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Designing a Package of Scientific Thinking Training and its Effect on Problem-Solving Skill in Preschool Children

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ABSTRACT

Scientific thinking is a type of knowledge seeking involving intentional information seeking, including asking questions, testing hypotheses, making observations, recognizing patterns, and making inferences. The purpose of this research was to design a package of scientific thinking training and investigate its effect on problem-solving skill in preschool children. For this purpose, this study was designed in two steps: At first step, based on Kuhn theory and by reviewing and analysing available resources, the scientific thinking training package was designed. This teaching package included discussions between the researchers and the child about stories with topics related to children's environment that they may not have encountered in everyday situations in the form of questions. At the second step, in order to determine the effect of scientific thinking training on problem-solving, 30 children aged five to six (15 female-15 male) with a moderate score in Raven intelligence test was chosen from three primary schools. The participants were trained individually in scientific thinking for eight sessions. Data were analysed using repeated measures analysis of variance. Findings showed that teaching scientific thinking significantly improved problem solving skills (p <005) and this effect was stable over time. The results of this study showed that preschool education and interaction with teachers is an opportunity to provide stimulated situations appropriate to children's abilities, and provide conditions for improving problem-solving. Thus, it can be concluded that scientific thinking training is an appropriate method for improvement of problem-solving skill in preschool children.

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Introduction

One of the main goals of the education system is to develop thinking skills in learners; that is, to teach children how to think and reason in the realm of general knowledge and specific knowledge so that they can face the challenges and problems of everyday life. One of the leading theories about thinking is scientific thinking. Scientific thinking is one of the main skills to enter the knowledge-based society in the 21st century, and the debate is to what extent children are capable of hypothesizing and experimental experiments (Lombardi et al., 2018). Scientific thinking is defined as a kind of purposeful thinking that a person involves in intentional information seeking (Morris et al., 2012). Scientific thinking is derived from a systematic and rule-based program called Oheric, which includes observation, hypothesis, investigation, and conclusion (Ledrapier, 2010), and it often focuses on the extent to which people are able to reason about causal relationships that allow them to empirically test scientific content and test hypotheses about everyday affairs (Dunber & Klahr, 2012). Paul and Elder (2019) introduced scientific thinking as a style of thinking in which a person improves the quality of his thinking about any subject, content or scientific problem, through skillful supervision and control of inherent structures and based on rational processes. These processes include knowledge of scientific questions, identification of evidence, conclusions and the communication of these conclusions (Tosun, 2019).

Vitti Rodrigues and Emmeche (2021) also examined several styles of scientific thinking, which include meaningful thinking, experimental thinking, classification, statistical analysis, and finding the cause of problems. According to Kuhn's theory, the process of scientific thinking acquisition consists of four stages: a) Exploration: when children encounter new situations, they begin to acquire information; b) Analysis: it involves comparing the information in the theory with the empirical evidence in the conditions; c) Conclusion: the conclusion is obtained according to the examination of comparisons; d) Discussion and reasoning: what happens in the previous stage is challenged regardless of whether the result is right or wrong (Kuhn, 2010). Scientific thinking in children, similar to what Inhelder and Piaget (1958) presented, is a kind of operation about operations, but despite what they have presented about formal operations, it is not delayed until adolescence and the early years of children's lives. It is an age full of extensive experiences leading to theorizing and revising many early theories. Children are more likely than adults to draw conclusions before insufficient evidence and focus on causal inferences first. They are not good at ignoring variables that do not play a causal role (Liben & Moler, 2015). Finally, it is necessary to realize that scientific thinking in children is different from philosophy for children. Philosophy for children is an educational activity that improves thinking in children and distinguishes philosophy as a way to cultivate moral thinking, critical thinking and creative thinking. In scientific thinking, the main argument used is inductive reasoning, which includes the stages of scientific activity of testing, discovering, arguing, and interpreting evidence in the framework of building theories, and is used as a means of understanding and reviewing evidence (Thitima & Sumalee, 2012).

Recent research indicates scientific thinking can be promoted through different methods in children (Herlina et al., 2023; Van der Graaf et al., 2018; Weisberg & Sobel, 2022). In order to teach scientific thinking, it is suggested to use collaborative learning techniques, storytelling and creating educational conversations (Donaldson & Hammrich, 2016; Lugmayr et al., 2017). Also, one of the methods of teaching thinking is based on the adaptive approach in which scientific concepts are formed by considering experiences and the learning environment is designed to encourage the learner to build knowledge in the form of data collection, hypothesis, and test predictions (Dejonckheere et al., 2016; Fusaro & Smith, 2018; Hmlin & Wisneski, 2012; Kuhn, 2015; Scherer & Tiemann, 2014). In the following, the question arises as to what kind of educational approach can be used for this purpose and what cases can be seen in its effect?

One of the leading theorists in this approach is Vygotsky (1987). Vygotsky believed that a child develops the knowledge of concepts from their everyday experiences in the context of social life and as a result of specific experiences, it is generalized to broader concepts (Hmlin & Wisneski, 2012). In this theory, the use of experience makes sense according to the concept of zone of proximal development (ZDP). This concept refers to the role of a more capable person who plays the role of supporter or scaffolding in the process of acquiring special knowledge or skills for the child (Saif, 2019). He stated that experiences in the approximate developmental area are performed using tools that mediate the construction of perception and thinking, and language is a tool that help the child to know social and physical environment by conversations (Robson, 2012). Therefore, the child's speech is internalized through dialogue and interaction and thinking is formed (Saif, 2019). According to Vygotsky's theory, reasoning conversations between an educator and the child facilitates and enriches the process of education. However, preschool science activities do not seem to include a regular curriculum based on what the scientific thinking process present (Lederpier, 2010). Developing the science thinking in children includes various cognitive skills such as problem solving (Lerner et al., 2015), which has been the important part of child development studies (Maker et al., 2022; 2023).

Problem solving includes a series of strategies such as observations, making prediction and hypothesizing, analyzing information and reasoning to achieve a goal (Hong & Diamond, 2012). Problem-solving skills are not acquired through a simple experience. The four major interdisciplinary skills that are mutually influential in problem solving include analyzing and understanding a message, reasoning, applying, structuring, and combining (Blondiaul et al., 2014). According to Vygotsky, problem-solving skills are also part of the development of intelligence and are gained through the acquisition of children's experiences in the environment, where education goes beyond independent exploratory learning and offers collaborative exploratory learning. In this type of training, reasoning and solution finding is done with the help of an instructor and according to the approximate area of the child's development (Hmlin &Wisneski, 2019).

Therefore, acquiring such a skill requires training in the application of thinking (Dostal, 2015). Children in the context of informal education are naturally curious about learning, begin their experiences through active exploration, have some problem-solving skills, and can even apply problem-solving metacognition strategies (Chen & Siegler, 2013; Lederpier, 2010; Olcer, 2017; Ramani & Brownell, 2014; Robson, 2012; Van der Graaf et al., 2018; Vidergor, 2018). In the process of teaching cognitive skills, the teacher must respect the child's abilities, allow him/her to have the necessary independence to discover, and give the opportunity to use their informal strategies (Dejonckheere et al., 2016). In addition, instead of focusing on the correctness of the answers, children should be asked to justify their approach after solving the problem (Lederpier, 2010). This method allows the child's ideas to be modified by experience and to go much deeper even if there is an initial misrepresentation of the world (Duckworth, 1987), and problem-solving skills can be expressed as a result. However, there are few data on teaching scientific thinking in preschool-age children and its effectiveness on problem solving skills. Thus, the main aim of the current study was to examine the effect of specific types of instructional approaches to teaching scientific thinking on children's problem-solving skills.

The Current Study

Scientific thinking is part of the so-called 21st century skills, which prepares children for participation in the knowledge society (Fischer et al., 2014) and problem-solving skills are one of the foremost and fundamental skills in life (Bahar & Aksu, 2020; Çiftci & Bildiren., 2020). Children who identify problematic situations can investigate causes and consequences, create thought processes, and choose appropriate solutions (Bahar & Aksut, 2020; Mehmet, 2017). Given that the behaviors acquired at an early age are permanent; therefore, it is vital to train problem-solving skills in preschool and elementary school and the early years of child life (Özbey & Köyceğiz, 2019). Previous studies have mainly focused on 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 (Csapó & Funke, 2017; Villeneuve, 2019).

In this regard, Lederpier (2010) stated that it is necessary for children to learn the application of reasoning in scientific activities and everyday issues. It seems that scientific thinking can help children improve their problem-solving skills. Based on previous studies, implementing the appropriate learning model can empower students' scientific thinking skills, hence, the present study was designed to examine the effect of scientific thinking training on preschools' problem-solving skills. Also, despite agreeing on the importance of scientific thinking and its teaching method, it seems that the choice of its educational content has not been considered and there is no approved training package, so considering the lack of a training package, it seems that designing a training package for scientific thinking is essential. As mentioned by Van der Graaf et al. (2018) and Dejonckheere et al. (2016), this package should be appropriate for children's cognitive abilities and should be able to affect thinking skills, including (such as) problem solving skill.

Method

Design

This study was recruited in two major stages. The study adopted an exploratory descriptive design in the first phase and a quasi-experimental design with pre-test, post-test, follow-up with control group was used in the second phase.

In the first stage of the research, scientific thinking training package for preschool children was designed through reviewing theoretical and research literature and analysis of available programs. This part encompassed four steps: Step 1) Definitions and characteristics of the concept of scientific thinking were discussed and based on the Kuhn's theory, the model of training was considered in four stages: a) exploration; b) analysis; c) conclusion; d) discussion and reasoning; Step 2) The background and programs in the resources were examined including existing books, articles, and research; Step 3) The resources were reviewed and the lack of organized and applicable package to teach scientific thinking was revealed; and Step 4) A training package was designed according to the analysis of available resources (e.g. Donaldston & Hammrich, 2016; Dostal, 2014; Erturk, 2015; Jamhari & Sipahutar, 2018; Kuhn, 2010; Lederpier, 2010; Lugmayr et al., 2017; Osterhaus et al., 2015; Ramani & Brownell, 2014; Tosun, 2019) in the form of a story plan for 8 sessions. The experiments for those sessions were related to the environmental issues including planting, and personal health and illness. In these experiments, children were confronted with seemingly correct, but incomplete or contradictory situations, and questions and hypotheses arose in their minds. Stories included situations with one hypothesis, two hypotheses, and in more advanced stages, three hypotheses, that is, in the initial sessions, the study of how to perform the experiment using a method to achieve the result, and in subsequent sessions, the development of children and the story. The tests were expanded and the experiments were presented in the form of examining the conditions between two or more test methods. At the same time, these experiments were performed by drawing pictures on the board, and children expressed their opinions about the accuracy of the experiments. Of course, an important intellectual challenge for children was the argument they made for their answer. The following is the first session of teaching scientific thinking.

The story of the farmer and the miraculous medicine for the growth of trees “Agriculture travelled to a distant land”. There were many trees and flocks in that green land. But the farmer wondered why the trees of this land were small and did not grow. The farmer thought of what he could do to make the trees grow, made a medicine, called it growth medicine for the trees, and to test its effect, he put it on the trees and returned home. After a while he travelled again to a distant land and saw that all the trees had grown and grown. “He concluded that only the medicine he made caused the trees to grow, and suggested to all farmers that it was enough to use his miraculous medicine to grow the trees.”

At the end of the story, the children were asked if the farmer had done the experiment correctly. Why? The researcher-child debate was that the researcher first taught children to explore what conditions require the growth of trees. In the second stage, children were trained to evaluate the use of growth-enhancing drugs against the conditions required to care for trees. The children then entered the third stage with the help of the researcher to infer how correct the farmer's experimental method was. In the last stage, which is a discussion and argument, the researcher entered a discussion with the children about their response and discussed the credible reasons from the children's language and the results from their point of view.

The CVI index used the agreement of experts to evaluate the items "relevance", "clarity" and "simplicity" according to the method of Waltz and Bausell (1981) and to examine the content validity index. For this reason, seven specialists who worked in the field of cognitive psychology and thinking or had conducted research and activities in this field participated in this stage. The results showed that the CVI index for the questions was higher than 0.79 and the average of the total scores was 0.88. According to the obtained results, the content validity of the designed package of teaching scientific thinking for preschool children was confirmed.

Participants

For this study, 30 preschool children (15 female, 15 male) aged from five to six were selected as a purposive sampling. These children were selected from among the families who lived in the 6th district of Tehran province with average socio-economic status. Also, these children were selected from among those who took the Raven IQ test and scored 110-100. According to the explanations made in the briefing session and obtaining parental consent, fifteen participants were finally selected in each group according to Seltman (2018) and randomly assigned into experimental and control groups. Before the implementation of the test, importance of scientific thinking was explained to the principals, teachers and parents and the mental and psychological safety of children during education and evaluation were clarified for them.

Instruments

Problem-solving Tasks

In order to evaluate problem-solving skills in preschool children, the content of problem-solving tasks was designed as parallel questions so that children's answers are accompanied by thinking and reasoning. The sources used to design problem-solving situations where the topics presented in the theory of scientific thinking, the book Journeys of the Mind (Talkhabi, 2019) and the concepts of science and mathematics for preschool education.

In ten problem-solving situations designed for preschool children, information processing exercises (relationship analysis and comparison and confrontation, ordering, classification), situation evaluation, reasoning (ability to provide reasons for ideas and actions), application of creative thinking and research (predicting outcomes, testing and conclusions) were considered. The content of these assignments generally included issues related to weight, keeping animals and plants in different conditions and distinguishing similarities and differences based on reasoning related to the intended situation such as travel conditions in different seasons and selecting the appropriate space based on the type of equipment. All problems were designed to allow children to answer questions using reasoning, and increase the effectiveness of the scientific thinking training process including enhancing the ability to explore, analyze, infer, and reason. Ten questions designed in pairs of five parallel questions were aimed in such a way that the children's answers were accompanied by thinking and reasoning so that the effect of the scientific thinking process in increasing problem-solving skills can be investigated using the designed conditions.

The problem-solving scores in the five stages of pre-test and post-test were 8, 4, 9, 3 and 6 points, respectively, and the total score in each of the stages - pre-test and post-test - was 30 points. In the pre-test phase, problem solving skills were examined in five stages. Then, the process of scientific thinking was taught in 8 sessions. In the post-test stage, the problem-solving skills were examined in five stages and then after a month, a follow-up meeting was held with the repetition of the content discussed in the post-test.

The content validity of the questions was evaluated by the experts. The CVI index relative to problem-solving tasks was higher than 0.79, so it can be claimed that the designed assignments had good content validity. Also, the reliability of tasks using the test-retest method was 0.724, which is a statistically acceptable value.

Procedure

Before implementing training sessions, the purpose of the research was explained to parents and written consent for participating their children in this study was obtained. The selected children were then divided into two groups including sample of preliminary implementation and main sample of research. After evaluating the effectiveness of scientific thinking training in promoting problem solving skills in preschool children in the preliminary stage, based on pre-test, post-test, follow-up with control group design, the main sample randomly were divided into experimental and control groups. In the pre-test stage, problem solving skills were assessed in five stages. Then the process of scientific thinking was taught in 8 sessions. In the post-test stage, problem solving skills were tested in 5 stages and then one month after the last post-test stage, a follow-up session was held with the repetition of the content presented in the post-test. In order to evaluate the effectiveness of scientific thinking training on improving problem solving skills in preschool children, the repeated measurements with mixed design was used and data analysis was performed with SPSS-25.

It should be noted that the control group received scientific thinking training after the intervention of the experimental group due to ethical considerations.

Results

To evaluate the effectiveness of scientific thinking training on improving problem solving skills, the obtained data were analysed using the repeated measures analysis of variances. Repeated measures test assumptions with are presented including Shapiro-Wilk's test for normality of dependent variable distribution, Mauchly's test of sphericity for variance-covariance matrix homogeneity of dependent variable, and Levene's Test of Equality of Error Variances for the assumption of homogeneity of covariance between groups.

Table 1.
Test of Problem-Solving Skills Scores Using Shapiro-Wilk Test

Shapiro-Wilk			Sig.
Variable	Statistics	DF	
Problem solving 1	0.89	8	0.23
Problem solving 2	0.93	8	0.52
Problem solving 3	0.85	8	0.11
Problem solving 4	0.82	8	0.06
Problem solving 5	0.83	8	0.06
Total score	0.93	8	0.53

Based on the results obtained from the Shapiro-Wilk test, the condition of equality of intragroup variances as well as the normal distribution of the data is established because the values obtained for these tests in a group at the level of 0.05 is not significant. Also, Levene's Test was used to investigate the conditions for establishing equality of variances between the two groups. Table 2 reports the test results.

Table 2.
Levene`s test of Equality of Error Variances

	Levene Statistics	df1	df2	Sig
Problem solving 1	0.001	1	6	1.00
Problem solving 2	1.50	1	6	0.26
Problem solving 3	4.50	1	6	0.07
Problem solving 4	2.45	1	6	0.16
Problem solving5	1.00	1	6	0.35
Total score	0.001	1	6	1.00

The assumption of the homogeneity of variance of the scores of the two groups was investigated using Levene's test and considering that the value of Levene's F value is not significant at the level of α = 0.05, the assumption of homogeneity of variance of the data is established.

In order to perform the repeated measures analysis of variance test, the presumption of sphericity (equality of variance of the difference of all repeated measure pairs) was checked by performing the Mauchly's test.

Table 3.
Mauchly`s Test of Sphericity

Mauchly`s Test				Sig.
Variable	**Mauchly`s W**	**Approx.Chi-Square**	**df**	
Problem solving 1	0.96	0.51	2	0.77
Problem solving 2	0.92	1.06	2	0.58
Problem solving 3	0.99	0.09	2	0.95
Problem solving 4	0.94	0.78	2	0.67
Problem solving5	0.96	0.42	2	0.80
Total score	0.55	7.63	2	0.06

Due to the non-significance of Mauchly's statistic, the sphericity modified degrees of freedom is the basis of the F report. Table 4 shows the results of repeated measures analysis of variance test in problem solving skills assignments in pre-test, post-test and one-month follow-up.

Table 4.
Results of Repeated Measures Analysis of Variance in Problem Solving Skills in Pre-Test, Post-Test and Follow-Up

Variable	Source	Type III Sum of Squares	df	Mean Squares	F	Sig.
Problem solving 1	Group	42.71	1	42.71	15.78	0.001
	Time	8.82	2	4.31	10.93	0.001
	time* group	13.95	2	6.97	17.69	0.001
Problem solving 2	Group	8.10	1	8.10	11.51	0.002
	Time	4.35	2	2.17	8.07	0.001
	time* group	0.86	2	0.43	0.95	0.06
Problem solving 3	Group	28.90	1	28.90	16.18	0.001
	Time	14.60	2	7.30	22.55	0.001
	time* group	11.27	2	5.63	17.39	0.001
Problem solving 4	group	16.90	1	16.90	46.90	0.001
	Time	15.02	2	7.51	54.00	0.001
	time* group	9.86	2	4. 93	35.52	0.001
Problem solving 5	Group	22.50	1	22.50	14.37	0.001
	Time	51.48	2	25.74	52.65	0.001
	time* group	22.46	2	11.23	22.97	0.001

Variable	Source	Type III Sum of Squares	df	Mean Squares	F	Sig.
Total score	Group	557.51	1	557.51	45.45	0.001
	Time	377.86	2	188.93	119.98	0.001
	time* group	264.62	2	132.31	84.02	0.001

According to Table 4 and emphasizing the amount of F obtained from the study of time effectiveness, it can be stated that there is a significant difference in problem solving skills scores at three levels of pre-test, post-test and follow-up measurement (p = 0.05). Examining the differences between groups also shows a significant difference in all problem-solving scores, which indicates an improvement in problem-solving skills by teaching scientific thinking. The interaction effect of group and time also shows a significant difference in the scores of problem-solving skills except problem solving skills 2. Table 5 shows the mean, standard deviation and the differences between the two groups in the three stages of pre-test, post-test and follow-up.

Table 5.
Mean, Standard Deviation and the Pairwise Differences between the Experimental and Control Groups in Three Stages of Pre-Test, Post-Test and Follow-Up

Variable		Pre-test		Post-test		Follow-up		Mean differences Pre-test-post-test	Mean differences Pre-test-follow-up
		Mean	SD	Mean	SD	Mean	SD		
Problem solving 1	Experimental	4.33	0.29	5.70	0.24	6.26	0.29	*-1.37	*-0.56
	Control	4.06	0.29	3.73	0.24	4.00	0.24	0.27	0.06
Problem solving 2	Experimental	2.60	0.16	3.06	0.17	3.46	0.16	*-0.46	*-0.86
	Control	2.40	0.16	2.33	0.16	2.60	0.17	-0.07	0.20
Problem solving 3	Experimental	4.86	0.23	6.53	0.21	6.40	0.24	**-1.67	**-1.54
	Control	4.73	0.25	4.86	0.21	4.80	0.24	-0.13	-0.07
Problem solving 4	Experimental	1.26	0.12	2.80	0.11	2.86	0.14	**-1.54	*-1.60
	Control	1.33	0.12	1.53	0.12	1.46	0.11	-0.20	-0.13
Problem solving 5	Experimental	1.06	0.17	3.46	0.25	3.93	0.27	**-1.43	**-1.56
	Control	1.46	0.17	1.93	0.25	2.06	0.27	-0.47	-0.60
Total score	Experimental	14.13	0.56	21.60	0.61	22.5	0.57	-**7.47	**-8.40
	Control	14.00	0.55	14.40	0.60	14.93	0.57	-0.40	-0.93

The results of Bonferroni post hoc test show that in problem solving 1, the difference between the mean scores of the pre-test and post-test is significant while the difference between the mean scores of pre-test and follow-up is not significant. Also, the results of this test show that in problem solving 2, there is no significant difference between the mean scores of pre-test and post-test, but the difference between the mean scores of pre-test and follow-up is significant. In problem solving tasks 3, 4 and 5 as well as the total score of problem-solving skills, the difference between the mean scores of pre-test and post-test and pre-test and follow-up is significant. Therefore, it can be stated that the effect of this program on improving the problem-solving skills of preschool children is significant and this effect does not disappear over time and remains stable.

Discussion

The aim of the present study was to design a scientific thinking training package and determine its validity, and in the second stage, to determine the effectiveness of scientific thinking training on improving problem-solving skills in preschool children. In the first phase, after reviewing the studies and resources available in the field of teaching scientific thinking, considering Kuhn's theory and using the suggestions and examples presented in social adaptation approach that emphasize the supportive role of the instructor in the forming of higher mental functions, the content of the training package including topics such as nature, educational environment and health, was designed to able children to analyse the story of each experiment and the influencing factors, compare the proposed conditions with the available information, and draw conclusions using reasoning.

In the second phase, the aim was to determine the effectiveness of scientific thinking training on promoting problem solving. According to the results of teaching scientific thinking, this skill can be implemented and taught for preschool children. This result is consistent with other studies that suggest cognitive ability in children (e.g. Chen & Siegler, 2013; Lederpier, 2010; Olcer, 2017; Ramani & Brownell, 2014; Robson, 2012; Vidergor, 2018) and that children can focus on problems and understand how to solve the problems presented. As early years of life are of vital importance to achieve the goals in the coming years and childhood creates the framework of life in the following years, science education and scientific activity should be involved in the preschool education programs.

Another result of the present study was that teaching scientific thinking had a positive effect on problem-solving skills and children after training had higher reasoning skills in problem solving. Such a finding confirms the results of the studies on the impact of training on problem-solving skills (Dostal, 2014; Rubenstein et al., 2019; Yampinige & Chaijaroen, 2010). It was concluded that one of the applications of teaching scientific thinking is to improve the skill of hypothesizing, comparing and reasoning in problem solving skills. Consequently, if the teachers create training conditions according to the approximate area of growth and with the aim of developing cognitive skills, problem solving skills will improve.

To describe how the training using the designed package is effective, it can be mentioned that the content was used from topics related to daily life so that it would be understandable for the children. In addition, presenting experiments through storytelling and the game has been one of the effective ways of education at this age. Therefore, not only creating attractiveness and drawing children's attention to the topic under discussion, but also creating a symbol of reality and a motivational atmosphere helped the transformation of understanding, reasoning and thinking in children to achieve a higher level of thinking. Moreover, the use of questions in the form of conversations and discussions between the researcher and the children according to the social constructivist approach might be another factor which made the training package effective. The designed dialogues included confrontation of viewpoints, transfer of understanding, reflection of the required information and creation of a question and answer atmosphere. These dialogues were designed and guided in such a way that children could draw conclusions by using inductive reasoning in the education process.

In general, the results of the present study, in contradiction with the views of Inhelder and Piaget (1958) and the view of Vygotsky (1987) confirmed that by educating children, they will be successful problem-solving skills. It is necessary to state that the result of present study was in contrast with the view that underlines cognitive limitation of learners. The children in the present study were curious and had the desire to enjoy experiences in discussions, to understand conversations in a logical way and present a theory. In addition, they were able to improve their cognitive skills through interaction in relation to the researcher, learn the restraint of thinking and discuss events and concepts and solve problems. Therefore, by creating such interactions, we can ask them to engage in reasoning and consider these skills in future problem-solving situations.

The results of post hoc test also showed that in problem 1, the difference between the mean scores of pre-test and post-test was significant while the difference between the mean scores of the pre-test and follow-up was not significant. The results of this test also showed that in problem 2, there was no significant difference between the mean scores of the pre-test and post-test, but the difference between the mean scores of pre-test and follow-up was significant. In explaining the results of these two questions, it can be said that although there is no statistically significant difference, the average scores of problem-solving skills showed the improvement of children’ problem-solving skills compared to the pre-test stage and the positive impact of teaching scientific thinking. It is also important to note that in this study, the goal of children's improving in problem-solving skills was related to the teaching scientific thinking and statistical significance was not prioritized. Because the promotion of children in cognitive skills, including problem solving, is one of the most important factors in progress in the academic years and success in today's technology environment. If children at preschool age can acquire high problem-solving skills, they can enter the knowledge-based society and face the ambiguous situations in later years, with more self-esteem in the application of thinking skills.

Another noteworthy point is that in the review process, while improving the problem-solving skills of the children, they were more motivated to solve the next tasks. Also, according to preschool officials, children were more diligent than before in completing their preschool assignments, which included drawing, arranging, and jigsaw puzzles that required more reflection, analysis, and precision. It can be assumed that the improvement in cognitive skills (in this study is the successful performance of children in problem solving skills) has a positive effect on their mental state and this finding is consistent with the findings of Robson (2012) showing that the improvement in problem-solving skills is associated with higher mental health, less anxiety and more self-confidence.

Conclusions

Given that the development of cognitive skills is effective in various aspects of performance including problem-solving skills, as well as less attention to the importance of teaching scientific thinking in children, the researchers found it necessary to examine the issue. It is necessary to pay attention to the training of special thinking skills from an early age, which is the basis of mental abilities to teach people from childhood to deal with problems with developed reasoning and to be able to progress towards their goals. Therefore, preschool education officials are suggested to consider the teaching of cognitive skills, including scientific thinking, as one of the applications in educational planning in order to expand the content and provide educational conditions for educators and learners.

The inclusion of a specialized thinking program in children's curriculum requires continuous meetings and training for educators on how to implement the educational process according to the characteristics of learners. In addition, considering the need for appropriate cognitive tools for children, it seems useful that the education and assessment process be provided to educational authorities and parents in the form of applications and websites so that they can also enjoy the benefits of distance cognitive education.

A noteworthy point in the research limitation is that providing interest and focus for each child to participate in the required screening process, due to their young age, required a lot of time. Therefore, conducting more extensive research on the implementation of educational content, by spending more time and the wider community, as well as the study of variables related to the teaching of scientific thinking in children seems useful and interesting. Finally, due to the fact that research in the field of scientific thinking is still not enough, more extensive studies, considering the role of this variable in relation to other learning variables in children can have fruitful results.

By mentioning the importance of the social constructivist approach in the research results and considering the importance of the development of thinking in preschool age, we hope that the proposed package will be available to educators in the form of educational tools in the form of computer and online programs. Also, considering the importance of the role of teachers and parents in teaching thinking, it is suggested that training sessions be considered for them on how to effectively use scientific thinking techniques.

Conflicts of Interest

No conflicts of interest declared.

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Appendix

The content of a sample problem-solving questions is as follows:

Problem solving 1 in the pre-test stage

Children are shown pictures of different parts of a house with different equipment. The child is then asked: How many people do you think live in the house, given the number of rooms in the house? How did you find out? Does each room belong to a child or an adult? How did you find out?

Solving the parallel problem in the post-test phase:

Children are shown a luggage with different clothes in it and it is said that the owner of the luggage allowed us to see inside the luggage. Items that include gown, shirt, child blouse, are shown to the child. The child is then asked: Given the items chosen, do you think the weather in the place the family intends to travel is cold or warm? How did you find out? Each of the clothes belongs to the man or a woman? How did you find out?