisy groups, green empty boxes are filled with daisies. As 8 daisy groups are desired to be dragged, the system will not allow this. This process compels the child to find the right daisy group that he/she needs to complete number 7 to number 10.

In the second part of the computer program, the aim is to make children realize that changing places of numbers that are added in an addition operation does not make any difference on the result. After the child does the operation in the first part, when the second part button is pressed, the places of the numbers in the former operation will change whereas the result will be the same which will indicate that changing places of numbers does not affect the result. Figure 2 illustrates the computer screen of the second part of the addition operation.

In the subtraction operation, there are sound recordings on Caillou's casting, equalizing, separating and comparing problem cases. For instance, Caillou speaks "I have 1-2 flowers. (just after this sentence, two flowers appear on the left hand corner of the screen) One day, 1 of my flowers withered. (following that sentence one of the flowers withers.) I took the two flowers, which withered, out of my garden. I wonder how many flowers I have now. Can you help me by placing flowers into my garden to find out how many flowers I have?" In this process, operation numbers on the right hand corner of the screen also appear on the screen. The child is required to find the results from the daisies below and drag them with his/her finger to the part containing the question mark. Considering children's capability to do operations through tangible materials, while preparing the program it was planned that daisies are present as many as the numbers in the operations, and after the flowers wither as many as the number to be subtracted.

While preparing the program with educational toys, toys which would provide coloured and tangible materials for children were designed. The children were provided with 5 different educational toys. With each toy, the studies went on for two weeks.

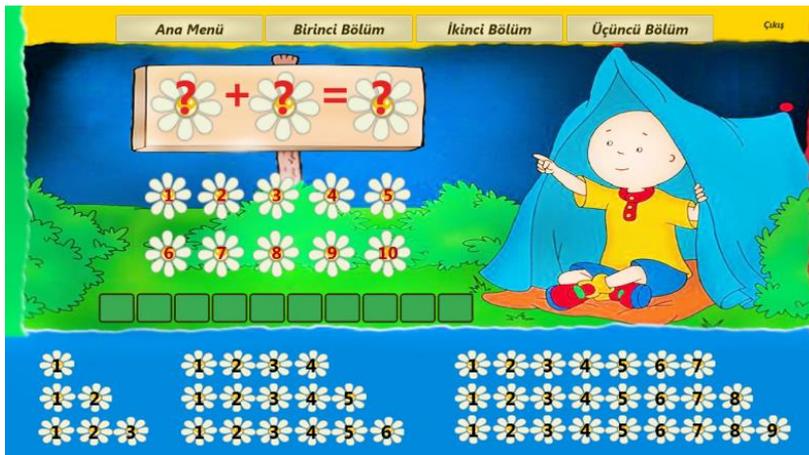


Figure 1. The computer screen of the first part of the addition operation

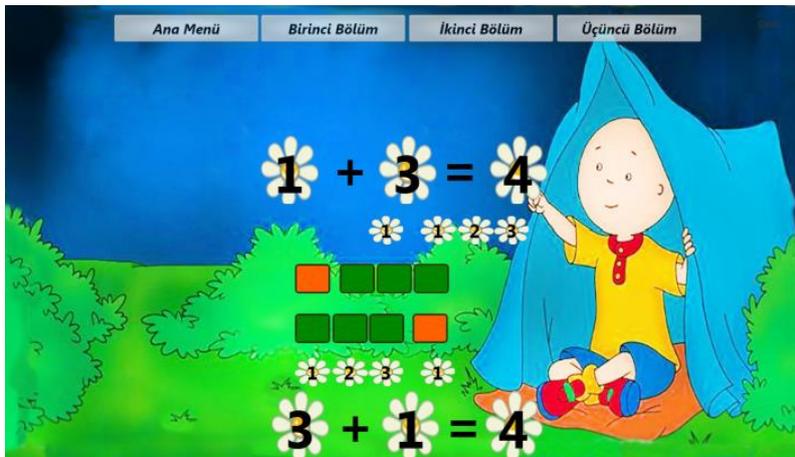


Figure 2. The computer screen of the second part of the addition operation



Figure 3. The computer screen the subtraction operation

No special program was prepared for the class where the traditional education program was implemented, and the class teacher was not interrupted in the activities he carried out. It was observed that the teacher carried out activities using picture-study sheets.

Prepared education programs were implemented for a total of 10 weeks (2 days per week) in the second term of the 2011-2012 academic year. Before implementing the program and just after implementing it, the children

in the group were given the “Scale for Operational Skill of Preschool Children (6-year old)” personally by the researcher.

Analysis

In order to test the effects of addition-subtraction teaching on children’s operational skills based on programs provided to the children using smart boards,

educational toys and the traditional methods, the average post-test scores of the “Scale for Operational Skills of Preschool Children (6-year old)” were compared with One-Way Analysis of Variance (Anova). The LSD Test was done in order to determine among what groups there was a significant difference as a result of the ANOVA analysis. While evaluating differences among groups, the arithmetic average value and significance value were taken into consideration depending on the results of analyses.

FINDINGS

The first hypothesis discussed in the research is: “the addition-subtraction program provided with smart boards will cause a meaningful increase in children’s success (post-test) scores compared to the traditional methods”. The second hypothesis is: “the addition-subtraction program provided with educational toys will cause a meaningful increase in children’s success (post-test) scores compared to the traditional methods”. The third hypothesis is: “the addition-subtraction program provided with smart boards and educational toys will not cause a meaningful difference in children’s success (post-test) scores”. In order to test these hypotheses, the post-test scores (success) of children in all groups were compared following the teaching practices. Average post-test scores and standard deviation values of the children who were subjected to smart boards, educational toys and traditional education are provided in Table 4.

One-Way analysis of Variance was carried out in order to determine whether there is a significant difference among the groups’ post-test scores, and to determine the differences between the groups. Results

are provided in Tables 5 and 6.

Examining the results of analysis in Table 5, it can be seen that there is a significant difference between the methods used to teach children addition skills [$F(24.012)=0.000$; $p<0.05$]. Children’s success in addition skills varies significantly depending on the method used during education. This difference is in favour of the children who are included in groups in which smart boards and educational were utilized. In other words, addition success of children trained with smart boards ($x=17.66$) and educational toys ($x=18.66$) techniques is greater ($p<0.000$) than those children who are trained with traditional techniques (12.23). Moreover, addition operation success of children trained with the educational toys technique is greater than those who are trained with smart boards. Yet, this difference is not a significant difference among groups. Consequently, education given with smart boards and educational toys has a positive effect on children’s operational skills and makes them more successful when compared with traditional education.

Examining the results of analysis on Table 6, it can be seen that there is a significant difference between the methods used to teach children subtraction skills [$F(22.524)=0.000$; $p<0.05$].

Children’s success in addition skills varies significantly depending on the method used during their education. This difference is in favour of the children who are included in groups which used smart boards and educational toys. In other words, subtraction success of children trained with smart boards ($x=14.33$) and educational toys ($x=18.50$) techniques is greater ($p<0.000$) than those who are trained with traditional methods (9.50). Furthermore, subtraction operation success of children trained with the educational toys

Table 4. Arithmetic average and standard deviation values related to post-test addition and subtraction skills scores of groups

Methods	N	Addition X	Addition Ss	Subtraction X	Subtraction Ss
1- Smart Board	30	17.66	4.30	14.33	7.27
2- Educational Toy	30	18.66	2.21	18.00	2.49
3- Traditional Methods	30	12.23	4.63	9.50	3.66

Table 5. ANOVA results related with groups’ post-test scores associated with addition skill

Source of Variance	Sum of Squares	Sd	Mean Squares	F	P	Significant difference
Between Groups	719.089	2	359.544			1-3
Within Groups	1302.700	87	14.974	24.012	0.00	2-3
Total	2021.789	89				

Table 6. ANOVA results related with groups’ post-test scores associated with subtraction skill

Source of Variance	Sum of Squares	Sd	Mean Squares	F	P	Significant difference
Between Groups	1090.556	2	545.278			1-3
Within Groups	2106.167	87	24.209	22.524	0.00	2-3
Total	3196.722	89				1-2

technique is greater than those children who are trained with smart boards ($p < 0.005$). Consequently, it can be claimed that the education provided with smart boards and educational toys has a positive effect on children's operational skills, yet education provided with educational toys is more successful.

DISCUSSION

The research basically asserts that addition-subtraction operational skills which are among the basic mathematical skills to be attained by children during preschool period can be acquired starting from that period, and preschool mathematics programs can be successfully implemented using smart boards and educational toys in order to improve operational skills. According to the results gathered from the study, children acquire operational skills at a higher level with methods using smart boards and educational toys when compared to traditional education.

Studies in which mathematic program using smart boards and educational toys methods are used to teach mathematical skills support the results of this research. For instance, Ekici (2008) examined the effect of using smart boards on students' mathematical success in primary school found that students who were given education with smart boards were more successful.

Lopez (2010) taught foreign language (reading) and mathematics to 3rd and 5th grade students using smart boards. He found that the use of smart boards had a positive effect on children's academic success. Morgan (2010) observed children aged between 3 and 7 who were using smart boards. He stated that the smart board is a suitable instrument for cooperative teaching and that teachers should consider using the smart board as an interactive instrument.

Moreover, it is emphasized in studies that the smart board maintains children's attention since it provides viewing the images more efficiently by giving the opportunity to see on a larger screen, and it aids achieving learning objectives (Mechling, Gast and Krupa, 2007). It is asserted that using technology in education helps children to recognize their performances and incompetency through interaction, and controls their learning by providing feedback. In addition, children pay more attention to the lesson through graphics, sounds, animations and figures, and have highly-motivating learning experiences (Clarke, 2001; Cooper and Brna, 2002). In the research carried out by Glover, Miller, Averis and Door (2007) they observed classes in a primary school where smart boards were used, and they concluded that the smart board increases attention and motivation towards learning. Hwang, Chen and Hsu (2006) found that using smart board while solving mathematical problems helps students to develop a positive attitude towards smart

boards. BECTA (2003) data also indicate that smart boards have a positive effect on learning and teaching processes.

In his research where Davun (1997) developed visual instruments to improve the concept of numbers among nursery class students, he found that practical, colourful toys which have convenience of usage are useful for children, and while playing with them they practice what they have learned and in that process children learn more efficiently. In their studies, Gilmore and Braynt (2006) suggested that using tangible objects and various presentation methods have a positive effect on mathematical thinking of the children. Artut and Tarım (2006) carried out a study in order to improve preschool children's addition and subtraction skills by means of cooperative learning, and they found at the end of their study that children are more successful in addition and subtraction operations with tangible materials compared to those with semi-tangible materials.

Chao, Stigler and Woodward (2000) studied the effect of two educational toys (one of them is the tile and the other one is objects in various structures used in order to indicate the number), which they designed for nursery school students to successfully learn the concept of number. They devised nine games for children to learn basic numbers. At the end of the study, it was found that these two different materials have different effects on learning. Yiğit (2008) compared the efficiency of the Montessori teaching method with traditional teaching methods in helping children aged 4-5, attending preschool institutions, to acquire the concept of number. In the Montessori approach, mathematical terms are introduced to the children through educational materials, and the most fundamental feature of these materials is that they use abstract terms. This allows children to move from the tangible towards intangible, and to improve their problem solving skills.

Moreover, in the case of acquiring addition skills, it was determined that there is no significant difference between the smart board and educational toy methods. Tataroğlu (2009) found that this did not create a remarkable difference for 10th grade students in terms of academic success for the subject of quadratic functions. This result is similar to the findings of our research. Synthesizing the results of this research with those of others, it is understood that when compared to traditional methods, the programs prepared with the educational toy and smart board methods are more student-centred, more attention grabbing, help children to acquire operational skills more efficiently, motivate students more in the process of learning and form more positive attitudes towards mathematics. Nevertheless, it is also understood that the use of smart boards is not efficient in all fields related to operational skills: the smart boards and educational toys methods can be used in studies related to the addition operation, yet the

educational toys method should be preferred in studies related to the subtraction operation.

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