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The effect of project approach-based science education program on problem-solving skills of preschool children

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In this study, the effect of project approach-based science "education program on problem-solving skills" of preschool children attending a kindergarten was investigated. The study was conducted with a quasi-experimental design with pretest and posttest control group at a kindergarten affiliated with the "Ministry of National Education" located in a province in Turkey. The study sample consisted of 70 children (35 in the experimental group, 35 in the control group). The study data were collected through Personal Information Form and Age 4–7 "PSSS". While the Project Approach-Based Science Education Program (PABSEP) was applied to the children in the experimental group in 28 sessions for three days a week for 10 weeks in addition to the National Education Program, the National Education Program was continued in the control group. As a result of the analyses of the data obtained, significant differences were determined between the "PS" scores of the two groups in favor of the experimental group following the education programs applied ($p < 0.05$). It was concluded that the PABSEP positively affected the problem-solving skills of the preschool children, and that this effect was permanent ($p < 0.05$).

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Introduction

The 0–6-year age group is a special period in which experiences that will affect personality, linguistic, social, emotional, physical, and cognitive development of children are experienced. Therefore, the experiences provided to children in this period shape their future. In this period, which covers the "preschool period" and in which introduction to academic life was realized for the first time, variables such as socioeconomic status, language, and culture can limit the learning experiences of children. Elimination of the differences that may be caused by such variables is possible only through quality education. Any intervention made in this period when children's brain development and learning pace is the fastest may create a great impact (Bildiren and Kargın, 2019; Dobbins et al. 2016). One of the educational approaches that can make an intervention of this kind is the project approach, which is one of the modern educational methods in which the child is an active learner and gains experiences by doing and living. The project approach, which is planned as constructivist, child-centered, inquiry-based, process-oriented, and small or whole group-based, is consistent with the children's innate tendency to discovery, including their desire to be curious about their environment in a natural manner and appears as an approach that makes children's experiences meaningful (Chen et al. 2017; Helm and Katz, 2016). This pedagogical approach provides children with numerous educational benefits, including developing their critical thinking, mathematics, communication, and literacy skills, and supports all their developmental areas (Arıkan, 2020; Arıkan and Kimzan, 2016; Helm and Katz, 2016; Temel et al. 2005; Tuğrul, 2008; Şahin and Başal, 2021). Considering children's curiosity, examination and discovery desires, the project approach is an appropriate approach for children's nature. Experiencing this approach with children facilitates the work of the teacher in addition to optimizing the efficiency obtained in the education process because this approach provides the child with the opportunity to learn by doing and experiencing in a natural process (Yıldız Bıçakçı and Gürsoy, 2010). Within the scope of this approach, children are in continuous interaction with teachers and peers. It keeps children away from memorization, gets them to meet with the joy of discovery, and opens the door to learning for them (Şahin et al. 2011). Science and mathematics activities in which children use their scientific process skills effectively can be comprehended better through the project approach. This approach is rather important for children in terms of its placing the child in the center, supporting critical thinking in children, directing children towards researching, supporting development as a whole, and developing children's awareness of their responsibility towards the environment and society in which they live (Yıldız Bıçakçı and Gürsoy, 2011). Project studies, which can be carried out individually or as a group, are conducted on a certain subject through comprehensive research (Anlıak et al. 2008). The basis of the project studies is for children to collaborate and solve any problem they may encounter in their lives (Köyceğiz and Özbey, 2019). Individuals try to establish interactions with other individuals, objects, or events throughout their lives in order to adapt to the environment. Problems may sometimes occur during such interactions. This situation is experienced more intensely by children, who try to make sense of the world, get to know their environments, and learn new things. For a 15-month-old baby who is trying to eat something on his/her own, not being able to fill the spoon with food as s/he is holding the spoon by the handle is a problem, or the shoe laces coming loose is a problem for a preschool child. Sometimes, children do not recognize a problem when they encounter it, and even if they recognize it, they cannot solve it, may not want to solve it, or try to solve it. Each problem that children do not notice, can solve, or cannot solve can appear in different forms in their lives and disrupt their life balance. Therefore, getting children to gain problem-solving skills, which is one of the 21st-century skills, in the preschool period, in which especially the foundations of personality are laid, is rather important for them to be problem-solving individuals in the future. As this skill is a complicated one, it should be taught to children in stages, and this should be supported with programs in which appropriate approaches, methods, and techniques are used. Science, mathematics, and artistic activities and project studies in the preschool period improve children's creative, critical, and different thinking skills and support their problem-solving skills (Bildiren and Kargın, 2019). Preschool children who have intense curiosity and desire to discover participate more actively in science and project studies; therefore, in this study, a project approach-based science education program (PABSEP) was preferred. As each child grows up in a different environment and has different circumstances, the events and situations that arouse the curiosity of children of different ages may differ (Broström, 2015). In such cases, the questions children ask to satisfy their interest and curiosity need to be addressed in a way that is appropriate to their developmental stage ("Ministry of National Education", 2022). As children begin to develop language skills, they begin to ask questions such as "What is that?" by pointing to objects in their environment, followed by questions such as "why, and where?". As they grow older, they begin to ask more detailed questions, such as "Why doesn't it rain upwards?" and "How did I born?" Parents need to respond to these questions in a scientific way that is appropriate to the child's developmental stage (Alabay, 2020; Ruggeri, et al. 2021). During the preschool years, children's innate interest in science increases, and they begin to develop an understanding of cause and effect and the ability to recognize similarities between events and objects in their environment. They develop their unique understandings and explanations of events and situations through a combination of curiosity, observation, exploration, questioning, play, interaction with others, and trial and error (Howitt and Campbell, 2021). Preschool education, which is the first step in formal education, is the level of education where science education is first taught in a planned and programmed way.

In the "Ministry of National Education Preschool Education program" already in use in Turkey, it is emphasized that children's needs and interests should be considered and that project studies can be conducted by using each subject as an instrument (MoNE, 2013). Considering that the first 6 years of children are quite important in terms of development, it is believed that a project approach-based education program to be applied in preschool will positively contribute to children. Hence, the subject of the study is to determine the problem-solving skills of preschool children who receive an education based on a PABSEP.

In the study, it was aimed to determine the effect of the PABSEP applied to preschool children on their problem-solving skills.

Hypotheses

H_1 between Problem-Solving Skills Scale posttest scores of the" children in the experimental group to whom preschool activities prepared in line with PABSEP are applied and the children in the control group to whom The "Ministry of National Education (MoNE) preschool program" activities are applied.

H_2 There is "a significant difference between Problem-Solving Skills Scale pretest and posttest scores of the" children in the experimental group to whom preschool activities prepared in line with PABSEP are applied.

H_3 There is no "significant difference between Problem-Solving Skills Scale pre and post-test scores of the children" in the control group to whom MoNE preschool program activities are applied.

H_4 There is "a significant difference between Problem-Solving Skills Scale total and subscale posttest scores of the" children in the experimental group to whom preschool activities prepared in line with PABSEP is applied and the children in the control group to whom MoNE preschool program activities are applied.

Method

Research model. The study was conducted with a quasi-experimental model with pretest–posttest, and control group between September 2022 and January 2023.

Population and sample. The population of the study consisted of preschool children attending independent nursery schools located in a provincial center in Turkey. G*Power 3.1.9.2 was used in determining the sample size. Considering the reference results obtained from the literature review made on the subject before the implementation of the study, it was determined that at least 34 children should be included in each group. The calculation was based on a priori analysis for the difference between two independent means (two groups), with the following parameters: two-tailed test, effect size $d = 0.7$, α error probability = 0.05, power (1–β error probability) = 0.80, and an allocation ratio of 1. This resulted in a noncentrality parameter $\delta = 2.886$, critical $t = 1.997$, degrees of freedom = 66, with sample sizes of 34 for each group, leading to a total sample size of 68 and an actual power of 0.812 Table 1.

Regarding the use of "Age 4–7 "PSSS" and implementation of PABSEP, ethical approval was taken from the "University Health Sciences Non-Interventional Clinical Research Ethics Committee" (2021/2427). For the study sample, an independent nursery school attended by children in the same age group and development stage among nursery schools affiliated with MoNE in a provincial center in Turkey in the 2022–2023 academic year was determined. As the number of children per class was limited due to the COVID-19 pandemic, 4 classes were included in the study. Two classes receiving education in the morning period were determined as the experimental group, and two classes receiving education in the afternoon period were determined as the control group.

As a result of the results obtained in the G-Power program, it was planned to include 58 children in the study, 29 experimental and 29 control. A total of 80 children, 40 children in each of the experimental and control groups, were included, taking into account situations such as leaving the study, giving up participation, and absenteeism. 5 children from the experimental group (2 children were absent, 2 children were deregistered from school due to illness, 1 child's family did not allow him to participate in the study) and 5 children from the control group (3 children's families moved, 2 children changed schools) were excluded from the study due to their inability to continue education. The children to be included in the study were selected through a random sampling method within the scope of inclusion criteria. 70 children within the age range of 5–6 years, were included in the study sample (See Fig. 1).

Table 1 Distribution of the demographic information of the children in the experimental group and the control group.

Experimental				Control		Total	
Variable	**Group**	***f***	**%**	***f***	**%**	***F***	**%**
Gender	Boy	20	57.1	20	57.1	40	57.1
	Girl	15	42.9	15	42.9	30	42.9
Date of birth	2016	27	77.1	27	77.1	54	77.1
	2017	8	22.9	8	22.9	16	22.9
Duration of attending the school	1 year	27	77.1	27	77.1	54	77.1
	2 years	8	22.9	8	22.9	16	22.9
Birth order	First child	8	22.9	10	28.6	18	25.7
	Middle child	10	28.6	10	28.6	20	28.6
	Last child	17	48.6	15	42.9	32	45.7
Sibling status	Yes	33	94.3	31	88.6	64	91.4
	No	2	5.7	4	11.4	6	8.6
Mother's age	20–29	9	25.7	11	31.4	20	28.6
	30–39	21	60.0	18	51.4	39	55.7
	40–49	5	14.3	6	17.1	11	15.7
Mother's educational level	Primary school	7	20.0	6	17.1	13	18.6
	Secondary school	8	22.9	15	42.9	23	32.9
	High school	12	34.3	10	28.6	22	31.4
	Undergraduate	8	22.9	3	8.6	11	15.7
	Graduate	0	0.0	1	2.9	1	1.4
Father's age	20–29	2	5.7	1	2.9	3	4.3
	30–39	21	60.0	22	62.9	43	61.4
	40–49	12	34.3	12	34.3	24	34.3
Father's educational level	Primary school	4	11.4	7	20.0	11	15.7
	Secondary school	2	5.7	4	11.4	6	8.6
	High school	17	48.6	9	25.7	26	37.1
	Associate degree	1	2.9	3	8.6	4	5.7
	Undergraduate	7	20.0	8	22.9	15	21.4
	Graduate	4	11.4	4	11.4	8	11.4

Data collection tools

Personal information form. The form prepared by the researcher in order to identify sociodemographic characteristics of the children consists of 7 questions (gender, date of birth, duration of attending preschool education, birth order, sibling status, mother's-father's age, mother's-father's educational level).

Problem-solving skills scale (Age 4–7) "(PSSS)". "The scale developed by Aydogan, Omeroglu, Buyukozturk, and Ozyurek is a scale that was developed within the scope of a TUBITAK project and aims to determine the competencies of the children aged between 4 and 7 years regarding the cognitive processes they display in the face of real problem situations (Aydoğan et al. 2012)." The scores obtained from the scale provide data for determining the performance of the children regarding problem-solving skills.

"PSSS" has two different versions, one for the ages between 4 and 7 years and one for the ages between 8 and 11 years. The form for the 4–7-year age group is for preschool children and primary school 1st grade students who are learning how to read and write. The Age 4–7 "PSSS" includes 50 illustrated questions, 2 sample illustrated questions, and statements for describing these problems. The scale items are applied to the children individually.

The reliability coefficient of the Age 4–7 "PS" was calculated as 0.79 in the pilot study and 0.81 in the norming study. In the present study, the Cronbach's alpha reliability coefficient of the scale was found to be 0.86.

Preparation of PABSEP

While preparing the PABSEP for preschool children, domestic and foreign education programs were reviewed in order to create a philosophy for the program. In order for the program to be suitable for the ages, developments, cultural structures, interests, and needs of the preschool children, a literature review on project approach and science education was made, and approaches used in the preschool period, learning and development theories, and example programs were examined.

Project approach-based learning process is included in constructivist and progressive philosophy in which the learner is in the center and actively involved. It is an approach in which

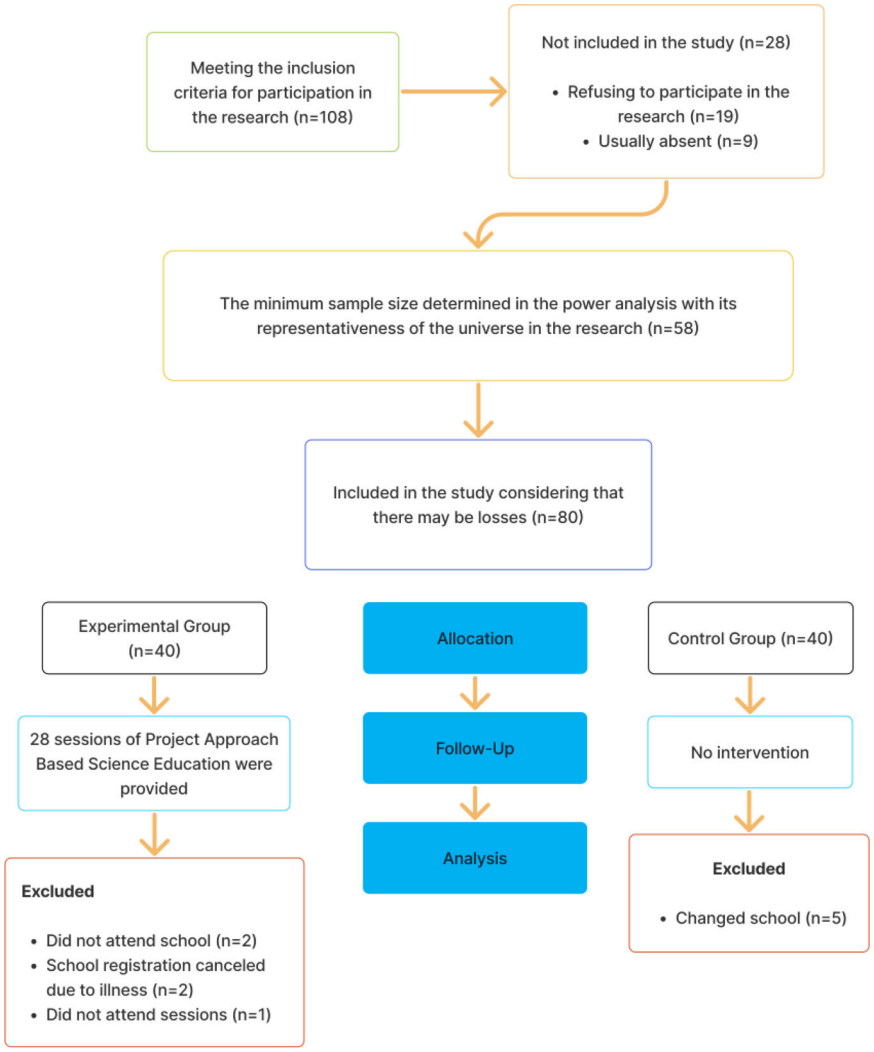

Fig. 1 Consort diagram. Allocation of participants according to the CONSORT flow diagram.

attention is paid to selecting subjects that will appeal to the interests of the children, and children gain intense experiences through the activities prepared within the framework of these subjects, and learning is realized (Setiasih et al. 2017).

Project approach argues that a connection should be established between individual learning and life and school. Project approach is used in many different fields such as educational sciences, technology, engineering, and health (Karaca, 2021). This approach, which supports the 21st century skills, being based on learning by doing and experiencing, the learning being active and in the center, and its applicability among many disciplines make the approach more attractive. It is thought that especially in recent years, science education has become quite important, that children in early childhood period should develop positive attitudes towards science education, and that using project approach in science education will positively contribute to learners.

Today, problem-solving skill as one of the 21st century skills is considered a skill that should be developed, learned and actively used (Özyürek et al. 2018). Thanks to their problem-solving skill, individuals can easily adapt to the environment where they live. Therefore, problem-solving skill, which we encounter as a significant skill in each step of life and is an essential aspect of learning process, is accepted as a social process connected with all domains of development (Pekdoğan, 2019). It is suggested that it is necessary to provide a suitable environment for individuals' problem-solving skills to develop, and this would only be possible in a learning environment where the individual is active.

By examining the 2013 Preschool Education Program prepared by MoNE, first of all, the properties of the program were considered. Accordingly, being child-centered, flexible, game-based, balanced, and developing creativity in children were determined to be the basis of the program. As a result of the needs analysis form applied to preschool teachers in order to ensure that the programs comply with educational objectives, program contents were determined.

It was seen that although there are learning outcomes and indicators supporting science education in the MoNE Preschool Education program, and it was stated that it supports all developmental areas, integration of science education with different activity types was not emphasized, and there were problems in the implementation in terms of integrating it well with the program.

In light of all this information, four project themes (We Are Learning Plants and Insects, Little Scientists at Work, Let us Save, and Love the Environment and Recycle) were determined within the scope of the PABSEP aimed at supporting problem-solving skills, which have an important place in children's daily lives and academic competences. While preparing the activities to be included in the program, science activities in the Preschool Education Program were taken as the basis, and these activities were integrated with other activity types (Turkish, Mathematics, Game, Drama, Preparation for Reading-Writing, and Music).

Implementation of PABSEP

Meetings were held with the classroom teachers of the classes included in the experimental group and the control group, and they were informed about the pretest and posttest to be administered to the groups. Necessary information about the purpose of the study, implementation process, program content, activities included in the program, and materials to be used was provided to the classroom teachers of experimental group classes. The parents were reminded that their children should attend their classes in the implementation process of the program. The researcher participated in classes before the pretest application as an observer to be familiar with the school, education environment, and children, and found the opportunity to meet with the children by getting involved in the activities, Then, "PSSS" was applied to the children in the experimental group and the control group as a pretest. A class attendance list was prepared in order to follow up on the children's participation in activities to be performed. Within the scope of the study, the PABSEP was applied to the experimental group in the 2022–2023 academic year between 19 September–02 December 2022 as four projects and 28 activities three days a week for 10 weeks. Pictures were taken and recorded while the program was being applied. The materials and printouts included in PABSEP (worksheets, painting paper, cutting and matching paper, etc.) were prepared in good condition and in sufficient numbers for the children by the researcher in a meticulous way that will attract the attention of the children. Following the completion of each activity, families were informed about family participation and reminded that they should be involved in the activities. For the activities performed at home with families, pictures and video recordings were asked from the parents. PABSEP was planned to be applied in 6 h a week for 10 weeks, 60 h in total, (by distributing it to 2 h in 3 days a week). In the implementation process, as planned application time proved insufficient in terms of finalizing the projects, activity durations were prolonged, and all activities were completed within 72 h. After PABSEP was applied to the children in the experimental group, "PSSS" was applied again to the children in both groups as a posttest.

Data analysis

In order to compare parametric and nonparametric tests to be used in the study, pretest was applied to both groups before implementing the PABSEP, posttest was administered to both groups after the implementation of the program. And, in this context, normality test, in which skewness and kurtosis values were examined, was applied in order to determine whether the data were normally distributed. Normality test is rather important in terms of evaluating the distribution of the data, and deciding what analyses and analysis techniques will be used (Şencan and Fidan, 2020). The statistical significance level was set at $p < 0.05$. As it was determined that the data showed normal distribution, one of the parametric statistical methods, independent samples t test was used in the analysis of the data. Analysis of covariance was used to determine whether there was a difference between the posttest scores of the experimental and control groups. To determine whether the difference in the final measurement scores of the experimental and control groups was due to the experimental condition, the pre-measurement scores were included in the analyzes as covariates (covariance).

Findings. In this part, analysis results regarding the determination of the effect of PABSEP on problem-solving skills of the children in the experimental group and the control group are presented.

Independent samples t test was used in order to reveal the difference between "PSSS" total scale and subscale pretest scores of the experimental group and the control group. As a result of the analysis, a significant difference was found in favor of the experimental group in terms of pretest total scores ($t = 3.175$; $p < 0.05$) and "describing the problem ($t = 3.374$; $p < 0.05$)", "deciding on the adequacy of the information for the solution to the problem ($t = 2.040$; $p < 0.05$)", and "identifying the elements of the problem ($t = 4.135$; $p < 0.05$)" subscales pretest scores. As a result of the independent groups t test, the effect size in the statistically significant sub-dimensions and the total score was determined to be small (Cohen's $d = 0.2$; $p < 0.05$).

Independent samples t test was used in order to reveal the difference between problem-solving skills scale total scale and subscale posttest scores of the experimental group and the control group. As a result of the analysis, it was seen that "PSSS" total scale and subscale posttest scores of the participants in the experimental group were higher compared to the scores of the participants in the control group. Accordingly, it was seen that posttest mean score of the experimental group participants ($X = 44.94$) was higher compared to the mean score of the control group participants ($X = 30.05$), and the difference was statistically significant ($p < 0.05$). As a result of the analysis, a significant difference was found in favor of the experimental group in terms of posttest total scores ($t = 17.595$; $p < 0.05$)" and "Noticing the Problem ($t = 7.653$; $p < 0.05$)" "Describing the Problem ($t = 11.986$; $p < 0.05$)", "Asking Questions About the Problem ($t = 8.833$; $p < 0.05$)", "Predicting the Cause of the Problem ($t = 10.025$; $p < 0.05$)", "Deciding on the Adequacy of the Information for the Solution to the Problem ($t = 10.381$; $p < 0.05$)", Identifying the Elements of the Problem ($t = 6.706$; $p < 0.05$)", "Identifying the Elements of the Problem ($t = 6.706$; $p < 0.05$)", "Use of Objects Differently from What is Known ($t = 7.736$; $p < 0.05$)", "Predicting the Consequences of Certain Actions ($t = 7.197$; $p < 0.05$)", and "Finding the Most Appropriate Solution ($t = 7.607$; $p < 0.05$)", "Choosing the Most Unusual Solution Among Many Solutions ($t = 8.455$; Cohen's $d = 0.6$; $p < 0.05$)" subscales posttest scores. As a result of the independent groups t test, the effect size in the statistically significant sub-dimensions and the total score was determined to be high impact (Cohen's $d = 0.8$; $p < 0.05$).

The results of the covariance analysis, which was carried out by controlling the pre-tests in order to determine whether the difference between the post-test scores of the children in the experimental and control groups was significant, are given in Table 3.

When Table 3 is examined, it is concluded that there is a significant difference in favor of the experimental group between the post-test scores of problem-solving skills when the pretest scores of the experimental and control groups are kept under control. In addition, the effect size was found to be high ($F(1,67 = 69.78$; $p < 0.05$; Cohen's $d = 0.80$). It can be said that project-based science education had a positive effect on the problem-solving skills of the experimental group. According to the effect size, it can be said that project-based science education is more effective than teaching based on the education program of the MoNE. (See Fig. 2).

According to Fig. 2, in the study examining the Problem-Solving Skills of 4–7-year-old children, the pretest and posttest results of the general scale scores of the experimental and control groups were examined together. It was revealed that the control means showed a slight improvement.

Discussion and conclusion

As individuals gain problem-solving skills, which are seen as one the essential skills of the 21st-century skills, starting from the early years of life is important in terms of the permanence of

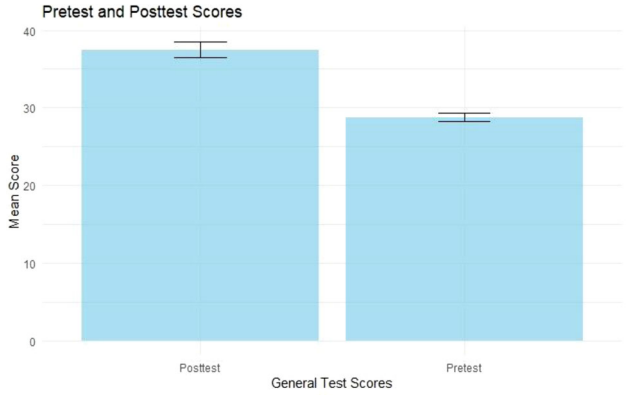

Fig. 2 Problem-solving skills pretest-posttest scores.

these skills. The findings of the study are discussed in light of the relevant literature.

In addition to being one of the essential skills of the 21st century, problem-solving skill is a skill required throughout life as individuals can encounter problem situations in all aspects of their lives. Problem-solving skill, defined as individuals' ability to overcome and solve the problems they face in their daily lives, develops along with each problem, and it is also seen as a process in which individuals learn through observing others and applying what they have observed. Problem-solving skills developed starting from the early years of life contribute to all domains of development, primarily including cognitive and socioemotional development. Therefore, the foundations of this skill should be laid as early as possible (Karayol and Temel, 2018; Akçay-Malçok and Ceylan, 2022; Yılmaz et al. 2018).

When the literature is reviewed, it is seen that there are a plethora of studies in which children's problem-solving skills are investigated; however, no study was encountered in the literature in which the effect of PABSEP on preschool children's problem-solving skills was investigated. In this context, it is thought that the findings of the present study will make a contribution to the literature.

Before the implementation of PABSEP, a statistically significant difference was found between "PSSS" total scale pretest score and "describing the problem", "deciding on the adequacy of information about the problem", and "identifying the elements of the problem" pretest scores of the children in the experimental group and pretest scores of the children in the control group ($p < 0.05$) (Table 2). In the literature, in studies conducted with pretest, posttest, and control group, while it was expected that the pretest scores of the experimental and control groups would be close to each other, there were also studies in which significant differences were found between the groups in terms of certain subscales of the scale used (Kiremitçi, 2012). In a study in which the prevalence of project-based learning (PBL) has increased significantly, contributing to serious discussions about its advent. In the study, the effect of the PBL method on collaborative learning, disciplined subject learning, iterative learning, and original learning was examined. The study revealed that the PBL technique increased student participation in knowledge information sharing and discussion (Almulla, 2020). In a study in which the effect of a drama-supported problem-solving education program applied to children attending a mobile nursery school was examined, a significant difference was determined between the pretest scores of the children in the experimental and control groups in the subscales of "describing the problem" and "predicting the consequences of certain actions" (Pehlivan, 2019). In another study in which the effect of intelligence games education program on children's problem-solving skills was investigated, significant differences were found between the pretest scores of the experimental and control groups in the subscales of "describing the problem", "deciding on the adequacy of the information for the solution to the problem", and "predicting the consequences of certain actions" (Kurupınar, 2021). It is seen that these findings support the findings of the present study. In the study, variables such as inability to select the children in a controlled manner, professional seniority of the teachers, how much the teachers included the learning outcomes and indicators related to problem-solving skills in the education process, high problem-solving skills of the teachers, high problem-solving skills of families of the children, and high problem-solving skills of the children when they started the school could not be controlled. High problem-solving skills pretest scores of the children in the experimental group in three subscales and in the total test may have resulted from these variables that could not be controlled.

On the other hand, no significant difference was found between the experimental group and the control group in terms of pretest scores in the subscales of "noticing the problem", "asking questions about the problem", "predicting the cause of the problem", "using objects differently from what is known", "predicting the consequences of certain actions", "finding the most appropriate solution", and "choosing the most unusual solution among many potential solutions". It can be stated that children being selected from those attending the same nursery school, similar ages, culture, and socioeconomic levels of the children, and similar attendance and family demographic information may have affected this situation.

The difference between pretest and posttest problem-solving skills total scale mean scores of the children in the control group was found to be statistically significant ($p < 0.05$) (Table 3). It can be stated that the increase in the posttest scores of the children in the control group to whom no intervention was made and only MoNE Preschool Education program was applied may have stemmed from the family environment where the children were raised, their environment, peers, teachers, and classroom environment. There are studies in the literature stating that factors such as the ages of the parents of the children in the family where they received their first education, their educational status, their accepting the child as an individual, attaching importance to the opinions of the child, and their child-raising attitudes affect problem-solving skills of the children (Begde and Özyürek, 2016; Eroğ lu, 2001; Görücü and Karakuş, 2017; Özyürek et al. 2018). It can be claimed that teachers' democratic attitudes, providing children with a free learning environment, including different types of activities in the classroom environment, and using different learning approaches and techniques in the classroom environment affect children's problem-solving skills. In studies conducted in this regard, it was determined that as a result of teachers' reflecting on their high problem-solving skills onto the classroom environment, they became role models and increased children's problem-solving skills (Güven, 2020). Children's intelligence scores and high critical thinking, questioning, and creativity skills also affect their problem-solving skills (Bildiren and Kargın, 2019; Erbaş et al. 2018; Kavuncuoğlu, 2019; Kurupınar, 2021). The presence of materials in the control group classrooms that children could use in different ways (find-plug toys, jigsaw puzzles, mirror, magnifying glass, rope, beads, Lego, etc.) and encouraged them to think creatively and solve problems and allowing children to use these freely in the classroom may have led to the increase in the posttest scores of the children in the control group. These findings show that the significantly higher posttest scores of the control group children than their pretest scores can be affected by various factors. On the other hand, there are studies in the literature that reported that the difference between problem-solving pretest and posttest scores of the children in the control group was not statistically significant, which is not consistent with the findings obtained in the present study (Aksüt, 2015; Kekeç Altun, 2013; Kurupınar, 2021; Turupcu Doğan, 2019). In a study in

Table 2 Comparison of the experimental group and the control group according to "psss" total scale and subscale pretest scores.

Subscales	Group information	N	Mean	SD	t	p
Noticing the problem	Experimental Group	35	3.1429	1.19171	−0.236	0.814
	Control Group	35	3.2000	0.79705		
Describing the problem	Experimental Group	35	3.6000	1.03469	3.374	**0.001***
	Control Group	35	2.9143	0.61220		
Asking questions about the problem	Experimental Group	35	1.8571	1.16677	0.654	0.515
	Control Group	35	1.6857	1.02244		
Predicting the cause of the problem	Experimental Group	35	3.5714	1.00837	1.049	0.298
	Control Group	35	3.3429	0.80231		
Deciding on the adequacy of the information for the solution to the problem	Experimental Group	35	3.3429	0.93755	2.040	**0.046***
	Control Group	35	2.9429	0.68354		
Identifying the elements of the problem	Experimental Group	35	3.4286	0.94824	4.135	**0.000***
	Control Group	35	2.5714	0.77784		
Use of objects differently from what is known	Experimental Group	35	2.7714	1.05957	0.517	0.607
	Control Group	35	2.6571	0.76477		
Predicting the consequences of certain actions	Experimental Group	35	3.2571	1.40048	0.371	0.712
	Control Group	35	3.1429	1.16677		
Finding the most appropriate solution	Experimental Group	35	3.2571	1.24482	1.746	0.086
	Control Group	35	2.8286	0.74698		
Choosing the most unusual solution among many solutions	Experimental Group	35	2.0857	0.70174	0.966	0.338
	Control Group	35	1.9143	0.78108		
Pretest general	Experimental Group	35	30.3143	4.63853	3.175	**0.002***
	Control Group	35	27.2000	3.48779		

$p < .05$

Table 3 Covariance analysis of problem-solving skills post-test scores of experimental and control groups.

Source of variance	Sum of squares	SS	Average of squares	F	p	Cohen's d
Pre-test	2.68	1	35.92	4.18	0.04	
Group	44.82	1	51.84	69.78	0.00	0.80
Error	43.03	67	39.91			
Total	65.57	69				

which the PBL is understood to be a promising approach that improves student learning in higher education. Empirical research on PBL is reviewed with a focus on student outcomes. Affective outcomes were most applied, which were measured by questionnaires, interviews, observation, and self-reflection journals (Guo et al. 2020). In the study, it was determined that following the PABSEP, posttest scores of the children in the experimental group in the total scale and all subscales significantly differed compared to the scores of the children in the control group ($p < 0.059$ (Table 4). It was also found that problem-solving skills of the children in the experimental group developed more compared to the control group children. When the literature regarding problem-solving skills of preschool children was reviewed, no study which directly examined the effect of PABSEP on children's problem-solving skills was encountered. In a study, it was determined that activity-based science education applications provided to preschool children aged between 5–6 years were effective in developing children's problem-solving skills, and that this effect was permanent (Aksüt, 2015). In a study in which the results of the study showed that compared with the traditional teaching model, PBL significantly improved students' learning outcomes and positively contributed to academic achievement, affective attitudes, and thinking skills, especially academic achievement (Zhang and Ma, 2023). In another study in this regard, the effect of drama-supported problem-solving skills education on problem-solving skills of children attending a mobile nursery school was examined, and it was found that the education program implemented positively affected children's problem-solving skills, and that this effect was permanent (Pehlivan, 2019). Similarly, as a result of a study in which the effect of "STEM" activities applied to preschool children aged between 48–72 months on the children's problem-solving and scientific process skills was examined, it was found that "STEM" applications developed the children's problem-solving and scientific process skills (Bal, 2018). In a similar study conducted by Kinik, an individual education program based on Montessori education was found to have increased problem-solving skills of children with special needs (Kınık, 2018). It has been determined that inquiry-based science and engineering program supports preschool children's problem-solving skills in science and engineering fields (Lin et al. 2021). It has been found in various studies that "STEM" applications in "preschool period" develop children's skills of creativity, critical thinking, problem-solving, and looking for different and original ways of solution while solving a problem (Akçay-Malçok and Ceylan, 2022; Akgündüz and Akpınar, 2018; Yalçın and Erden, 2021). In the study conducted by Kurupinar, it was determined that intelligence education program increased children's problem-solving skills permanently (Kurupınar, 2021). In another study conducted with the participation of gifted children, it was concluded that project approach-based early intervention program developed problem-solving skills of the gifted children, and that the effect was permanent (Bildiren and Kargın, 2019). It is seen that the findings obtained in these studies support the findings obtained in the present study. In light of the findings of the study, it can be claimed that in education programs that are equipped with rich stimulants and include various activity types, factors such as letting the children study on their own, providing concrete materials, cultural activities, being based on the principle of learning by experiencing, children's noticing where and how they made the mistake, provision of self-control and self-audit, orienting towards discovering through researching make children's learning process more enjoyable and facilitate it. In research in which magazines were analyzed and synthesized, it was emphasized that the PBL learning model is a learning model suitable for the 21st century. The research results showed that PBL can be categorized as a learning model in science learning that can improve student learning

Table 4 Comparison of the experimental group and the control group according to "psss" total scale and subscale posttest scores.

Subscales	Group information	N	Mean	SD	t	p
Noticing the problem	Experimental Group	35	4.6857	0.52979	7.653	0.000*
	Control Group	35	3.4286	0.81478		
Describing the problem	Experimental Group	35	4.9143	0.28403	11.986	0.000*
	Control Group	35	3.2000	0.79705		
Asking questions about the problem	Experimental Group	35	4.0000	0.76696	8.833	0.000*
	Control Group	35	2.3429	0.80231		
Predicting the cause of the problem	Experimental Group	35	4.6857	0.52979	10.025	0.000*
	Control Group	35	3.0286	0.82197		
Deciding on the adequacy of the information for the solution to the problem	Experimental Group	35	4.7429	0.50543	10.381	0.000*
	Control Group	35	3.2000	0.71948		
Identifying the elements of the problem	Experimental Group	35	4.4857	0.50709	6.706	0.000*
	Control Group	35	3.1714	1.04278		
Use of objects differently from what is known	Experimental Group	35	4.2571	0.65722	7.736	0.000*
	Control Group	35	2.8571	0.84515		
Predicting the consequences of certain actions	Experimental Group	35	4.6857	0.47101	7.197	0.000*
	Control Group	35	3.3429	0.99832		
Finding the most appropriate solution	Experimental Group	35	4.6000	0.55307	7.607	0.000*
	Control Group	35	3.2571	0.88593		
Choosing the most unusual solution among many solutions	Experimental Group	35	3.8857	0.86675	8.455	0.000*
	Control Group	35	2.2286	0.77024		
Posttest general	Experimental Group	35	44.9429	2.31292	17.595	0.000*
	Control Group	35	30.0571	4.43875		

outcomes and train students in problem-solving. As a result of the research, it was revealed that PBL has an impact on student learning, especially in science learning. (Nurhidayah et.al. 2021). The results obtained showed that the PABSEP was an effective program on children's problem-solving skills. In addition, it was determined that the skills gained through the PABSEP were permanent. Based on these results, family education workshops, conferences, and seminars aiming at families' supporting their children's problem-solving skills can be organized. Furthermore, courses on how to support children's problem-solving skills can be incorporated into the curricula of education faculties of universities. MoNE 2013 Preschool Education Program can be implemented in preschool education institutions based on a project approach. In order to determine the long-term effects of the program, researchers can conduct longitudinal studies.

Data availability

Readers can access basic data about the study from the corresponding author. They can also access the training program used in the study and developed by the researchers by contacting the corresponding author. All data generated or analyzed in this article is available upon request to the corresponding author. Since the objectives and achievements on which the curriculum is based belong to the MoNE, researchers do not have the authority to share them publicly. Correspondence and requests for materials should be addressed to the corresponding author.

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Author contributions

BG: Literature review, writing the introduction, methodology, organization of the article, following the publication process, discussion, writing the results. AK: Literature review, data analysis, methodology, discussion, writing the results.

Competing interests

The authors declare no competing interests.

Ethical approval

Ethical approval was taken from the "İnönü University Health Sciences Non-Interventional Clinical Research Ethics Committee" in April 2021 (2021/2427). The procedures used in this study adhere to the tenets of the Declaration of Helsinki. Ethical approval was obtained by the corresponding author before starting the study. The study was approved by the Inonu University in Turkey non-interventional clinical research ethics committee.

Informed consent

Before starting the research, children and their families were informed about its purpose. Informed consent to participate in the study was obtained from participants in each data collection round (informed consent was asked on the first page of each questionnaire). Consent was obtained from the mothers of the participating children in June 2021.

Additional information

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