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An Investigation on the Effects of Experiment Based Education Program on Six Years Olds' Problem Solving Skills *

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Abstract

In this study, it was aimed to determine the problem solving skills of six years old (60-72 months) children and determine the difference between the children who received experiment based education and those who did not. Pretest, posttest, and control group experimental design was employed in the study. This study was carried out with 42 children in preschools in the 2012-2013 academic year and 22 of them (11 girls, 11 boys) were in the experimental group and 20 of them (11 girls, 9 boys) were in the control group. The children's mean age was 64.38 months and they were members of middle income families. Following the pretest applications, children in the experimental group received "Experiment Based Education Program" for two days a week during a ten week period. The experiment based science education program was consisted of experiments aiming to improve children's use of scientific process skills, independent thinking, decision making, and problem solving process. In the study, the "General Information Form" to have general information about the children and the "Problem Solving Scale in Science Education (PSSSE)" to identify the children's problem solving skills were utilized. The reliability and validity studies of the PSSSE were achieved by the researchers. The data were analyzed with the Mann-Whitney U Test, Independent Samples T Test, and Wilcoxon Signed Rank tests. According to the results, there was a statistically significant difference at the 0.05 significance level between the mean scores of PSSSE for children in the experimental group who received the experiment based education program and for those in the control group. The children in the experimental group had higher scores compared to the controls. This finding revealed that the Experiment Based Science Education Program was effective on the improvement of problem solving skills in preschool science education.

Keywords

Experiment based education program

Problem solving skills

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Introduction

Starting from the early years; children observe, interpret, and try to seek answers to their questions about the events in their immediate environment thanks to their curiosity. When children seek answers to their questions, the cognitive structures related with the science and nature develop throughout their lifetime. Children see, touch, feel, and actively are involved in experiments and improve their learning process (Balat & Önkol, 2010).

Experiments help children develop their observation skills and environmental awareness. When children are involved in experiments, they establish cause and effect relationships, problem solving skills, self reliance, and linguistic skills (Şimşek & Çınar, 2008). Experiments affect child's several senses and child's learning becomes permanent; besides, provide concrete experiences for scientific process and learning of scientific concepts (Şahin, 2000). Korwin and Jones (1990), Seeler, Turnwald and Bull (2004), Tsai (1999) and Wang (1994) reported that the children involved actively in experiments had increases in the scientific process skills and creativity and also achieved permanent learning.

When children are involved in experiments, they work with simple concrete materials. Working with the concrete materials is cited as one of most effective methods in improving children's problem solving skills (Lind, 2000). The problems represented in those studies included child's daily life problems. When the child sees that daily life problems could be resolved with simple ways and materials, he believes that problems could be resolved and thus develops self reliance. That also helps the child to make connections between daily life experiences and science, use scientific methods in finding solutions to the problems, and observe the nature with questioning eyes (Ergin, Pekmez & Erdal, 2005; Flick, 1993; Ünal & Aral, 2010).

In their studies, French, Conezio and Boynton (2000); Helm and Gronlund (2000); Şahin and Yıldırım (2006) observed that scientific activities increased children's scientific questioning, planning and execution skills, problem solving skills, creativity, and academic risk taking levels. As indicated in such studies, children's thought, argument, and questioning skills needed to be fostered to improve scientific thinking skills (Chaille & Britain, 2003; Worth & Grollman, 2003). Epstien (1993) found that when children were provided with the opportunities of planning and deep thinking; their language, social, and overall developmental skills had significant increases (as cited in Dağlıoğlu & Çakır, 2007).

While children are involved in research and analysis, they experience using scientific research methods, thinking, questioning, observing, planning and application, using appropriate materials to gather data, establishing cause and effect relationships between events, and making alternative analysis and scientific research (Bell, Semetana & Binns, 2005; Ünal & Aral, 2010).

Büyüktaşkapu, Çeliköz and Akman (2012), Ornstein (2006), Önen and Gürdal (2006), Turpin and Cage (2004) applied education programs in which children were involved in research process and indicated that the children's scientific process and research skills were improved, they found solutions to the problems through appropriate planning and applications, and established cause and effect relationship. Besides it is proven by the research that when children were provided with the opportunities of making research and experiments, their problem solving skills were improved (Altun, Dönmez, İnan, ,Taner, & Özdilek, 2001; Charlesworth & Lind, 2003; Doğru, Arslan, & Şeker, 2011; Drons & Given, 2005; Faulkner-Schneider, 2005; Helm & Gronlund, 2000; Kaptan & Korkmaz, 2002; Mirzaie, Hamidi, & Anaraki, 2009; Raviv, 2004; Stoll, Hamilton, Oxley, Eastman, & Brent, 2012).

As indicated by the research results, the science education needs to be given to the children beginning from the early years to help them finding ways of reaching scientific knowledge, developing creativity and problem solving skills, finding realistic solutions to the problems encountered, improving independent thinking and reasoning, establishing cause and effect relationships (Ünal & Aral, 2010).

In this context, it is required to provide environments to preschool children both in the home and school wherein they could make experiments. Experiments do not only improve children's problem solving skills, but also their positive attitudes toward science and research skills.

Purpose of the study

The main purpose of this study was to identify the effects of the Experiment Based Education Program (EBEP) on the problem solving skills of six years old children receiving preschool education.

Method

Research Design

In this study, it was aimed to determine the effects of the Experiment Based Education Program on the problem solving skills of six years old children receiving preschool education. Since the Experiment Based Education Program was as being new and different programme, its effectiveness was determined by comparing with the traditional preschool education program. The pretest, posttest and retention test quasi experimental design with control group was used. The dependent variable was six years old children's "problem solving skills" and the independent variable was the “Experiment Based Education Program".

In the study, the experimental group received "Experiment Based Education Program" in addition to their ongoing education program and the children in the control group followed their routine education process implemented by their teachers. The researchers did not interfere to the ongoing education of the control group.

Study Sample

The research was done in the kindergartens of elementary schools of Ministry of National Education in the city center of Malatya in the academic year of 2012-2013. First; a list of middle socio economic level elementary schools with kindergartens was obtained in line with the suggestions of Malatya City National Education Directorate. Keeping in mind that the children in the same school could be affected from each other, two different schools were randomly chosen from the list. One of those was chosen as the experiment and the other was chosen as the control by drawing.

Among the purposeful sampling methods, the criterion sampling was utilized in this study. In the criterion sampling, the observation units in a study could be consisted of the individuals, cases, or objects sharing some certain qualifications (Büyüköztürk, Çakmak, Akgün, Karadeniz & Demirel, 2013). While choosing sampling group in this study, it was required that the children recruited in the study showed normal development as ascribed by their teachers, came from unbroken families and had never been involved in a science education program. A total of 42 children were involved in the study; 22 of them (11 girls, 11 boys) were in the experiment and 20 of them (11 girls, 9 boys) were in the control group. The mean age of children in the study was 64.38 months. In both groups, the 50% of children were the last child, and 42% were the first child in the family. In both groups, 78% of children had never received preschool education.

Data Collection Tool

In the study, the “General Information Form” to gather general information about the children and their mothers and fathers and the "Problem Solving Scale in Science Education (PSSSE)" developed by Ünal & Aral (2014) to determine the children's problem solving skills were used. In the General Information Form, the children's name and surname, age, gender, previous preschool education, number of siblings, birth order, ages of mother and father, parents' education level, and

parents' professions were asked. The general information forms were filled out by the children's parents.

The PSSSE was developed to measure 60-72 months old children's problem solving skills in science education. The scale was consisted of 16 problem situations and accompanied pictures depicting the problem situations.

A total of 174 children aged between 60-72 months attending kindergarten at the time of study were chosen through random sampling and composed the sample for the reliability and validity studies. Among the sample, 52% were girls, 48% were boys; 41.95% were the first child and 61.5% had never attended to any type of preschool. The data gathered through the PSSSE were analyzed with the factor analysis. The repeated factor analysis showed that the remaining 16 items were dispersed on two factors with high factor loads, thus the scale was composed of two subscales. The items of two subscales were examined and sent to the field experts for suggestions. In line with the expert suggestions, the first subscale was named as "Science and Nature Problems (SNP)" because the content of these items was about science and nature. The second subscale was named as "Material Usage Problems (MUP)" because the content of these items required to use additional materials to solve the problems. The factor analysis results showed that the SNP was consisted of 9 problem situations and the load values of these items were between 0.417 and 0.636; and explained 22.05% of the total variance. The MUP was consisted of 7 items, and the load values were between 0.410 and 0.719, and explained 18.08% of the total variance. The total variance explained by the two factors was 40.13%.

The construct validity of the PSSSE was examined through two types of factor analysis. The first one was the item analysis. Through item analysis, corrected item-total correlations for each item's own factor were computed. The corrected item-total correlations which is also cited as the item discrimination level was between 0.319 - 0.472 for the SNP and between 0.302 - 0.424 for the MUP. The internal consistency coefficient was 0.75; the goodness of fit between the independent experts was 0.69; and the test retest correlation was 0.96.

Data Collection Method

In order to develop the Experiment Based Education program, the literature was reviewed by the researchers and the activities involving experiments supporting problem solving skills were prepared in line with the Preschool Education Program for 36-72 months old children of the Ministry of National Education (Akgül, 2007; Andrews, & Knighton 2010; Chaille, & Britain, 2003; Charlesworth, & Lind, 2003; Edom, & Woodward, 2006; Graham, Mellett, Challoner, & Angliss, 2010; Green, 1996; Heddle, & Shipton, 2010; Kamay, & Kaşker, 2006; Potter, 2005; Schiller, & Hastings, 1998; Stangl, 1993, 1994; Tahta, 2010, Üçok, 2004).

A total of 20 experiments and activities integrated with these experiments were involved in the Experiment Based Education Program. The experiments were to administer twice weekly for a ten week period. In designing the experiments, it was crucial that the experiments were in line with the children's interests and needs, and direct life experiences; also the experiments could be done by the children themselves and required the usage of basic scientific process skills. In designing the experiments; the objectives, the general structure of educational environment, environmental features, and children's developmental aspects were taken into account.

In the application phase of the experiment based education program, first some other activities involving play, Turkish language, and music were applied to attract attention of the children. As an example to those preparatory activities; a rhythmic cleaning theme song was sang to the children before starting a cleaning theme experiment. Then a conversation on cleaning was started with the children. Some petroleum jelly was poured on the hands of children and some glitter powder was sprinkled on the jelly. They were asked what they could do to get rid of the glitter powder on their hands. In this experiment, children were provided with the opportunities in solving the problem. The children found the right answer by themselves by trying to clean the jelly and powder with the paper tissue, wet wipes, and soap. The children were assisted to conclude that the soap worked better

in cleaning the jelly and powder. Then the black pepper experiment was applied in which the children saw how the soap eliminated the germs. The children were provided with plastic cups and required to fill them with water and pour two teaspoons of black pepper in each cup. They were asked what would happen if a finger point was dipped into the cup. This inferential process could ensure the child's participation not only at the physical but also at the mental level. Thus children could be involved in the experiments both with their hands and their mental processes. When a piece of soap was dipped into the cup, it was observed that the black pepper particulars were disseminated through the edges of the cup. The experiments help children use basic scientific processes. Children were allowed to repeat the experiments with detergents and other soap bars. When the experiments were finished, the children were provided with the open ended questions, art activities, and worksheets for the evaluation phase. The activities involved in the Experiment Based Education Program were presented with the experiments in which the children could use scientific process skills and support their independent thinking, decision making, and problem solving processes. The experiments were designed in a kind of nature allowing the children to understand the events in more concrete ways, learn through experience, establish cause and affect links, thus realize more permanent and meaningful learning. These experiments were designed as group experiments. The experiments were designed with the intention to provoke children say their ideas, put those ideas in practice and discuss the results. The experiments done in the groups caused the interactions to be formed among children and provoked them to discuss the results. After the implementation phase of experiments, open ended questions were asked and the children were required to make the pictures of experiments. Besides, the worksheets about the experiments were used.

The Experiment Based Education Program was consisted of such experiments which could improve the children's scientific and independent thinking skills, decision making, and problem solving.

After the preparation phase, a total of 11 experts involving four preschool education experts, four curriculum development experts and three preschool teachers working in the field evaluated the Experiment Based Education Program. Considering the suggestions of experts on the program, the necessary changes were made and the program took its last format.

Analysis of Data

The analysis step of data gathered through PSSSE were determined according to descriptive statistics and normality tests. Shapiro-Wilk test was used to check the normality of data gathered through the PSSSE. Shapiro-Wilk test is used to check the normality of data gathered from the samples smaller than 50 (Büyüköztürk, 2008).

According to Shapiro-Wilk test results on the pretest scores of PSSSE; the experiment and control groups had normal distributions ($p>0.05$); however, there were deviations from the normal distribution for the posttest scores ($p>0.05$). Thus, among the parametric tests; t test for Independent Groups (Student t) was used to compare the pretest scores of experimental and control groups. To compare the posttest subscale scores of the experimental and control groups, the nonparametric Mann-Whitney U test was used, and the total (SNP+MUP) score means were analyzed with the t test (Student t) for Independent Groups.

According to Shapiro-Wilk test results of the persistency test score means gained from the PSSSE; the SNP subscale persistency test score means had normal distribution ($p>0.05$), but the MUP subscale and the total (SNP+MUP) persistency test score means showed deviation from the normal distribution ($p<0.05$). To compare the scores of persistency tests, parametric or nonparametric tests were used. The posttest and persistency test score means of the SNP subscale were analyzed with the t test for Dependent Groups (Paired t test); the posttest and persistency test score means of the MUP subscale and total scale (SNP+MUP) were analyzed with the Wilcoxon Signed Rank test.

Results

The main purpose of this study was to determine the effects of Experiment Based Education Program on the problem solving skills of six years old children. The findings reached in line with this purpose were described in the following tables.

Table 1. Independent t Test Results of the Pretest Scores of the PSSSE' Subscales for the Children in the Experiment and Control Groups

PSSSE	Groups	n	$\bar{X}$	Median	Min.	Max.	Sd.	t	p
SNP	Experiment	22	2.00	2.00	1.22	2.56	0.35		
	Control	20	1.78	1.83	0.89	2.56	0.46	1.73	.091
MUP	Experiment	22	2.01	2.14	1.14	2.43	0.36		
	Control	20	2.20	2.28	1.71	2.57	0.22	1.99	.052
Total (SNP+MUP)	Experiment	22	2.01	2.00	1.44	2.50	0.29		
	Control	20	1.96	1.93	1.25	2.38	0.31	0.52	.609

When Table 1 is examined, it is seen that there was no any significant difference between the pretest score means of the subscales of PSSSE ($p>0.05$). This result also indicated that the experiment and control groups were homogeneously distributed.

Table 2. Mann Whitney U Test and Independent t Test Results of the Posttest Scores of the PSSSE' Subscales for the Children in the Experiment and Control Groups

PSSSE	Groups	n	$\bar{X}$	Median	Min.	Max.	Sd.	Mean Rank	MWU U	MWU p
SNP	Experiment	22	2.74	2.77	2.44	3.00	0.18	31.50		
	Control	20	1.78	1.77	1.11	2.33	0.35	10.50	0.000	.000*
MUP	Experiment	22	2.69	2.71	2.00	3.00	0.24	30.45		
	Control	20	2.02	2.00	1.29	2.71	0.29	11.65	23.00	.000*
								t	**p**	
PSSSE	Experiment	22	2.72	2.75	2.25	2.94	0.172			
	Control	20	1.89	1.87	1.38	2.38	0.271	11.9	.000*	

*$p<0.05$

When Table 2 is examined, it is seen that the SNP subscale posttest score means were 2.74 for the experimental group; and 1.78 for the control group; the MUP subscale posttest score means were 2.69 for the experimental group; and 2.02 for the control group; the overall PSSSE posttest score means were 2.72 for the experimental group; and 1.89 for the control group. According to the Mann Whitney U test results, there was a significant difference between the posttest score means of the SNP subscale ($U:0.000$, $p<0.05$) and the MUP subscale ($U:23.000$, $p<0.05$) for the children in the experiment and control groups. According to the Independent t test done with the posttest score means of PSSSE, there was a significant difference between the scores of children in the experimental and control groups ($t:11.9$, $p<0.05$).

Table 3. Wilcoxon Signed Rank Test Results Regarding the Pretest and Posttest Scores of Subscales of The PSSSE for The Children in Experiment Group

Experiment Group								
PSSSE		**n**	$\bar{X}$	**Min.**	**Max.**	**Sd.**	**Wilcoxon z**	**p**
SNP	Pretest	22	2.00	1.22	2.56	0.39		
	Posttest	22	2.74	2.44	3.00	0.18	-4.12	.000*
MUP	Pretest	22	2.02	1.14	2.43	0.34		
	Posttest	22	2.69	2.00	3.00	0.25	-4.09	.000*
Total (SNP+MUP)	Pretest	22	2.01	1.44	2.50	0.30		
	Posttest	22	2.72	2.25	2.94	0.17	-4.12	.000*

*p<0.01

When Table 3 is examined, it is seen that there was a significant difference between pretest and posttest SNP subscale scores (z:-4.12); pretest and posttest MUP subscale scores (z:-4.09); and the pretest and posttest total scores (SNP+MUP) (z:-4.12) (p<0.01). Those difference was in favor of the posttest scores at the significance level of 0.001.

Table 4. Wilcoxon Signed Rank Test Results Regarding the Pretest and Posttest Scores of the Subscales of the PSSSE for the Children in Control Group

Control Group								
PSSSE		**n**	$\bar{X}$	**Min.**	**Max.**	**Sd.**	**Wilcoxon z**	**p**
SNP	Pretest	20	1.78	0.89	2.56	0.46		
	Posttest	20	1.78	1.11	2.33	0.35	-.121	.903
MUP	Pretest	20	2.20	1.71	2.57	0.22		
	Posttest	20	2.02	1.29	2.71	0.29	-2.59	.010*
Toplam (SNP+MUP)	Pretest	20	1.96	1.25	2.38	0.31		
	Posttest	20	1.89	1.38	2.38	0.27	-1.38	.168

*p<0.01

When Table 4 is examined, it is seen that there was no any significant difference between the pre and post test scores on the SNP subscale (z:-0.121) and total pre and post test scores on the overall PSSSE (SNP+MUP) (z:-1.38) (p>0.01) for the control group. However, a significant difference was detected between the pre and post test scores on the MUP subscale (z:-2.59) for the control group. Additionally, as seen in Table 4, regarding the control group, the post test scores gained from the overall PSSSE (SNP+MUP) and the MUP subscale were lower than the pretest scores. This finding could be resulted from the teacher attitudes (Zeytun, 2010), material shortages at the preschools (Ercan & Yalçın, 2013), inadequacy in methods and techniques in addition to the crowded clasrooms (Ayvacı, Devecioğlu & Yiğit, 2002; Garbett, 2003, Güler & Bıkmaz, 2002; Kallerly, 2004; Karamustafaoğlu, Üstün & Kandaz, 2004; Levitt, 2001; Parlakyıldız & Aydın, 2004).

Table 5. Dependent t Test and Wilcoxon Signed Rank Test Results Regarding the Posttest and Retention Test Scores of Subscales of the PSSSE for the Children in Experiment Group

PSSSE		n	$\bar{X}$	Median	Min.	Max.	Sd.	t	p
SNP	Posttest	22	2.74	2.77	2.44	3.00	0.18		
	Retention test	22	2.76	2.77	2.44	3.00	0.16	-1,31	.204
								Wilcoxon z	
MUP	Posttest	22	2.69	2.71	2.00	3.00	0.25		
	Retention test	22	2.69	2.71	2.00	2.94	0.22	-0.036	.971
Total	Posttest	22	2.72	2.75	2.25	3.00			
SNP+MUP	Retention test	22	2.73	2.75	2.31	2.94		-0.753	.451

When Table 5 is examined, it is seen that the posttest scores gained from the subscales of PSSSE by the children in the experiment group were not significantly different than the scores of retention test. The posttest and retention test score means were so close ($p>0.05$). Thus, there was no any decline in the respective scores by the time passed after the posttest application through the retention test.

Discussion, Conclusion and Suggestions

This research indicated that the children could gain problem solving skills beginning from the preschool period and the experiment based education program could be implemented to improve young children's problem solving skills. According to the study results, the Experiment Based Education Program was effective in supporting the children's problem solving skills. Besides, the skills gained through the Experiment Based Education Program had persistency over time.

The studies indicating the importance of acquiring the problem solving skills at an early age and preparing special programs encouraging problem solving skills had similar results with this research (Anlıak & Dinçer, 2005, Arı & Seçer, 2003, Çağdaş & Yıldız, 2003, Dereli, 2008, Hong, 2008, Kargı, 2009; Önen & Gürdal, 2006, Özdil, 2008, Ramani, 2005). Doğru et al. (2011) fund that the five week science experiment based program had positive effects on the problem solving skills. It was concluded that when preschool children were provided with the chances of conducting science experiments, their problem solving skills were improved.

French et al. (2000) concluded that the scientific activities and experiments in the "sciencestart" program were influential in children's problem solving in daily life. When the teachers and children are involved in science, they produce appropriate, logical comparisons and reviews.

The literature review reveals that the preschool children learn better when they are provided with the materials triggering their all senses and use these materials while investigating (Güler & Bıkmaz, 2002), it is proved that the experiments, observations, and field trips improve children's comparison, classification, building cause and effect relationships, attention to details, predicting, and problem solving skills; besides, they provide the children with different perspectives (Bal, 1993; Balat & Önkol, 2010; Demiriz, & Ulutaş, 2000; Owens, 1999). Lambert (2001) also indicated that the types of activities, activity materials, and verbal responses as well as the nonverbal responses were important in the development of creative thinking and problem solving skills.

Some of the experiments done in the Experiment Based Education Program were group applications. It could be stated that the experiments implemented as the groups in coordination support the children's problem solving skills. It is found that the experiment studies done by the groups in coordination provide the children with the opportunities of generating individual ideas, practice, and seeing the concrete results of their practices; besides these group studies also affect the children's social development and most importantly significantly increase the problem solving skills (Bearison, Magzeman & Filardo, 1986; Fawcett & Garton, 2005; Gauvain & Rogoff, 1989; Gök & Sılay, 2009; Johnson, 1992; Light ve Glachan, 1985; Perlmutter, Behrend, Kuo & Muller, 1989; Söker, 1998, Şahin, 2000).

In the application phase of the Experiment Based Education Program, the children were involved in the learning processes actively that is to say they learned by doing. The materials used in the experiments were natural and familiar with the children's immediate environment. Similarly, Seeler et al. (1994) stated that the children actively involved in the learning process developed their sense of responsibility and achieved lifelong and permanent learning. Çeken (2002), Korwin and Jones (1990), Laçin (2003), Tsai (1999), and Wang (1994) indicated that the experiments provided learning by doing and were active learning ways because they eased the scientific concepts to be memorized, ensured the conceptualization of scientific processes and source of knowledge, and helped the children in understanding the scientific concepts by providing materials used in everyday life.

Aydede and Matyar (2009); Çağdaş and Yıldız (2003); Dharmadasa and Silvern (2000); Doğru et al. (2011); Flick (1993); Haury and Rillero (1994); Lambert (2001); Mirzaie et al.(2009); Satterthwait (2010); Stoll et al. (2012) stated that the children involved in education programs that were implemented with the simple tools depending on research and implementing active learning approach had higher levels of problem solving skills compared to the children who were educated with the traditional approaches.

As understood from the other studies, the experiments provided efficient, effective, and permanent learning and, they were among the most important active learning methods. It could be stated that the education programs based on experiments perceive the child in the center of learning and value the first hand activities as important in providing permanent and understandable knowledge compared to the traditional approaches. The experiment based education programs also foster the creativity, are effective in the improvement of scientific process skills, keep children's attention and interest for long periods of time, positively affect language, psychomotor, and cognitive development areas, help in developing positive attitudes toward science and make the life more understandable by providing opportunities of problem solving in everyday life. In this context, it could be stated that the experiments which are important in learning by doing need to be applied in more effective ways.

In line with the results gained from this research; it could be suggested that the scientific activities, exploration activities, and art activities need to be more involved in the education programs and thus the children's problem solving skills could be supported. To support the preschool education, "science education based problem solving education programs" could be developed. The Ministry of National Education together with the universities and voluntary organizations could apply "science projects" to foster children's problem solving skills. The effects of Experiment Based Education Program on preschool children's attitudes toward science, their academic achievement, and scientific process skills could be examined. To achieve all of these, the families and teachers are regarded as the most important stakeholders. In this respect, the teacher education programs could be enriched and awareness studies about science and science education could be implemented for teachers and families.

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