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Investigation on the Effects of Activity-Based Science Teaching Practices in the Acquisition of Problem Solving Skills for 5-6 Year Old Pre-School Children*

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ABSTRACT

This research study was conducted to examine the effectiveness of activity-based science teaching practices on the acquisition of problem-solving skills for 5-6 year old preschool children. A total of 32 children were included in this research study. The Personal Information Form and 4-7 Age Problem Solving Ability Scale were used as the data collection tools in the study. Pre-test-post-test control group design was employed. In the experimental group, activity-based science teaching practices prepared by researchers of this study were implemented in 12 weeks (24 integrated activities). In the control group, there was no specific implementation related to problem solving skills other than the Turkish Ministry of National Education Preschool Curriculum. In the analysis of the data, Mann-Whitney U and Wilcoxon Signed-Rank tests were administered. Results showed that activity-based science teaching practices were effective in improving preschool children's problem solving skills.

Keywords: Preschool period, problem solving skills, activity-based science teaching practices, early childhood education, early science education.

INTRODUCTION

Early childhood is one of the most critical periods of life in which the bases of personality are laid; basic knowledge, skills, and habits are acquired and developed (Arı, 2003). In Turkey, preschool education covering the ages of 0-6 is critical in terms of providing inquiry, questioning, asserting, innovation, confidence and problem-solving skills (Bertan et al., 2009).

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Curious children in the preschool period may gain experiences by discovering their surroundings. Through the experiences gained in this period, a child develops his/her skills such as active participation in the process, researching, curiosity, finding solutions to problems, analysis, synthesis and multi-faceted thinking (Aydoğan, 2004; Zembat & Unutkan, 2003). Children begin to show problem solving behaviors from early young ages. Thus, children who identify problem situations can investigate the causes and consequences, create thinking processes and choose appropriate solutions. For this reason, problem-solving skills are one of the most basic and critical skills that children can use throughout their life.

Considering that the behaviors gained at early ages are permanent, it is important to provide problem-solving skills in preschool and primary education and support problem-solving skills from the first years of life (Aydoğan, 2004). Previous research studies were mostly related to the importance of improving children's problem solving skills to overcome potential future problems, specification of problem solving skills and how to develop necessary problem solving skills. (Anlıak & Dinçer, 2005; Aydoğan 2004; Dereli-İman, 2014; Doğru, Arslan & Şeker, 2011; Kesicioglu, 2015; Ünal & Aral, 2014a; Yıldırım, 2007, 2014).

One of the areas where problem solving skills are essential is the science field. In the preschool period, concepts and information about science are not transferred to the children, but children learn by doing and living (Aktas Arnas, 2002). When children actively engage in science activities, they can improve their problem solving skills, which is one of the objectives in science education. (Ünal & Aral, 2014a). If children are allowed to participate in science activities in the early period, children can develop a sense of curiosity. Therefore, it is vital to prepare educational environments in which children can investigate, be curious, make causal relationships, have opportunities to create various ideas.

As Hadzigeorgiou (2001) noted, the appropriate time for children to develop positive attitudes towards science is in early childhood because the attitudes of the children towards science are related to their presence in science activities. In other words, creating a solid scientific basis by developing children's research and observation skills through effective science education is critical in this period. In addition, the science activities in this period to develop skills such as recognition, discovery, observation, estimation, interpretation, communication, independent thinking, problem solving have an important place (Avcı & Dere, 2002; Howe, 1996; Şahin, 1999).

In the Turkish Ministry of National Education (MoNE)'s preschool curriculum, the appropriate learning center for the realization of science education in the classroom is designated as "science centers." In these learning centers, children can develop their scientific process skills by stimulating their curiosity and desire to learn and support their learning about the physical universe in which they live. In the curriculum, science activities are stated as the activities that lead children to pay attention, ask questions, wonder, observe, research, examine, explore, and make sure that children use their scientific process skills while gaining first-hand experiences. Through these activities, environmental awareness can be provided for children while introducing the realities of life. Besides, (a) walking into natural environments to observe living and non-living assets in the nature, (b) informing about the value and protection of assets, (c) making discoveries and inventions, (d) preparing food in kitchen, (e) making collections, (f) preparing seasonal or weatherboards, (g) examining books and magazines, (h) taking photographs and photographing review, (i) monitoring, recognizing and using simple tools such as magnets, magnifiers, compasses, (j) examining natural and unnatural materials, and (k) inviting professionals in the related fields as guests are activities that support science education. Experiments, concept networks, and analogy (simulation) methods are also included in science education (MoNE, 2013). Given the fact that basic science concepts begin to emerge in the preschool period when children's social-emotional, physical, cognitive, psychomotor and language development are at the fastest level (Kalley &

Psillos, 2001), it is emphasized that with the help of science education it is possible for children to understand the relationship between events and situations by observing the events in their surroundings and the nature (Hamurcu, 2003). In order to support children's development in this direction, it is important to create educational environments where they can investigate, draw curiosity, and establish cause-and-effect relationships. Doing so is possible with science events, which are activities that stimulate children's curiosity, mental ability, and research emotions (Aktaş Arnas, 2002). While preschool science activities provide students with concepts related to science and nature, these students can also gain basic skills necessary for life-long individual issues such as problem solving, scientific and multi-faceted thinking (Alisinanoğlu & Ulutaş, 2003; Güler & Bıkmaz, 2002; Karamustafaoğlu & Kandaz, 2006).

The importance and rationale of the research are considered that the behaviors gained during early childhood are permanent, and problem solving skills that are necessary and critical for life should be acquired in the preschool period. Preschool science activities and science and nature-related concepts, as well as problem solving, scientific and multi-faceted thinking such as life-long learning, are necessary to gain basic skills. Science education also supports other disciplines such as mathematics, Turkish, and play and drama. When it is considered that science education supports the development of children in all aspects of the preschool period, the role of science education, especially in supporting the cognitive development of the child, emerges. As stated in İnce Aka, Güven and Aydoğdu (2010), the method of problem solving should be effective and beneficial for increasing students' academic achievement and developing science process skills. In this context, it is important to examine the effects of activity-based science teaching practices on problem solving skills of children, in which teaching practices are prepared by taking into consideration the goals and indicators in the current curriculum, cognitive development, and developmental characteristics of children.

In the literature, there are various studies that emphasize different teaching levels and fields to develop daily problem solving skills in science classes (Balım, Deniş Çeliker, Türkoğuz, Evrekli & İnel Ekici, 2015; Osman, 2010; Rokhmat & Putrie, 2019). Besides, there are studies about children's problem solving skills supported by preschool music, mathematics, games, drama and Turkish activities (Aydoğdu & Yenilmez, 2012; Yıldırım, 2007), and other studies on science education in the preschool period (Avcı & Dere, 2002; Ayvacı, Devecioğlu & Yiğit, 2002; Büyüktaşkapu, 2010; Ünal & Akman, 2006; Ünal & Aral, 2010). In addition, there are research studies on problem solving skills in the preschool period as well as on the application of different training programs (Alabay, 2013; Anılak, 2004; Anlıak & Dinçer, 2005; Arı & Seçer, 2003; Aydoğan, 2004; Büyüktaşkapu, Çeliköz & Akman, 2012; Dereli-İman, 2014; Dereli, 2008; Dinçer, 1995; Kargı, 2009; Kesicioğlu, 2015; Önen & Gürdal, 2006; Özdil, 2008; Yıldırım, 2007, 2014; Yoleri, 2014). However, although there are research studies on problem solving in the preschool period (Ferreira & Trudel, 2012; French, Conezio, & Boynton, 2000; Hong & Diamond, 2012; Lartson, 2013; Ramani, 2005; Shiakalli & Zacharos, 2012), there are limited studies that are directly related to science education (Akkaya, 2006; Doğru, Arslan & Şeker, 2011; Ünal & Aral, 2014a, 2014b). Moreover, there has been no experimental study about science teaching practices in the preschool period in the related literature. In general, previous research studies considered science education and problem solving separately for children in the preschool period. However, there is a great deal of research on both science education and problem solving. Therefore, we aimed to determine whether activity-based science teaching practices were effective in providing problem solving skills to preschool children aged 5-6 years.

For this purpose, we aimed to answer the following research questions:

1. Was there any significant effect of activity-based science teaching practices on gaining problem solving skills for 5-6 year old preschool children?
2. Were problem-solving skills of 5-6 year old preschool children participating in activity-based science teaching practices persistent due to the effectiveness of activity-based science teaching practices?

METHODS

a) Research Model

True experimental designs describe the researches where subjects are placed in groups of independent variables at random levels. In this study, pre-test and post-test control group design, which is in the category of matched design, was used (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2009).

b) Study Group

To form participants for this study, we identified schools via analogous sampling method, which is a type of purposeful sampling method (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2009). Two classes, where children were in the same age group and similar development periods from independent preschools affiliated by the directorate of the National Education in Bolu province in Turkey, were determined. These two classes from different schools were randomly assigned as one experimental group and one control group. A total of 32 children were included in the study group as 17 children in the experimental group and 15 children in the control group.

The characteristics of the children in the study group were reported in Table 1.

Table 1. *Demographic information of children in the experimental and control groups*

		Experimental Group	Control Group	Total
Gender	Female	10	8	
	Male	7	7	
	Total	17	15	32
Age	5.5 years	10	14	
	6 years	7	1	
	Total	17	15	32

c) Data Collection Tools

In this research, we used the Problem Solving Ability Scale (PSAS) developed by Aydoğan, Ömeroğlu, Büyüköztürk and Özyürek (2012) to measure the problem solving skills of children. The PSAS aims to determine the competence of children between the ages of 4 and 7, and the cognitive processes they show in the real problem situations. The scores obtained from the scale provide data to determine situations in terms of children's problem solving skills performances. In the PSAS, the real life problem consists of 50 pictures containing situations and expressions in which the problems are defined. The scale is administered to children individually. The KR-20 reliability coefficient was calculated as 0.79 for pilot application data and 0.81 for the actual participants in this research study. The test-retest reliability calculated for the pilot sample and obtained as 0.75.

The subfactors of the scale are (1) Understanding the problem, (2) Defining the problem, (3) Asking questions about the problem, (4) Predicting the reason of the problem, (5) Deciding the effectiveness of the information to solve the problem, (6) Defining the factors of the problem, (7) Using objects differently, (8) Predicting the result of a series of actions, (9) Finding the best solution, and (10) Choosing the most unusual solution among many possible solutions.

Personal information form was used to determine the participants' demographic information. The personal information form was developed by researchers in this study.

Preparation of Activity-Based Science Teaching Practices

In each science activity prepared as an integrated activity, there was a problem in the field of science. Problem situations and problem solving skills were prepared in a sequence from a simple level to complex level. This situation is in parallel with the subfactors of the PSAS and the MoNE's problem solving skills gain used in this study in order to determine the problem solving skills of the children. While preparing activity-based science teaching practices, we let children learn by doing, considered the development level of the children, and made transitions among related activities.

Each activity in the activity area consists of concepts, target words, materials, gains, indicators, learning process, evaluation, and family participation. Twenty-four integrated activity-based science teaching practices were presented to experts in terms of (a) appropriateness of the educational activities for the targeted achievements and indicators, (b) appropriateness of the materials, concepts and target words, (c) regulation of the educational environment, (d) suitability of the learning process, evaluation and family participation. In this respect, feedback from five experts in the field of preschool education and three experts in science education were obtained. An expert opinion form prepared and the activity-based science teaching practices was finalized in line with the feedback of experts. The degree of relevance of expert opinions on the activity-based science teaching practices was calculated by taking the percentage of similarity of the views (Miles & Huberman, 1994) and found as .92. As a result, the integrated activities were found to be appropriate for the purpose of the research. Necessary corrections were made and 12-week (24 integrated activities) activity-based science teaching practices were finalized to implement for developing problem solving skills of the children.

Activity-based science teaching practices, prepared by the researchers of this study and applied only to the experimental group, were designed to support scientific processes that were considered important in the process of gaining problem solving skills for preschool children aged 5-6 years. An example of activity-based science teaching practices is provided in the Appendix. In the prepared activities, we aimed to (a) provide learning opportunities for participants to gain experience in their daily lives depending on their age and development characteristics and, (b) state the goals and achievements related to the problem solving skills with respect to the sequence of simple to difficult, concrete to abstract, general to specific, known to unknown.

While preparing the activity-based science teaching practices, firstly, the achievements and indicators included in the MoNE (2013)'s Preschool Education Program (36-72 Months) were examined. For example, cognitive development acquisition and indicators include one acquisition and seven indicators for problem solving in the program, as shown below.

Gain 19: Solves problem situations.

Indicators:

- Tells the problem.
- Suggests various solutions to the problem.
- Selects a solution.
- Tells the justification of the chosen solution.
- Tries the chosen solution.
- Select a new solution when the chosen solution cannot reach the aimed solution.

• Suggests creative solutions to the problem (MoNE, 2013).

Activity-based science teaching practices were prepared based on the achievements and indicators in the MoNE (2013) Preschool Education Program (36-72 Months), and achievements and indicators for problem solving skills developed by Aydoğan (2012). Activity-based science teaching practices were developed by associating problem situations with science areas (e.g., physics, chemistry, and biology). Additionally, achievements and indicators related to problem solving skills were also taken into consideration in developing activity-based science teaching practices. Each event prepared as an integrated activity included a problem situation in the field of science. Both the problem situations and achievements and indicators related to problem solving skills were prepared in a straightforward sequence at different complexity levels. Attention was drawn to the fact that while activity-based science teaching practices were developed, children had to learn by doing in an appropriate level of development and could do transitions among activities.

d) Data Collection

Activity-based science teaching practices were conducted for 45 minutes for each session, two days a week, on Tuesdays and Thursdays for 12 weeks. The PSAS was administrated as a pre-test before starting the implementation in the experimental and control groups. During the implementation process, there were no activity-based science teaching practices for problem-solving skills with children in the control group. Activity-based science teaching practices were implemented outside the classroom in a school in the experimental group. After completion of activity-based science teaching practices, the PSAS was applied as a post-test by researchers in the same settings and conditions under which preliminary tests were conducted in the experimental and control groups. Three weeks later, the PSAS was reapplied in the experimental group to see whether the implementation was permanent. The permanence test was applied in the same conditions and settings as in the pre- and post-test.

e) Data Analysis

Data collected via the PSAS were analyzed using an appropriate data analysis program, SPSS 20. Firstly, we used the Mann-Whitney U test to analyze differences among the sub-dimensions scores of the PSAS in the experimental and control groups. Mann-Whitney U test was used in the analysis of pre-test scores to examine the balance of the experimental and control groups before the implementation.

For the first research question, the Wilcoxon Signed-Rank test was used to see the effectiveness of the experimental procedure. Finally, the Mann-Whitney U test was utilized to analyze the post-test scores for the evaluation of groups after the experimental procedure. For the second research question, the post-test and persistence test scores of the experimental group were used because the persistence test was applied only to the experimental group. The Wilcoxon Signed-Rank Test was used in the comparison of the post-test and permanence test.

FINDINGS and DISCUSSION

Findings are covered under two headings related to the sub-objectives of the research.

1. *Findings on the effect of the activity-based science teaching practices in gaining problem solving skills for 5-6 year old preschool children*

Table 2. *Mann-Whitney U test for the difference between experimental and control groups of problem solving ability scale pre-test scores*

Pre-test			N		Rank Average	Rank total	$\bar{x}$	z	U	p
Problem solving ability scale	Total	Experimental Group	17	30.70	17.91	304.50	30.70	-0.913	103.50	0.361
		Control Group	15	28.53	14.90	223.50	28.53			

As shown in Table 1.2, Mann-Whitney U test results on the difference between the pre-test scores of the experimental and control groups indicate that there was no significant difference between the pre-test averages of the experimental and control groups (p> 0.05).

In an ideal experimental study, pre-test scores for experimental and control groups should be as close as possible (Kaptan, 1998). According to the results, it can be said that the children in the experimental and control groups had similar problem solving skills. This situation is essential to demonstrate the effect of teaching practices.

2. Findings related to the difference between pre-test, and post-test of PSAS and sub-dimensions scores of children in the experimental group

The results of the Wilcoxon Signed-Rank test on whether the children in the experimental group differed significantly in their problem solving skills before and after the activity-based science teaching practices are shown in Table 3.

Table 3. *Wilcoxon Signed-Ranks test results on the difference between the pre-test and post-test scores of the experimental group*

Experimental Group		N	Negative Rank Average	Positive Rank Average	z	P
Understanding the problem	Pre-test	17	3.50	7.29	-3.000	0.003
	Post-Test	17				
Defining the problem	Pre-test	17	0.00	7.50	-3.332	0.001
	Post-Test	17				
Asking questions about the problem	Pre-test	17	0.00	8.50	-3.545	0.00
	Post-Test	17				
Predicting the reason of the problem	Pre-test	17	3.00	7.73	-2.827	0.005
	Post-Test	17				
Deciding the effectiveness of the information to solve the problem	Pre-test	17	0.00	7.50	-3.354	0.001
	Post-Test	17				
Defining the factors of the problem	Pre-test	17	2.00	7.42	-3.101	0.002
	Post-Test	17				
Using objects differently	Pre-test	17	0.00	8.50	-3.572	0.00
	Post-Test	17				
Predicting the result of a series of actions	Pre-test	17	3.50	5.19	-2.332	0.020
	Post-Test	17				
Finding the best solution	Pre-test	17	3.00	6.30	-2.709	0.007
	Post-Test	17				

Choosing the most unusual solution among many possible solutions	Pre-test	17	0.00	8.50	-3.594	0.00
	Post-Test	17				
Problem solving ability scale total	Pre-test	17	0.00	9.00	-3.623	0.00
	Post-Test	17				

$p < 0.05$

Results of the Wilcoxon Signed-Ranks test indicated that there was a significant difference between total PSAS pre-test scores and total PSAS post-test scores ($z = -3.623$, $p = 0.00$, $p < 0.05$). This difference observed when the rank average of the difference scores of the scale was taken into consideration favoring the post-test scores. According to these findings, it can be said that the implemented activity-based science teaching practices to improve problem-solving skills enhanced the problem-solving skills of the children in the experimental group. Similarly, in a previous study, Ünal and Aral (2014b) found that an experiment based education program applied to preschool children was effective in improving children's problem-solving skills. Additionally, Şahin, Güven and Yurdatapan (2011) noted that there was a significant difference in the ability to use scientific processes at the end of the project-based education practices for preschool children. These two results support the findings in this research.

Findings and discussion on the difference between sub-dimensions of PSAS pre-test and post-test scores of children in the control group

The Wilcoxon Signed-Rank test results for the difference between PSAS pre-test and post-test scores of the children in the control group are given in Table 4.

Table 4. *Results related to the difference between the sub-dimensions of PSAS pre-test and post-test scores of children in the control group*

Control Group		**N**	**Negative Rank Average**	**Positive Rank Average**	**z**	**P**
Understanding the problem	Pre-test	15	5.750	4.79	-1.350	0.177
	Post-Test	15				
Defining the problem	Pre-test	15	5.000	6.00	-0.277	0.782
	Post-Test	15				
Asking questions about the problem	Pre-test	15	5.00	7.00	-1.979	0.048*
	Post-Test	15				
Predicting the reason of the problem	Pre-test	15	4.50	6.00	-0.577	0.564
	Post-Test	15				
Deciding the effectiveness of the information to solve the problem	Pre-test	15	3.50	6.00	-2.153	0.831
	Post-Test	15				
Defining the factors of the problem	Pre-test	15	5.75	4.40	-0.061	0.951
	Post-Test	15				
Using objects differently	Pre-test	15	4.00	6.75	-1.925	0.054
	Post-Test	15				
Predicting the result of a series of	Pre-test	15	5.50	3.90	-0.214	0.831

actions	Post-Test	15				
Finding the best solution	Pre-test	15	5.17	4.92	-0.836	0.403
	Post-Test	15				
Choosing the most unusual solution among many possible solutions	Pre-test	15	5.50	6.29	-1.069	0.285
	Post-Test	15				
Problem solving ability scale total	Pre-test	15	5.00	7.36	-2.486	0.013*
	Post-Test	15				

p <0.05*

As a result of the statistical analyses, although there was a statistically significant difference between total pre-test and post-test scores of the PSAS and asking question about the problem subscale, it was seen that there was no significant difference between pre-test and post-test scores of children in the experimental and control groups in understanding the problem, defining the problem, predicting the reason of the problem, deciding the effectiveness of the information to solve the problem, defining the factors of the problem, using objects differently, predicting the result of a series of actions, finding the best solution, choosing the most unusual solution among many possible solutions subscales. In the MoNE Preschool Curriculum (MoNE, 2013), children's achievements and indicators related to problem-solving skills are included. The increase in the post-test scores of the PSAS for children in the control group can be a demonstration that the MoNE Preschool Curriculum supports children's problem solving skills. This can be explained by the continuation of the development of children’s problem solving skills in the preschool classroom setting. The fact that preschool classrooms are social environments where carried out educational activities include problem solving skills, therefore, there is a potential increase in children's problem solving skills.

Findings and discussion on the difference between PSAS *post-test scores of children in the experimental and control groups*

Descriptive statistics for the difference between the PSAS post-test scores of the children in the experimental and control groups are presented in Table 5, and the statistics for the Mann-Whitney U test are shown in Table 6.

Table 5. *Descriptive statistics for the difference between the PSAS post-test scores of the children in the experimental and control groups*

Post-test		**N**	$\bar{x}$
Problem solving ability scale total	Experimental group	17	45.64
	Control group	15	31.66

As a result of the analysis, the average scores of the children in the experimental group were found to be 45.64 while the scores of the children in the control group were found to be 31.66. The children in the experimental group participated in activity-based science teaching practices, showed a higher level of problem-solving skills than children in the control group, who did not participate in the activity-based science teaching practices.

Table 6. *Mann-Whitney U test results on the difference between the experimental and control groups' post-test scores*

Post-test		**N**	**Negative Rank Average**	**Positive Rank Average**	**z**	**P**	**N**
Understanding the problem	Experimental	17	19.94	339.00	-2.578	69.00	0.01
	Control	15	12.60	189.00			
Defining the problem	Experimental	17	23.06	392.00	-4.491	16.00	0.00
	Control	15	9.07	136.00			
Asking questions about the problem	Experimental	17	22.82	388.00	-4.231	20.50	0.00
	Control	15	9.33	140.00			
Predicting the reason of the problem	Experimental	17	21.97	373.50	-3.678	34.50	0.00
	Control	15	10.30	154.50			
Deciding the effectiveness of the information to solve the problem	Experimental	17	21.74	369.50	-3.891	38.50	0.00
	Control	15	10.57	158.50			
Defining the factors of the problem	Experimental	17	23.47	399.00	-4.749	9.00	0.00
	Control	15	8.60	129.00			
Using objects differently	Experimental	17	22.91	389.50	-4.509	18.50	0.00
	Control	15	9.23	138.50			
Predicting the result of a series of actions	Experimental	17	19.62	333.50	-2.268	74.50	0.02
	Control	15	12.97	194.50			
Finding the best solution	Experimental	17	21.03	357.50	-3.267	50.50	0.00
	Control	15	11.37	170.50			
Choosing the most unusual solution among many possible solutions	Experimental	17	22.68	385.50	-4.118	22.50	0.00
	Control	15	9.50	142.50			
Problem solving ability scale total	Experimental	17	24.00	408.00	-4.832	0.00	0.00
	Control	15	8.00	120.00			

$p < 0.05$

Results documented that there was a significant difference between the PSAS total post-test averages of the children in the experimental and control groups ($p < 0.05$). The significant difference seems to be in favor of the experimental group. Based on these results, it can be said that activity-based science teaching practices affect children's problem solving skills positively. The meaningful difference between the scores of the Problem Solving Skills Scale of the children in the experimental and control groups can be explained by (a) use of appropriate learning environment and materials, (b) use of appropriate teaching methods and techniques in practice, (c) inclusion of these skills and demonstrations in the preparation of activity-based science teaching practices and children’s active participation with learning by doing. Previous studies showed that (a) the experiment=based teaching program applied to children in preschool was effective in giving children problem-solving skills (Ünal & Aral, 2014b), (b) there was a significant difference in the ability to use scientific processes at the end of project-based education practices of preschool children (Şahin, Güven & Yurdatapan, 2011), (c) creative problem solving activities were found to be effective on the experimental group in the research that examined the effects of creative problem solving activities applied to 5-year-old children on children's creativity (Yıldırım, 2014), (d) the Inter-Personality Cognitive Problem-Solving Program enriched 5-6 year-olds children’s problem-solving skills (Anlıak, 2004), (e) integration of interpersonal problem solving skills significantly improved 5-year-old kindergarten children’s interpersonal problem solving skills (Dinçer, 1995). The results in these previous studies support the finding in this study that problem-solving skills of children can be increased with appropriate teaching practices in relation to problem-solving skills.

2. Findings and discussion on the difference between PSAS *and subscale post-test and* persistence test *scores of children in the experimental groups*

Table 7. shows the results of the Wilcoxon Signed-Rank test on the difference between the scores of the PSAS post-test and persistence test for the children in the experimental group.

Table 7. *The results of the Wilcoxon Signed-Rank test on the difference between the scores of the PSAS post-test and persistence test scores for the children in the experimental group*

Experimental Group		N	Negative Rank Average	Positive Rank Average	z	P
Understanding the problem	Persistence Test	17	0.00	2.00	-1.732	0.083
	Post-Test	17				
Defining the problem	Persistence Test	17	3.00	3.00	-1.342	0.180
	Post-Test	17				
Asking questions about the problem	Persistence Test	17	4.00	5.00	-0.302	0.763
	Post-Test	17				
Predicting the reason of the problem	Persistence Test	17	4.00		-0.378	0.705
	Post-Test	17		4.00		
Deciding the effectiveness of the information to solve the problem	Persistence Test	17	0.00	1.00	-1.000	0.317
	Post-Test	17				
Defining the factors of the problem	Persistence Test	17	2.00	2.00	-0.577	0.564
	Post-Test	17				
Using objects differently	Persistence Test	17	0.00	2.00	-1.633	0.102
	Post-Test	17				
Predicting the result of a series of actions	Persistence Test	17	0.00	2.00	-1.633	0.102
	Post-Test	17				
Finding the best solution	Persistence Test	17	2.00	2.50	-0.00	1.00
	Post-Test	17				
Choosing the most unusual solution among many						

possible solutions	Persistence Test	17				
	Post-Test	17	5.00	5.00	-2.333	0.020*
Problem solving ability scale	Persistence Test	17	6.33	7.82	-2.129	0.033*
total	Post-Test	17				

p <0.05

We found that there was a statistically significant difference (z = -2.129, p = 0.033, p <0.05) between the PSAS total post-test and persistence test scores of children participating in activity-based science teaching practices. When the averages of the total scores of the children in the experimental group were examined, we determined that the post-test score average was 45.64 and the persistence test score average was 46.64. Results showed that the average of persistence test scores was higher than the post-test scores and this difference was statistically significant. In addition, there was a statistically significant difference between the scores of choosing the most unusual solution among many possible solutions subscale post-test and persistence test. This may explain the meaningful difference in that children may have engaged in activities to improve problem solving skills during the three-week period following the completion of the activity-based science teaching practices process until the persistence test was implemented. However, there was no statistically significant difference between the pre-test and persistence test scores of understanding the problem, defining the problem, predicting the reason of the problem, deciding the effectiveness of the information to solve the problem, defining the factors of the problem, using objects differently, predicting the result of a series of actions, finding the best solution subscales. According to these results, it can be said that the activity-based science teaching practices applied in the experimental group continued to have effects on children. Previous studies showed that (a) as a result of Constructivist Science Teaching Program activities for 6-year-old children in a preschool children gained scientific process skills at a higher level than traditional teaching and the skills acquired through the program's activities were more permanent than those acquired through traditional teaching (Büyükbaşkapu, Çeliköz & Akman, 2012), (b) children's scores of the subscales of the Scale for Problem Solving in Science Education in the experimental group were not different from the scores obtained in the persistence test (Ünal & Aral, 2014b). The results in these previous studies support the finding that appropriate problem solving skills of children are persistent. These studies show that training programs on problem solving skills are effective in the survival of children's problem solving skills. This supports the finding in this study that problem solving skills of children with appropriate activity-based science teaching practices continues. The effectiveness of the applied activity-based science teaching practices on children can be explained by the features of activity-based science teaching practices that are child-centered, based on active learning, involved in individual and small group practices, based on real life experiences, clear and understandable practices.

CONCLUSIONS and RECOMMENDATIONS

The purpose of this research study was to investigate the effects of activity-based science teaching practices on 5-6 year old preschool children's acquisition of problem solving skills. Results indicated that children's pre- and post-test scores in the control group showed significant differences. In addition, when children's total scores of the pre-test and post-test in the experimental and control groups compared, the average of children's post-test total scores in the experimental group was significantly higher than the average of children's post-test total scores in the control group. There are significant differences in the research that examine the effect of gender and age variable on problem solving skills in various educational programs (Walker, Irving and Berthelsen, 2002).

Recent empirical research suggests that particularly middle/high school students, involved in Design-Based Science (DBS) improve both in their science content knowledge and problem solving skills (Barrows & Kelson, 1993; Fortus, Dershimer, Krajcik, Marx & Mamlok-Naaman, 2004; Mehalik, Doppelt & Schuun, 2008). In the view of this, from early childhood education to high school education, age and gender could be effect the problem solving skills.

We also found that children's pre- and post-test scores of PSAS in the experimental group differed and the problem solving ability of the children participating in the activity-based science teaching practices increased. In the light of these, we concluded that the children in the experimental group had a significant increase in post-test problem solving scores, depending on the experimental procedure. In short, activity-based science teaching practices were found to have a positive influence in enhancing children's problem solving skills. In the light of these results, it was reached that the activity-based science teaching practices implemented in the experimental group affected children's problem solving skills positively. Besides, a number of researchers have recommended restructuring school science in the classroom and suggested to teach science subjects around real-life problems relevant to students' lives. School science has traditionally been taught around well-defined problems; thus, design science activities or lessons that involve real-world problem solving should be integrated into science education (AAAS, 1990).

The results of this study suggest that science activities should be given importance in the preschool period. Based on the fact that the science activities applied in this research are effective in improving children's problem solving skills, it can be suggested that problem solving education programs including science teaching practices that support preschool education can be developed. Teachers can organize educational environments to support children's problem solving skills so that science events can further improve children's problem solving skills. Teachers can prepare suitable materials for activities to improve children's problem solving skills in accordance with the achievements and demonstrations and may include appropriate methods and techniques.

It is important that problem solving skill should be studied with different working groups. Problem solving is a skill that can be developed through appropriate teaching. For this reason, the development of children's problem solving skills starting from the preschool period can be investigated by longitudinal studies. Furthermore, problem solving skills of children can be supported by providing a wide range of science activities in the prepared educational programs and instructional programs. These activities can improve the problem solving skills of 5-6 year old children. Children who can solve problems in daily life as individuals can also solve problems in science integrated areas. Also, using easily accessible materials in the activities, teachers and educators can integrate the activities in their classrooms frequently.

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APPENDIX: An example of activity-based science teaching practices

RECYCLING WILL BE FABULOUS

Activity Field: Science, Mathematics, Art
Concepts: Clean-Dirty
Target Words: Waste, recycling
Materials: Banana peel, apple garbage, tin box, plastic bottle, packing paper, cardboard, paper and so on. Wastes, as many as the number of children gloves, aprons and garbage bags.
Complete Indicators
<u>*Achievement 11:*</u> Find a possible solution from many alternatives.
Among the many alternatives given, a student chooses and tells a possible solution to the problem situation.
The selected solution explains the reasons for the choice of the route.
<u>*Achievement 12*</u>: Selects the most unusual, original solution from many possible solutions.
Among the many possible solutions, the student chooses the most unusual, original method that can be used to solve the problem (the student makes a decision the method).
Suggests different original methods that can be used in the solution.
<u>*Outcome 19:*</u> Produces solutions to problem situations.
<u>*Indicators:*</u>
Probe suggests various solutions.
The student tells the reason for the solution.
The solution is chosen.
Proposing suggests creative ways of solution.
<u>*Achievement 10:*</u> It fulfills its responsibilities.
<u>*Indicators:*</u>
Indicates that you are willing to take responsibility.
It fulfills its responsibility.
It says possible consequences if responsibilities are not met.
Learning Process: Firstly, preparation of the classroom environment: When the children are not in the classroom, the trainer throws trash, including trashcans all over the classroom and garden. *Implementation process*: When children enter the classroom and the educator directs them to a corner where they can look after the class in general. Here, the children are asked about the situation where the garbage is scattered in the classroom. Then, the educator asks some questions to the children, such as "What is the situation with the classroom?, What could happen?, How does it feel to you that our classroom is in this situation right now? Can we play in this class? Can we sit together?" Afterward, this situation is discussed with the children. It is a problem for children because they are expected to say that they can not sit in the place with the garbage, can not play there and germs in the garbage can make them sick. Then the educator asks children about "Well, where else does garbage belong to be?, Is the garbage in your home a problem for you?, Where do you throw garbage/why? The teacher asks a few questions in the form and expects answers like "garbage cans, trashcans." After this problem, the children discovered how many trashcans are in the school and where they are found. Children can stick a toothpick on the foam for every trash they find. During this time, they can notice that the trashcans are used for different purposes, in different sizes and shapes. Children who see that there is more than one kind of trashcans can learn by exploring the concept of recycling. Children are discovered to have a separate box for paper. Then, the teacher can be asked about recycling and why we should recycle. In response to incoming

questions, if the need arises, the teacher can answer as for the reduction of environmental pollution. Then, the educator gives brief information about the topic. "If we collect our garbage separately, our garbage will return and return to us as books and etc., and the environment will not be polluted."

Then, the educator calls for a meeting to find a solution to the garbage problem and all children talk about the activity. Children's thoughts about the garbage problem are taken. Later, all the children who are separated from the groups start collecting by separating plastic-paper-glass-cardboard according to the class of garbage they wear in their activity aprons. They wear gloves and collect garbage with their hands. After collecting the garbage in the classroom and garden, they count the collected garbage and the group that collects the most garbage received applaud. After this activity, children are asked to wash their hands and remove their aprons and gloves.

The educator aims to suggest that the children provide different and original possible solutions to a problem situation. For example, in order to prevent bad smells from bathrooms, we discuss what to do with the recycling wastes we have collected and find an original solution. For this purpose, it is guided by the children's desire to work at the recycling waste table. The resulting products are displayed in the science center in the classroom.

Evaluation

1) When you first came to the classroom, how was our classroom?
2) Could you imagine a place without garbage? How would it be? Do you want to live there?
3) Seda's hand holds towel rolls, glue and several books. Seda wants to make a toy (want to make a slide) to roll the doll from the seat. What can she do with these items?