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The Effect of Creativity Training on Problem-solving, Continuous Attention, and Spatial Working Memory in Preschool Children

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ABSTRACT

This research aimed to examine the effectiveness of a creativity training program on the executive functions of preschool children. The research method employed a quasi-experimental design with pre-test, post-test, one-month follow-up, and a control group. The population consisted of five to six-year-old children in the preschool stage in District One of Tehran during the academic year 2021-2022. The sample size was selected based on Cohen's table with an effect size of 0.5 and a test power of 0.8, equaling 15 participants for each group. 30 children who met the entry criteria were identified and randomly replaced in two control and experimental groups. Participants completed such computer-based tests as Hungry Donkey Task, Tower of Hanoi, Continuous Performance Test, and N-Back Spatial Working Memory. During this period, the control group followed their normal daily schedule. Data was analyzed using mixed analysis of variance. The results indicated that the creativity training program significantly influenced decision-making, problem-solving, continuous attention, and spatial working memory. It is suggested that child psychologists and people dealing with preschool children use creativity training to enhance executive functions in preschool children.

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Introduction

Creativity is defined as the highest expression of new ideas, flexibility in perspectives, the ability to combine unrelated concepts in different ways, and avoiding common paths (Bender et al., 2012; 2014; Bender et al., 2012). In creativity, the concept of novelty, initiative, and personal and social factors are emphasized by proponents. However, creativity is a complex matter, and for this reason, Torrance, after fifty years of research and study in the field of creativity, stated that it is not possible to provide an explicit and comprehensive definition of creativity (Kaufman, 2016). Creative thinking clearly requires executive functions (Kaufman, 2016). These skills are associated with the activity of the prefrontal cortex (Bender et al., 2012; Dietrich, 2004). Success in creativity requires creativity, flexibility, self-discipline, and organization which are important for executive functions, including mental games with ideas, providing non-automatic responses, and maintaining focus (Diamond et al., 2013).

The ability to control thoughts and actions in response to goals is referred to as executive functions (Diamond et al., 2013). Executive functions are cognitive functions based on brain structures that are associated with cognitive processes (Zelazo et al., 2013). Executive functions are a class of cognitive processes associated with prefrontal cortex activities (Koechlin et al., 2011), and they seem to be related to creativity, which is considered a high-level cognitive ability (Bender et al., 2014). Executive functions are important structures that play a crucial role in controlling and directing behavior, and are important for successful performance in real-life situations (Buckner et al., 2014). They allow individuals to initiate and complete tasks and exhibit resilience in the face of challenges (Divin et al., 2018). Given the unpredictable nature of environmental conditions, executive functions are crucial structures that help humans recognize unexpected situations and quickly design plans and strategies (Mari et al., 2016).

Executive functions are more important than intelligence quotient for school readiness. They continue to predict mathematical and reading abilities throughout all school years. It is evident that prioritizing executive functions is crucial for improving school readiness and academic success. Executive functions are vital for success in various aspects of life (career, as well as marriage, mental and physical health) (Bendik et al., 2014; Güner-Yıldız et al., 2013; Sharma et al., 2017).

Deficits in some of these executive functioning are important to the diagnosis of some educational needs, such as attention, concentration, flexibility and problem solving. Authors such as Filippetti and Richard claimed that the development of executive functioning improves academic performance. These evidences are important to know how they relate to creativity and intelligence (Pasarin-Lovin et al., 2023). Creative games are considered as one of the important strategies to improve executive functions (Yogman et al., 2018). Creative games are considered as one of the important strategies to improve executive functions and lead to the improvement of cognitive flexibility, problem solving skills, and emotion management (Yogman et al., 2018). Meanwhile, rhythmic games provide favorable conditions for improving executive functions (Dolgikh et al., 2023; Rosas et al., 2019).

It is very important for children to acquire executive functioning skills as they are the foundation for learning and achieving goals, not only in academic areas but throughout life. While executive function skills in the preschool years predict children's readiness for school in both academic and socio-emotional dimensions, they also predict overall life success including academic progress during the school years, social competence, physical health, and future socio-economic status (Yogman, 2018). Researchers suggesting that executive function skills are better predictors of short-term and long-term academic progress than intelligence quotient (Zelazo et al., 2016).

Education is considered the most influential place for nurturing students with creative thinking in order to prepare them for future challenges. However, it must be acknowledged that in modern classrooms, teaching methods have increasingly become uniform and purposeful in transferring knowledge. It seems that teachers share their knowledge in a concrete manner and do not necessarily allow students to experience the methods through which discoveries are made. Understanding the nature of creativity and its application has significant implications for teachers and students. Teachers adopt different creative approaches and emulate them in order to have the greatest impact on their students. As for students, introducing them to creative approaches and techniques helps them develop creative thinking processes to pursue creative opportunities in their lives (Rosas, 2018). Some authors describe the preschool years as a golden age of creativity (Gardner, 1982). During these years, all children naturally demonstrate their creative abilities. Children play spontaneously and creatively, sing, draw, tell stories, and create puzzles. It is undeniable that children possess creativity. In fact, some believe that children are the embodiment of human creativity (Glăveanu, 2011).

In relation to the possibility of teaching creativity, many researchers and authors have expressed the possibility of teaching creativity. Research has shown that creativity is teachable, and schools play an important role in fostering or inhibiting creativity. For

example, the findings of research by Alfonzo et al. (2013) demonstrated that creative methods during a child's preschool years have an impact on their subsequent development. These researchers also designed an intervention program for developing creativity, considering both the outcome of creativity and the processes and abilities of divergent and convergent thinking.

Executive functions overlap with attention, reasoning, cognition, and problem-solving domains and include activities such as attention, status change, set maintenance, interference control, inhibition, spatial and temporal coherence, planning, working memory, regulation, and decision-making (Brandt et al., 2015). Executive functions help with conscious, purposeful planning and monitoring of necessary abilities for problem-solving. Performance skills allow individuals to focus on tasks, adapt to changes, recognize and understand how different issues may require different rules or actions. They also allow individuals to filter and stop thoughts or motivations. These skills impact individual interactions in their family, community, school, and workplace and extend to a broader ecosystem. Executive functions, when combined with creative thinking, play a vital role in vision, imagination, and intention in creating a desirable future (Klauwod, 2012).

The relationship between executive functions and executive functions such as response inhibition, working memory, and attention has been established in previous research (e.g. Carlson et al., 2015; Mazaku et al., 2017). The findings of Carlson et al. (2015) showed that the components of executive functions in the brain can predict false beliefs in individuals. Working memory and attention, as components of executive functions, not only have a significant impact on individual cognitive functioning (Brononi et al., 2014) but also predict individuals' beliefs (Carlson et al., 2015). Working memory, attention, concentration, and monitoring play an incredibly important role in the development of growth and acquisition of new skills in children (Diamond, 2013). Individual differences in the components of working memory, attention, concentration, and monitoring have significant effects on the acquisition and execution of a range of complex cognitive skills and impact everyday life (Zelazo, 2015). The study by Devine and Hughes (2018) showed that individuals with weak working memory, attention, and concentration perform executive functions and mental representations below the expected level, particularly in terms of planning and attention.

In the research of Ansbach and Hill (2003) and Zabelina and Beeman (2013), the relationship between creativity and executive functioning was demonstrated. Specifically, research shows that executive skills such as goal-directed attention and information processing capacity are greatly enhanced by training in creative thinking skills (Bott et al., 2014; Vartanian et al., 2007). On the other hand, higher-level performances are less susceptible to improvement after training. Solberg and Martin (2001, as cited in Pourdeyhimi, 2011) also considered fluid thinking as part of executive functions, and Dorin (2009) regarded creativity as an important aspect of executive functioning due to its impact on inhibition, goal-directed behavior, problem-solving, and mental flexibility. According to Jensen (2012), the prefrontal cortex is involved in activities such as judgment, problem-solving, planning, and creativity, and plays a significant role in creativity (Dietrich, 2004). Von der Linden et al. (2018) found that executive functions have a close relationship with thinking and creativity.

Recent Functional Magnetic Resonance Imaging (fMRI) research, which examined brain activity during creative tasks, has shown that the generation of creative ideas (such as creative thinking) is associated with extensive activity in the left prefrontal cortex and right middle temporal lobe, as well as the deactivation of the right parietal junction (Benedek et al., 2013). Some other studies have also shown that divergent thinking is associated with the activation of the ventral prefrontal cortex and higher regions of the dorsal prefrontal cortex, including the anterior and posterior regions of the prefrontal cortex (Abraham et al., 2012; Fink et al., 2009; Vartanian et al., 2007). Furthermore, there is increasing evidence that the ability to generate highly creative responses is related to effective executive functioning (Benedek et al., 2013; Gilhooly et al., 2007; Jack et al., 2013; Nusbaum et al., 2011). However, the exact nature of the relationship between different executive functions and creativity is still under investigation.

In Iran, various researchers have conducted creativity education programs, such as Ganji et al. (2012), Zekriayi et al. (2008), Ya'ghoubi et al. (2011), Mohammadi et al. (2019), Abdi Qashlaq and Puyamanesh (2014), and Raghibi et al., (2016). Creativity is not considered as an individual discipline in the pre-school curriculum. However, creativity is the foundation of the curriculum. Children should be able to express themselves in different and unique ways that are aligned with their learning needs and styles. To create this opportunity, relevant activities should support creativity (Der, 2019). By using creative approaches and techniques, teachers develop new methods, new tools, and new content for their own benefit. Creativity helps improve the academic performance of students (Der, 2018). It should be noted

that school is no longer just a place for learning, but a dynamic place for human development (Volk, 2009).

Considering the research on the relationship between creativity and culture, such as Sixsmith-Hayes (2015), Kwan Koh and Tsai (2012), Fazeli (2008), and Anderson et al. (2014), in this study, we aimed to design and evaluate the effectiveness of creativity education within a research framework taking into account the cultural conditions of our society on executive functions.

Considering that the best time for teaching creativity is childhood, the need to focus on this period and investigate creativity education for children can be an important research concern. It is hoped that through this research, a better understanding of these factors can be achieved, and a foundation can be provided for policymakers, planners, and managers of pre-school programs to take effective actions in implementing and incorporating creativity programs into students' curriculum. The present study examined the impact of creativity education on executive functions of pre-school children by developing a creativity education program for pre-school children based on the following question:

– What is the impact of creativity education on the executive functions of pre-school children?

In any research, there are ethical considerations that the researcher is required to follow. In this research, the ethical considerations were as follows:

1. Voluntary and optional participation in the research;
2. Description the steps of research before implementation;
3. The right to be anonymous in tests and to use codes instead of people's names;
4. Providing research results to parents of children upon their request;
5. Keeping participation information confidential and assuring them of confidentiality.

Method

Design

This study adopted a quasi-experimental with a pre-test-post-test design with an experimental group and a control group and a one-month follow-up.

Participants

The population consisted of five to six-year-old pre-school children in District 1 of Tehran in the year 2021-2022. To select the sample, first, two preschool centers were selected from district one of Tehran, and then 30 children who met the entry criteria were identified and randomly replaced in two experimental and control groups. The sample size was estimated using Cohen's table (effect size=0.5, power=0.8 and significance level 0.05) and 15 people were placed in each group. The inclusion criteria included the age range of 4-6 years, and the informed consent of parents for their children to participate in the research. Also, children who were absent more than twice in the experimental sessions were excluded from the study. The experimental group underwent 15 sessions of creativity training and the control group did not receive any intervention (Table 1). The creativity training intervention program was designed by Ghazizadeh et al. (2022). After the implementation of creativity training by the researchers and with the help of kindergarten teachers, the level of executive functions in both the experimental and control groups was assessed, and after one month, a follow-up test was conducted on both the experimental and control groups. The duration of each training session was one hour. During the experiment, the control group had its previous routine program and was not exposed to any specific variable during this period.

In order to describe the identified components and dimensions of creativity and executive functions, the mean, standard deviation, skewness and kurtosis were measured for each of the variables using the SPSS-22 software. To test the hypothesis of the research, the mixed analysis of variance test (intergroup-intragroup) was used.

Table 1.
Creative Education Package for Preschool Children

The Content of the Preschool Creativity Education Package		
1	**Session Name**	**Colorful wall**
	Overall Objective	Children's participation in designing and modifying the classroom space and layout and using various tools.
	Partial Objective	Classroom wall design (initiative-decision making)
2	**Session Name**	**I am energetic and calm**

The Content of the Preschool Creativity Education Package		
	Overall Objective	Self-expression through visual arts, teaching life skills (emotional intelligence), emotional release, appropriate verbal expression, interacting with other children with diverse thoughts and feelings, welcoming children's ideas with the aim of establishing effective communication and interaction, providing children with skills in a suitable and impactful manner using expressive techniques, performing
	Partial Objective	Teaching mindfulness and relaxation techniques (expansion-continuous attention)
3	**Session Name**	**Artistic painting**
	Overall Objective	Self-expression through visual arts, teaching life skills (emotional intelligence), emotional release, appropriate verbal expression, interacting with other children with diverse thoughts and feelings, welcoming children's ideas with the aim of establishing effective communication and interaction, providing children with skills in a suitable and impactful manner using expressive techniques, performing.
	Partial Objective	Welcoming children's ideas with natural and disposable tools (fluidity, flexibility, initiative, expansion-problem solving)
4	**Session Name**	**I am …**
	Overall Objective	I am skilled in self-expression through visual arts, teaching life skills (emotional intelligence), emotional release, appropriate verbal expression, interacting with other children with diverse thoughts and feelings, welcoming children's ideas with the aim of establishing effective communication and interaction, providing children with skills in a suitable and impactful manner using expressive techniques, performing.
	Partial Objective	engaging in interaction with other children through appropriate verbal and physical language and performing arts, emphasizing flexibility and attention
5	**Session Name**	**I play**
	Overall Objective	Learning skills based on music, creative performance, photography, poetry recitation, and physical-motor skills
	Partial Objective	Learning skills based on music (initiative-memory)
6	**Session Name**	**Collage**
	Overall Objective	Learning skills based on photography, painting, and creating tools for use in the classroom
	Partial Objective	Learning skills based on crafts and painting (initiative-attention)
7	**Session Name**	
	Overall Objective	Learning skills based on music, creative performance, photography, poetry recitation, painting, physical-motor skills
	Partial Objective	Let's perform a play
8	**Session Name**	**Shapes and lines**
	Overall Objective	Learning skills based on creative performance, photography, poetry recitation, painting, physical-motor skills
	Partial Objective	The use of lines and spatial representation (fluidity, expansion, flexibility - attention, memory)
9	**Session Name**	**Find**
	Overall Objective	Using unpredictable solutions, considering the environmental aspect, movement and brain stimulation, having the power of choice to understand differences, and strengthening verbal language
	Partial Objective	Search and accuracy in the environment and expressing details (flexibility, initiative, expansion-attention)
10	**Session Name**	**Brainstorming**
	Overall Objective	Providing opportunities and selecting topics through collaborative brainstorming with children using the "encouragement and participation in divergent thinking" method to satisfy the sense of curiosity and exploration
	Partial Objective	Encouragement to think creatively (fluidity, flexibility, initiative, problem-solving, decision-making, attention)

The Content of the Preschool Creativity Education Package		
11	**Session Name**	**Me in the mirror**
	Overall Objective	Working on self-confidence "self-awareness"
	Partial Objective	Self-awareness training (flexibility, attention)
12	**Session Name**	**Problem Solving**
	Overall Objective	Engaging in activities with non-routine methods, emphasizing and focusing on problem-solving processes, presenting real-world problems and conflicting situations.
	Partial Objective	Problem-solving (fluidity, flexibility, initiative, problem-solving, attention)
13	**Session Name**	**Stop and Go**
	Overall Objective	Teaching self-regulation strategies to children, enhancing working memory (capacity to hold information in mind)
	Partial Objective	Self-regulation (flexibility, decision-making, attention)
14	**Session Name**	Storytelling
	Overall Objective	The role of peers in exchanging information and achievements towards problem-solving
	Partial Objective	Peer interaction (flexibility, initiative, problem-solving, attention)
15	**Session Name**	The upside-down world
	Overall Objective	Strengthening physical power and focus
	Partial Objective	Engaging in upside-down activities (flexibility, initiative, attention expansion)

The Content Validity Ratio (CVR) and Content Validity Index (CVI) methods were used to validate the program. The CVR index for the overall content of the training package was 081, and the CVI index was 089, both indicating a desirable level of content validity for the training package based on expert opinions.

Instruments

To measure executive functions, four computer-based tests were used: Hungry Donkey Task, Tower of Hanoi, Continuous Performance Test, and N Back Test.

Hungry Donkey Task (HDT)

The Hungry Donkey Task is a children's version of the Iowa Gambling Task, which is used to measure decision-making ability as an executive, cognitive-emotional function. In this task, children are required to obtain as many apples as possible for a hungry donkey as much as possible. This software has been developed by the Sina Institute for Cognitive Behavioral Science Research.

Tower of Hanoi Test

The Tower of Hanoi Test is an assessment that measures at least two aspects of executive functions, namely strategic planning and problem-solving. This assessment is the most well-known test of organization and planning and is considered a new version of the Tower of London test.

In this assessment, there are three rods fixed on a flat base, and three disks of different sizes. The participant must move the disks onto the rods, starting from the initial position and reaching the target position. This assessment is widely used to evaluate executive function planning in relation to frontal lobe function. The scoring of the assessment is based on the number of moves the participant makes to solve the problem, the number of extra moves or errors made by the participant, and the time taken to solve the problem (Ghasemzadeh et al., 2005). Computer mapping software was also utilized in this study. The different stages of the assessment are displayed on the computer screen. Each screen displays two arrangements, each with three vertical columns of different sizes, and rings of three different colors placed on them. The upper arrangement is shown to the participant as the pattern or goal and cannot be changed. The lower arrangement consists of rings that can be moved by the participant by touching the computer screen. The number of moves the participant makes to match the original disk is recorded (Muller et al., 2014). The variable considered for evaluating the test results is the number of moves the participant takes to reach the final solution. However, the completion time of the task is also calculated based on cognitive processing speed, using a stopwatch. The validity and reliability of this test were accepted by default and do not require further confirmation due to its widespread use (Hosseini et al., 2019). The test has been assessed with a series of verbal questions about the movement of the disks, and a Cronbach's alpha of 0.79 has been obtained for it. This reliability was obtained using the pretest-posttest method, with a reliability coefficient of 0.81 (Snorrman, 2005). According to another study by Schnorman, the correlation coefficient was 0.70, and various studies have reported correlation coefficients for reliability ranging from 0.25 to 0.81 (Ghasemzadeh et al., 2005). Information related to this test is available for ages 3 to 12, and apparently a 6-year-old child can perform at the level of an adult in the Tower of Hanoi test (Walsh et al.,

2004). However, the reliability of this test using the pretest-posttest method has varied in different studies, and a test-retest stability of 0.90 has also been reported (Davis, 2011).

Continuous Performance Test (CPT)

Continuous Performance Test (CPT) is a test designed by Rosvold and his colleagues in 1956 and initially used to measure brain damage. In the 1990s, it was introduced as a test for evaluating children with attention deficit hyperactivity disorder (ADHD). It is now recognized as the most common laboratory tool for assessing continuous attention. In this test, a set of numbers and a set of shapes are presented with a specific time interval. Two target stimuli (a specific number and a specific image) are determined and presented for a relatively short period of time, and the participant must quickly press the corresponding key on the computer screen upon seeing the target numbers and images (Viswanathan et al., 2009).

The measured variables in this test include correct responses (pressing the target key in response to the correct stimulus), omission errors (not pressing the target key in response to the stimulus), commission errors or response errors (pressing the key in response to a non-target stimulus), and reaction time (average reaction time for correct responses to the stimulus in milliseconds) (Shin, et al., 2008). Omission errors and reaction time are associated with inattention, while commission errors are related to impulsivity, and processing speed is correlated with average reaction time. The scoring of this test is done using a computer system. Improvement in continuous attention is indicated by a decrease in reaction time, omission errors, and commission errors, and an increase in correct responses. In this study, both correct response scores and reaction times were used. Test-retest reliability coefficients for different parts of this test have been reported in the range of .59 to .93. Discriminant validity was examined through comparing normal and hyperactive groups with attention deficit, and a significant difference in performance between the two groups was found (Hadianfar et al., 2000). In the present study, the reliability of this test was obtained as .67, .72, .71, and .72 for reaction time to images, reaction time to numbers, correct response to images, and correct response to numbers respectively (quoted from Khosrotaash, 2017, p. 89).

Working Memory Test (SPACIAL N-BACK)

SPACIAL N-BACK is one of the components of executive functions to investigate working memory performance in this research along with other components of executive functions such as decision-making, problem solving and paying attention to it. It is a Working Memory Test that directly correlates with intelligence quotient and academic success in different individuals. There are various tests available for working memory, with N-Back being the most well-known (Jiggi et al., 2010). This test was first introduced by Kirchner (1985) as a measure of visuospatial working memory, with four levels of difficulty. In 1990, Gons introduced a version with a single level of difficulty (Khadadadi et al., 2014).

The reason for the preference of N-Back over other working memory tasks is that it is less complex compared to other tests and can be easily used and analyzed in cognitive neuroscience studies using imaging, phenomenological, and behavioral tools (Jiggi et al., 2010). In the N-Back test, a sequence of stimuli is presented to the participant. The task is to determine whether the current stimulus matches the one presented N sequences ago (e.g., 2-Back refers to a match with the stimulus presented two sequences ago, and 3-Back refers to a match with the stimulus presented three sequences ago).

The N-Back task exists in various forms, including visual, spatial, auditory, phonological, and dual N-Back, depending on the type of study conducted. Performing this task involves various cognitive processes: encoding the presented stimuli, monitoring, maintenance, updating of information, and matching the current stimulus with the N sequence before it. Decision-making, selection, inhibition, and analysis of interventions are also among the cognitive processes that occur during task performance. The sequential nature of this task requires simultaneous execution of all the aforementioned processes (Janides et al., 1997; Kahn & Engle, 2002; cited in Khadadadi et al., 2014).

Functional imaging studies show that as the number of N increases, the activity of brain regions responsible for executing this task increases (D'Esposito, 2006; cited in Khadadadi et al., 2014). The brain regions activated during task performance include the prefrontal and parietal cortices. These regions form a network involved in working memory (Vogel, 2003; cited in Khadadadi et al., 2014).

The validity and reliability of the spatial working memory test vary based on scientific articles and research, and it can differ depending on the type of test and its conditions. It also depends on the categorization of the test as simple or complex. In simple terms, the validity and reliability of the spatial working memory test refer to its accuracy and reliability in measuring spatial working memory. The accuracy and reliability of the results obtained from this test are crucial. One important criterion for evaluating the validity and reliability of the spatial working memory test is the type of test and its execution conditions. For example, using the spatial working memory test with random blocks

increases the stability of the results. Additionally, some studies have shown that the spatial working memory test has a moderate level of validity, indicating its usefulness as a measurement tool for spatial working memory in psychological studies (Khadadadi et al., 2014).

Findings

The findings are examined in this section and will be discussed further. Table 2 presents the descriptive indicators of the variables under study.

Table 2.
Mean and Standard Deviation of Executive Functions by Measurement Stage in Groups

Group	Variable	Indicator	Pre-test	Post-test	Follow-up
Experimental	Decision-making (total collected apples)	mean	38.67	56.53	54.13
		standard deviation	8.38	10.24	10.46
Control	Decision-making (total collected apples)	mean	39.47	38.67	42.13
		standard deviation	10.01	14.79	15.03
Experimental	Problem-solving (Tower of Hanoi puzzle)	mean	30.60	41.40	41.00
		standard deviation	8.86	8.42	10.06
Control	Problem-solving (Tower of Hanoi puzzle)	mean	29.00	27.27	27.80
		standard deviation	8.94	11.08	11.53
Experimental	Continuous attention (correct response)	mean	246.00	36.00	39.00
		standard deviation	51.93	68.95	56.57
Control	Continuous attention (correct response)	mean	235.33	20.67	24.67
		standard deviation	42.40	74.78	72.30
Experimental	Continuous attention (reaction time)	mean	58.00	72.00	72.00
		standard deviation	94.66	65.99	50.03
Control	Continuous attention (reaction time)	mean	58.33	57.00	59.06
		standard deviation	97.82	15.22	151.22
Experimental	Working memory spatial)(	mean	15.80	21.20	22.00
		standard deviation	4.92	4.21	4.19
Control	Working memory spatial)(	mean	15.40	13.80	16.80
		standard deviation	4.22	5.38	5.49

As observed, the mean in the experimental group shows a change in the post-test stage compared to the pre-test. Based on the results presented in the table, it can be said that the creativity training program has improved the executive function subscales. In the application of parametric statistical methods, it is necessary to first confirm the assumptions of the test in order to use the desired test. Therefore, the assumptions of the analysis of variance with repeated measures, including independence of observations, normal distribution of dependent variables, homogeneity of variances, and sphericity test, are examined in different groups. The significance level of the Shapiro-Wilk test for each research variable was greater than 0.05, confirming the assumption of normal distribution of the studied variables.

The assumption of equality of variance differences between the combinations of dependent variables in the groups was tested using the Mauchly's sphericity test, and the results were examined in the Mauchly's sphericity table, indicating a violation of the sphericity assumption ($p < 0.05$). Therefore, the Greenhouse-Geisser correction was used to obtain a more accurate approximation (Hooman, 2019).

Summary of the results of mixed analysis of variance for within-group and between-group factors are presented in Table 3. Also, the mixed analysis of variance test for the scores of executive functioning components with the Greenhouse-Geisser criterion is provided. The results of the mixed multivariate analysis of variance show that with the multivariate analysis of variance method, there is a significant effect for the within-group factor (pre-test, post-test, and follow-up), the interaction factor (difference in changes between the two groups in three measurement stages), and the between-group factor (difference between the experimental and control groups) ($p < 0.05$). These significant effects indicate that there is a significant difference in at least one of the executive functioning components in preschool children who have been trained with a creativity education program compared to preschool children in the control group.

Further differences between the between-group and within-group factors are examined by separating the variables and groups. In order to investigate the effect of the training method of the creativity education program on the scores of executive functioning components in the pre-test, post-test, and follow-up stages, a mixed analysis of variance (one within-subject factor and one between-subject factor) was used. The three stages of pre-test, post-test, and follow-up were considered as the within-subject factor, and the grouping of the subjects into two groups was considered as the between-subject factor.

In order to investigate the significant difference between the means of executive functioning components in the two groups in the three measurement stages, the assumptions of variance homogeneity and sphericity were first examined.

Table 3.
Mixed Analysis of Variance Test for the Scores of Executive Functioning Components with Greenhouse-Geisser Criterion

Variable	Statistical index Factors	SS	Df	MS	F	Sig	Eta coefficient
Decision-making (total collected apples)	Test (repeated measurement)	1553.07	1.22	1278.64	27.68	0.001	0.50
	Test interaction * group	1366.76	1.22	1125.25	24.36	0.001	0.47
	Between-group	2112.18	1.00	2112.18	6.25	0.02	0.18
Problem-solving (Tower of Hanoi puzzle)	Test (repeated measurement)	417.16	1.32	317.29	7.27	0.01	0.21
	Test interaction * group	731.29	1.32	556.22	12.75	0.001	0.31
	Between-group	2092.84	1.00	2092.84	8.91	0.01	0.24
Continuous attention (correct response)	Test (repeated measurement)	93048.89	1.37	67936.81	29.67	0.001	0.51
	Test interaction * group	103928.89	1.37	75880.51	3 3.14	0.001	0.54
	Between-group	251751.11	1.00	251751.11	29.3 6	0.001	0.51
Continuous attention (reaction time)	Test (repeated measurement)	103928.89	1.21	85648.51	16.45	0.001	0. 37
	Test interaction * group	89848.89	1.21	74045.08	14.22	0.001	0. 34
	Between-group	205444.44	1.00	205444.44	7.03	0.01	0.20
Working memory (spatial)	Test (repeated measurement)	216.60	1.19	181.64	14.26	0.001	0.34
	Test interaction * group	192.20	1.19	161.18	12.66	0.001	0.31
	Between-group	422.50	1.00	422.50	7.97	0.01	0.22

The results of the above table indicate that the calculated F value for the within-group factor (pre-test, post-test, and follow-up) is significant at the 0.05 level for each of the five components ($p < 0.05$). Therefore, there is a significant difference in the mean scores of executive functioning components between the pre-test, post-test, and follow-up stages. To further examine the differences between the measurement stages in the two groups, a post hoc test (Bonferroni) was used, and the results are presented in the following Table.

Table 4.
Bonferroni Follow-up Test for Comparing Measurement Stages in Two Groups

Group	Variable	Measurement stages	Mean differences	Standard error	Significance level
Experimental group	**Decision-making**	Pre-test - Post-test	-17.87	2.84	0.001
		Pre-test - Follow-up	-15.47	2.81	0.001
		Post-test - Follow-up	2.4	2.65	0.87
	Problem-solving	Pre-test - Post-test	-10.8	2.77	0.01
		Pre-test - Follow-up	10.40-	3.17	0.02
		Post-test - Follow-up	0.40	1.09	0.99
	Continuous attention (correct response)	Pre-test - Post-test	-120.00	22.8 0	0.001
		Pre-test - Follow-up	-144.00	19. 83	0.001
		Post-test - Follow-up	-24.00	10.8 1	0.10
	Continuous attention (reaction time)	Pre-test - Post-test	-6 13.00	29.8 4	0.001
		Pre-test - Follow-up	-140.00	30.17	0.001
		Post-test - Follow-up	-4.00	12. 83	0.99

Group	Variable	Measurement stages	Mean differences	Standard error	Significance level
	Working memory spatial)(	Pre-test - Post-test	- 5.40	1. 61	0.01
		Pre-test - Follow-up	- 6.20	1.45	0.001
		Post-test - Follow-up	-0. 80	0. 55	0.49
Control	**Decision-making**	Pre-test - Post-test	0.80	1.47	1.00
		Pre-test - Follow-up	-2.67	1.69	0.41
		Post-test - Follow-up	-3.47	1.87	0.11
	Problem-solving	Pre-test - Post-test	1.73	0.97	0.29
		Pre-test - Follow-up	1.20	1.6 3	0.99
		Post-test - Follow-up	-0. 53	1.13	0.99
	Continuous attention (correct response)	Pre-test - Post-test	34. 67	10.23	0.11
		Pre-test - Follow-up	-13.33	11.49	0. 80
		Post-test - Follow-up	-8 4.00	5 1.79	0.8 0
	Continuous attention (reaction time)	Pre-test - Post-test	5 .33	17.07	1.00
		Pre-test - Follow-up	-14.67	17.07	1.00
		Post-test - Follow-up	-19.99	0.01	0.99
	Working memory (spatial)	Pre-test - Post-test	1.60	0.71	0.12
		Pre-test - Follow-up	-1.40	0.71	0.21
		Post-test - Follow-up	-3.00	0.69	0.19

The Bonferroni follow-up test was used to examine the differences between means. The results showed significant differences in the scores of executive functioning components between pre-test and post-test, as well as between pre-test and follow-up. However, there was no significant difference between the scores of executive functioning components in the follow-up compared to the post-test stage, indicating that the scores of executive functioning components did not change significantly in the experimental group during the follow-up stage.

Considering the results of the Bonferroni follow-up test regarding the interaction of stages and groups, the calculated F value for the effect of stages (pre-test, post-test, and follow-up) between the creativity training program group and the control group was significant at the 0.05 level ($p<0.05$) for executive functioning components. Therefore, there is a significant difference in the average scores of pre-test, post-test, and follow-up for executive functioning components in the two groups. The interactive graph of the adjusted mean scores of executive functioning components in the creativity training program group and the control group at different stages (pre-test, post-test, and follow-up) is shown in the graph.

Figure 1.

Adjusted Mean Scores of Decision-Making (Total Accumulated Apples) in the Creativity Training Program Group and the Control Group at the Pre-Test, Post-Test, and Follow-Up

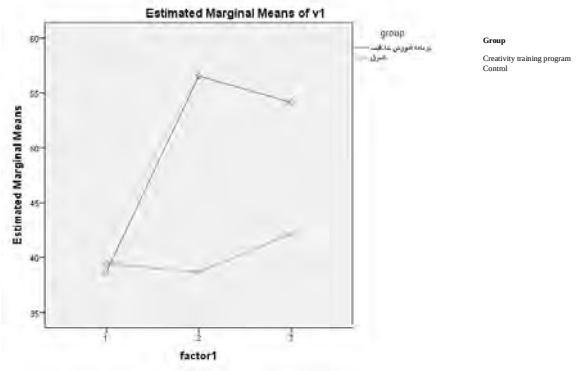


Figure 2.

Adjusted Mean Scores of Problem-Solving (Tower Of Hanoi Displacement) in the Creativity Training Program Group and the Control Group At The Pre-Test, Post-Test, and Follow-Up

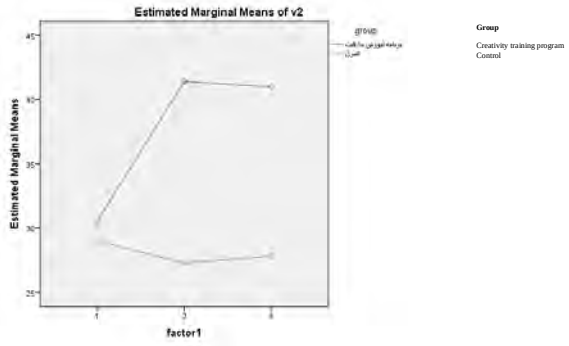


Figure 3.
Adjusted Mean Scores of Continuous Attention (Correct Responses) in the Creativity Training Program Group and the Control Group at the Pre-Test, Post-Test, and Follow-Up

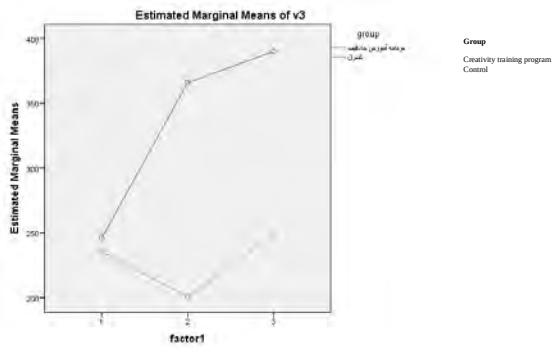


Figure 4.
Adjusted Mean Scores of Continuous Attention (Reaction Time) in the Creativity Training Program Group and the Control Group at the Pre-Test, Post-Test, and Follow-Up

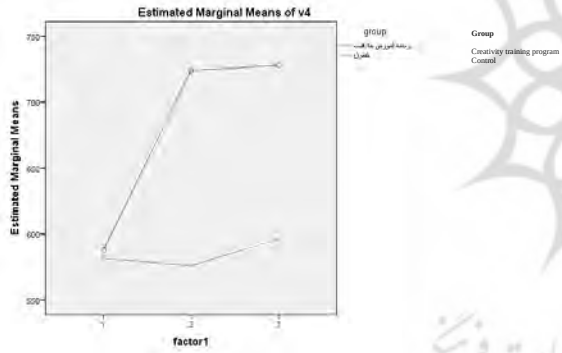
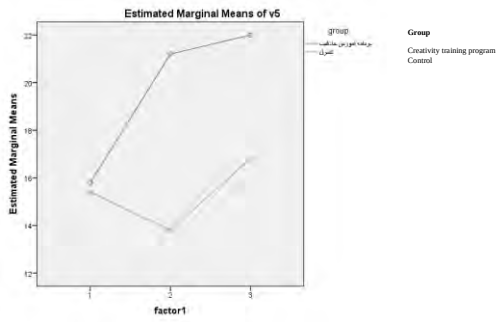


Figure 5.
Adjusted Mean Scores of Spatial Working Memory in the Creativity Training Program Group and the Control Group at the Pre-Test, Post-Test, and Follow-Up Stages



Based on the results of the Bonferroni post-hoc test, the calculated F-value for the between-group factor is significant at the 0.05 level ($p < 0.05$) for the executive function components. Therefore, there is a significant difference between the overall mean scores of the executive function components in the two groups.
In general, it can be concluded that the creativity training program has had an impact on the scores of the executive function components, as the experimental group (receiving the creativity training program) showed improvement in the scores of the executive function components compared to the control group.

Discussion

In this research, the results showed that the creativity training program significantly influenced the decision-making, problem-solving, continuous attention, and spatial working memory.The findings of this research are consistent with the findings of Mohammadyari et al. (2021), and Zelazo (2015), in terms of the effectiveness of training on executive functions. The research conducted by Balvardi and Babakhani (2020), Ansbury and Hill (2003), Zabelina and Bimbaum (2013), Kranzle (2020), Bott et al. (2014), Vartanian et al., (2007), Ariola and Ritter-Palmon (2016), Dorin (2009), and Wee et al. (2018) also support the association between creativity and executive functions.

Furthermore, the findings of this research are consistent with those of Zekriai et al. (2008), Butirona (2020), Arjmand Ghajar (2018), Harris (2018), Ganji et al. (2012; 2004), Bagato (2016), Radbakhsh et al. (2013), Shiung et al. (2022), Seyyed Amiri (2004), and Kiafar (2014). These studies used such methods as games, storytelling, brainstorming, art and painting, digital games, image visualization, group-based play activities, and mental imagination for improving executive functions.

In the analysis of the purpose and content of the first meeting, related to the decision-making component of executive functions, it is in line with the research results of Rukni Fard (2015) and Ganser and Gonen (2015). The finding of the second session with the aim of teaching mindfulness and calm body is in line with the research results of Kasht Varz (2013), Sheriff Qureshi (2014). The results of the analysis of the third session, with the aim of welcoming the child's ideas with natural tools and castings, and in relation to the effect of the problem solving component, are consistent with those of Ganji (2011), Garaigordobil (2011), Dzidevich (2015) and the findings of the fourth session with the aim of interacting with other children through appropriate verbal and body language and performing arts, are in line with those of Oztop (2020).

In the analysis of the fifth session with the aim of learning skills based on music, creative performance,

photography, poetry reading, physical-motor skills, the results are aligned with the results of Chronopoulo Vasiliki Riga (2012), Alikhani (2017), Saberi (2016) while the sixth session results with the aim of learning skills based on crafts and painting, are in line with the results of logical research (2013), Obalasi (2013) and Benlior (2013). Moreover, the findings of the seventh session with the aim of learning skills based on the show and pretend play are in line with those of Jafari (2013), Maudet and Holmes (2018), Sift (2020), Fehr and Rus (2016) and Motwil and Marjorie (2014).

In examining the results of the eighth session with the aim of using lines and spatial visualization, it was found that they were consistent with the research results of Hosseini (2015), Yildiz (2021) whereas the findings of the ninth session, with the aim of searching and accuracy in the environment and expressing details are supported by the research results of Ghasemi (2016) and Holmes and Romo (2013).

In the review of the 10th session with the aim of encouraging divergent thinking, the results were consistent with the results of Ghanei (2017) and Kiafar (2015), Guo and Ritter (2019) and Yusuf (2013). In the analysis of the 11th session results with the aim of teaching self-awareness, they were shown to be in line with the results of Kashtvarez research (2019) while the results of the twelfth meeting with the aim of solving the problem were in agreement with those of Moradi (2019). Furthermore, the findings of the 13th session with the purpose of self-regulation were in line with those of Ahrari (2017) and Sibinti (2011) and those of the fourteenth session with the aim of peer interaction were consistent with the results of Emadi (2015), Kararka and Hilil Ozon (2020), Holmes et al. (2020), Renamo (2014). Finally, the findings of the 15th session with the aim of doing the activities upside down were in line with those of Han Ping Chun (2018).

According to Kaufman and Beghetto (2012), creativity is related to learning, and a creative mind has more flexibility and readiness to learn new information. In the recreational model of creativity, imagination leads to increased cognitive abilities (Beier & Kaufman, 2017). The structural model of creativity (Amabile, 2016) also emphasizes the importance of creative activities in enhancing cognitive functions. Additionally, Kaufman emphasized that creativity enhances the ability to make connections between concepts and increases cognitive flexibility. In creativity training, attention is given to different problem-solving approaches, which can have an impact on increasing cognitive flexibility as an important component of executive functions. Moreover, creative individuals possess high resilience, which requires problem-solving and decision-making activities as important components of executive functions (Kränzle, 2020).

Conclusions

Education plays an important role in the growth of children's creativity, as Gardner stated and the imagination that develops in early childhood forms the basis for creativity in adulthood (Eslamiye, 2011). It can only be achieved through education which was also confirmed in the present study. Creativity requires classic cognitive abilities such as working memory, attention maintenance, and cognitive flexibility. Additionally, learning cognitive and metacognitive strategies has been shown to effectively improve creativity (Karami et al., 2013). In fact, generating new ideas through the combination of stored cognitive elements relies on working memory function, which is conceptualized as the ability to hold information in the mind and occurs simultaneously with creative thinking (Banduk et al., 2014).

Although this research showed the developed creativity training program has an effect on the executive functions of preschool children; nevertheless, like most studies, it was also faced with such limitations as that the researcher had to analyze the text to understand the mentality of the interviewees. It was also imperative to avoid any interference or personal biases in the interpretation of the data. Also, more time was needed for meticulous conducting of the interviews, reviewing, organizing, and analyzing the data.

The subject of teaching creativity leads to success in all stages of individuals' lives, better coping with challenges and life problems, entrepreneurial and employment capabilities, and making the right career choices in the future. It is important for the education system to pay sufficient attention to this matter. Although it has been proven that traditional education in this period should be transformed into creative education, this alone is not enough and requires the determination of decision-makers. Therefore, with the goal of targeting creativity education in the pre-school education system, educational leadership at the management level, strengthening the infrastructure of creativity education, and managing creative educational changes, as well as empowering teachers of this period in the direction of creativity education (learning teaching methods and creative learning-teaching approaches), creative lesson design courses in the classroom, and also using motivational and incentive methods to improve teachers' performance in this field should be sufficiently considered.

Based on this research findings, it is suggested that instead of teaching creativity in adulthood, this

education should start from the preschool level and the years before entering formal education, in order to establish creative responses in children and teach them to see themselves as a source of information and preserve their creative solutions for solving various life problems. Also, child psychologists and counselors are recommended to pay attention to the role of creativity education in order to improve the executive functions of preschool children. Additionally, future research can focus on sustainability studies to understand whether the creativity skills acquired in the preschool period are maintained in later ages or not. Furthermore, research in this field could be conducted for different age groups to enable result comparisons. The long-term effects of the designed creativity education program in this research could also be examined. Moreover, it is recommended that other researchers focus on examining other factors such as parental education, social skills training, self-regulation training, etc., on executive functions. It is suggested that the content of this package be included in the preschool curriculum.

Conflicts of Interest

No conflicts of interest declared.

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