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The Effect Of Coding Activities On Cognitive Tempo Of Preschool Children

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ABSTRACT

Coding activities support cognitive thinking skills by increasing children's imagination and creativity, improving their problem-solving skills, enabling them to produce different solutions to an problem situation, and transferring these solutions to similar problem situations. This research aims to examine the effects of coding activities on the cognitive styles of preschool children. This research is an experimental design with a pretest-posttest control group. Consists of a total of 25 children, 13 of whom are in the experimental group and 12 of whom are in the control group, studying in a public kindergarten in Selçuklu district of Konya province. The data collection tool used in this study to determine the cognitive tempo of participating children was KRISP-A (Kansas Reflection-Impulsivity Scale for Preschoolers, Form A), developed by Wright (1971) and adapted into Turkish by Seçer and colleagues (2010). A total of 20 sessions of Coding Activities were carried out with the children in the experimental group twice a week for ten weeks. No study was conducted with the control group, and the preschool program continued. The study concluded that coding activities shortened the response time of the children in the experimental group; in other words, coding activities supported the children's ability to respond faster.

Kodlama Etkinliklerinin Okul Öncesi Dönem Çocuklarının Bilişsel Tempolarına Etkisi

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ÖZET

Kodlama etkinlikleri, çocukların hayal gücü ve yaratıcılığını artıran, problem çözme becerilerini geliştiren, var olan bir problem durumuna farklı çözüm yolları üretebilmesini sağlayan ve bu çözüm yollarını benzer problem durumlarına transfer ederek bilişsel düşünme becerilerini desteklemektedir. Bu araştırma kodlama etkinliklerinin okul öncesi dönemi çocuklarının bilişsel stillerine etkisini incelemeyi amaçlamaktadır. Öntest-sontest kontrol gruplu deneysel desenli olan bu araştırmanın çalışma grubunu Konya ili Selçuklu ilçesinde bulunan bir devlet anaokulunda eğitim almakta olan 13'ü deney grubunda, 12'si kontrol grubunda olmak üzere toplam 25 çocuk oluşturmaktadır. Çalışmaya katılan çocukların bilişsel tempolarını belirlemek amacıyla Wright (1971) tarafından geliştirilen ve Seçer ve ark. (2010) tarafından Türkçe'ye uyarlaması yapılan KRISP-A (Kansas Okul Öncesi Dönemdeki Çocuklar için Düşünsellik – İçtepisellik Ölçeği A Formu) veri toplama aracı olarak kullanılmıştır. Deney grubundaki çocuklar ile on hafta olmak üzere haftada iki oturum şeklinde toplam 20 oturumluk Kodlama Etkinlikleri yapılmıştır. Araştırmanın kontrol grubuyla herhangi bir çalışma yapılmayıp okul öncesi programa devam edilmiştir. Araştırmada kodlama etkinliklerinin deney grubu çocuklarının yanıt süresini kısalttığı, başka bir deyişle kodlama etkinliklerinin çocukların daha hızlı yanıt verebilme becerisini desteklediği sonucuna ulaşılmıştır.

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INTRODUCTION

Our age is developing rapidly in terms of technology and science. It is imperative to shape the competencies of today's children within the framework of our age and the vision of the future. In this context, it is aimed for children to become more active and integrated into the future. The importance of applications for coding education, which is an important reflection of technology and is accepted as one of the skills of the 21st century, has increased. Coding activities have begun to be included in educational programs (Özbey, 2018; Ünsal, 2019). Odacı and Uzun (2017) describe coding as a kind of problem solving method.

When examining global research on programming, the emphasis on coding education, particularly during early childhood, becomes evident. Preschool education is acknowledged as a crucial period for acquiring various skills. Consequently, there is a prevailing belief that coding training should be introduced during this developmental stage. Coding applications enhance children's imagination and creativity while fostering the development of problem-solving, spatial, and analytical thinking skills. It encourages both process- and result-oriented thinking, instilling the practice of undertaking comprehensive, product-oriented projects and resolving issues through the integration of smaller projects. Coding facilitates the generation of diverse skills to address existing problems. Children also develop their problem-solving skills by finding solutions to existing problems through technology and their cognitive thinking skills by transferring them to similar situations (Demirer & Sak, 2017; Odacı & Uzun, 2017). Coding activities, especially those carried out using robotic kits, provide an environment for preschool children to test their hypotheses in the face of a problem situation, produce solutions to the problem situation, and make meaningful discoveries (Bers, 2008).

The preschool period, during which coding practices play a crucial role, represents one of the most intense and rapid phases in children's brain development. Brain development significantly influences cognitive development. Cognitive processes, encompassing perception, learning, concept acquisition, thinking, and problem-solving skills, hold paramount importance for cognitive development (Keleş & Çepni, 2006). These concepts differ for each child, resulting in differences in cognitive styles. Differences in how children perceive, process, and remember information do not indicate differences in abilities that measure their performance; instead, they are distinctions commonly defined as thinking styles. The way children individually approach a task constitutes a cognitive style, with numerous cognitive styles identified through research. Among these cognitive styles, cognitive tempo stands out as the most extensively studied. Cognitive tempo can be categorized as impulsive or reflective (Gander &Gardiner, 2010). Preschool children can produce various hypotheses in order to find a solution when faced with any problem. The various hypotheses that children form arise from differences in their cognitive tempo (Zelniker & Jeffrey, 1979).

The process involving a child's choice to react quickly or slowly when producing a solution to a problem is termed cognitive tempo and has two types: impulsive and reflective. When children exhibit a reflective tempo, they respond by thoroughly examining all stimuli and options, attempting to conceal their hesitations before determining the correctness of the hypothesis generated for the solution and before reacting. Due to their tendency to plan and think before reacting, they generally achieve successful results. Conversely, children with an impulsive tempo, when faced with any problem or situation, react without using the possible solution hypothesis as a basis. They do not concentrate on secondary important clues, express what comes to their mind in a hurry, and are driven by a fear of failure. Consequently, problem situations often end unsuccessfully (Gander & Gardiner, 2004). In other words, impulsive children dedicate little time to analysis, respond hastily without thorough examination, and therefore make many mistakes. Reflective children, on the other hand, are more cautious, utilizing more time for data analysis, leading to fewer mistakes (Gargallo, 1993).

Kagan and his colleagues made reflective and impulsive cognitive styles measurable by using the 'Matching Familiar Figures Test (MFFT)' (Kagan and his colleagues, 1964). The Matching Familiar Figures Test is a visual comparison test designed to identify the same shape among various alternative shapes. The test measures response time and the number of errors (expressed as 'correct responses'). Kagan and his colleagues divided individuals into two groups based on the scores obtained from the test. According to this grouping, reflective individuals are those with a longer thinking time and more correct answers, while impulsive individuals are those with a shorter thinking time and more incorrect answers (Kagan and his colleagues, 1964).

Wright (1971) developed the Kansas Reflection-Impulsivity for Preschool (KRISP) scale to determine whether preschool children fall into categories such as fast correctors, slow correctors, fast incorrectors, and slow incorrectors. The classification of children into these categories is based on the errors obtained from the scale, considering both the number of errors and their response time. Children are then labeled as fast correctors, slow correctors, fast incorrectors, or slow incorrectors.

When the literature was reviewed, no research was found on the effects of coding activities on the cognitive styles of preschool children. In light of this, the study aims to examine the impact of coding activities on the cognitive styles of preschool children.

Research Purpose:

The primary objective of this research is to investigate the influence of coding activities on the cognitive tempo of preschool children. To address this, the study sought answers to the following question:

Do coding activities affect the cognitive tempo of preschool children?

Sub-Aims of the Research:

Based on the main purpose of the research, the following questions were addressed:

- Do coding activities affect preschool children's response time scores on the Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP - Form A)?
- Do coding activities affect the number of error scores of preschool children on the “Kansas Reflection–Impulsivity Scale for Preschoolers” (KRISP – Form A)?

METHOD

Research Model:

In order to examine the effects of coding activities on the cognitive tempo of preschool children, a quasi-experimental model with a pre-test post-test control group was used. Group assignment was somehow made from existing groups. Therefore, a full design was not used in the study.The experimental model aims to examine the cause-and-effect relationship between variables. In the pretest-posttest control group model, two groups were created through unbiased assignment: the experimental group and the control group. Data were collected in two stages for both groups—before and after the experiment. In this regard, the independent variable of the study was determined as "Coding Activities," and the dependent variable was "Cognitive Tempo of Preschool Children."

Study Group

The study group of the research consisted of children aged 5-6 years who received pre-school education in a kindergarten in Selçuklu district of Konya province in the 2021-2022 academic year. Consent forms

were obtained from the participants' families stating that they voluntarily participated in the study.A total of 25 children were included in the study, 13 in the experimental group and 12 in the control group. Demographic characteristics of the experimental and control groups are presented in Table 1.

Table 1.

Demographic Characteristics of the Experimental and Control Groups

		Gender			**Age**		
		Girl	**Boy**	**Total**	**5 Years**	**6 Years**	**Total**
Experimental Group	*n*	8	5	13	11	2	13
	%	61.5	38.5	100	84.6	15.4	100
Control Group	*n*	8	4	12	1	11	12
	%	66.7	33.3	100	8.3	91.7	100

The experimental group consists of 13 children, 8 (61.5%) girls and 5 (38.5%) boys. It is known that 11 of these children (84.6%) are 5 years old and 2 (15.4%) are 6 years old. The control group consists of a total of 12 children, 8 (66.7%) girls and 4 (33.3%) boys. 1 of these children (8.3%) is 5 years old, and 11 (91.7%) are 6 years old.

Data Collection Tools and Processes

KRISP – form A

The Reflection – Impulsivity Scale for Preschoolers – Form A (KRISP – Form A) was developed by Wright (1971) to unveil the cognitive styles of preschool children. Seçer and colleagues (2010) conducted validity and reliability studies to adapt the scale to Turkish. For the reliability study, 30 students in preschool education were assessed by two observers. In the evaluation of students' reaction times in the KRISP - Form A, the correlation between the two observers for reaction time was found to be 0.83, and the number of errors was 0.78. As an additional indicator of the reliability of the KRISP - Form A, a test-retest reliability examination was conducted. Accordingly, 303 samples receiving preschool education were identified.

KRISP – Form A was administered twice to the sample with a two-week interval. Following the application, the Pearson Moment Correlation Coefficient between the two application scores was examined. As a result, the number of errors for the KRISP – A Form was found to be 0.74, and the response time was 0.89 (Seçer et al., 2010). The findings from the two separate applications of KRISP – A Form on the same group revealed a positive and significant relationship ($p < 0.01$). Based on the research results, it was determined that the consistency of KRISP - A Form between the two applications was at an acceptable level. The Spearman–Brown Correlation Coefficient for the reaction time of KRISP – A Form was determined as 0.85, and the number of errors was 0.71.

Within the scope of KRISP – Form A, the time until the first correct or incorrect answer is given is expressed in seconds after each stage. In the context of KRISP – A Form, the term 'number of errors' refers to the total number of incorrect answers given at each stage until the correct answer is found (Seçer et al., 2010).

Within the scope of KRISP - A Form, students are categorized as 'Fast Correctors,' 'Slow Correctors' (reflectives), 'Fast Incorrectists' (impulsives), and 'Slow Incorrectists' based on the median of the entire group and the division system of the number of errors along with response time scores, as outlined below:

- Fast Correctors: Refers to students within the scope of KRISP – A Form who make errors below the median and have a response time below the median.
- Slow Correctors (Reflectives): Refers to students within the scope of KRISP – A Form who make errors below the median and have a response time above the median.
- Fast Incorrectists (Impulsives): Refers to students within the scope of KRISP – A Form who make more errors than the median and have a response time below the median.
- Slow Incorrectists: Refers to students within the scope of KRISP – A Form who make more errors than the median and have a response time above the median.

KRISP – Form A consists of 10 items and 10 shapes. In the initial stage of administering the KRISP – A Form, the total time taken by each child to respond to the first appearance of the 10 shapes, and the overall number of errors made by them, are coded separately.

Data Collection Process and Application

During the two-day pretest phase, researchers collected scores from both the experimental and control groups using the Kansas Reflection-Impulsivity Scale for Preschool. The participants were individually brought to a designated environment for the pretest, ensuring it was quiet and suitable for their developmental level. No negative situations were encountered during this process.

Coding activities, averaging 60 minutes, were implemented twice a week in the classrooms where the children were studying for the experimental group. Before each session, researchers organized the classroom environment according to the planned activity.

In addition to the Republic of Turkey Ministry of National Education's preschool education program, the experimental group underwent 20 sessions of Coding Activities created by researchers over 10 weeks, twice a week. Meanwhile, the control group continued their regular preschool program without any additional intervention.

Following the completion of coding activities, the KRISP was readministered to both experimental and control groups, and the post-test scores of the children were recorded.

Analysis of Data

If the total number of participants in the experimental and control groups is less than 30, non-parametric tests are used in the research. In the study, the data obtained from the data collection tools were analyzed using the SPSS 25.0 software package. The significance of the difference between scores was tested at a significance level of .05. To determine the analyses to be applied to the collected data, it was checked whether the data exhibited a normal distribution. The results of the normality test are presented in Table 2.

Table 2.

Values of Data Regarding Normality Test

	Shapiro-Wilk	***p***
KRISP-A Formu (Response Time Pretest)	0.781	0.000
KRISP-A Formu (Number of Errors Pretest)	0.900	0.019

KRISP-A Formu (Response Time Pretest)	0.859	0.003
KRISP-A Formu (Number of Errors Pretest)	0.919	0.049

As a result of the Shapiro-Wilk test for KRISP, it was concluded that the data did not follow a normal distribution since p was < .05. Therefore, non-parametric tests were chosen for the data analysis in the study. Consequently, the Mann-Whitney U Test and the Wilcoxon Signed Rank Test were utilized to analyze the data.

FINDINGS

To see whether the control and experimental groups are equivalent, the results regarding the children's pre-test mean scores on KRISP – Form A are given in Table 3.

Table 3.

Mann Whitney U Test Results Regarding Pre-test Scores of Experimental and Control Groups

KRISP-A Form	Groups	n	X	S.S.	Mean Rank	Rank Sum	U	p
Response Time	Experiment Group	13	63.46	23.52	15.31	199.00	48.00	.103
	Control Group	12	54.21	24.62	10.50	126.00		
	Total	25						
Number of Errors	Experimental Group	13	3.76	3.05	11.62	151.00	60.00	.322
	Control Group	12	4.66	2.34	14.50	174.00		
	Total	25						

p<.05*

When examining Table 3, it is evident that there is no statistically significant difference in response time in the average pre-test scores between the experimental and control groups (U=48.00, p > .05). It was observed that there was also no statistically significant difference between the pre-test average scores of the experimental and control groups regarding the number of errors (U=60.00, p > .05). These values confirm that there is no statistically significant difference between the pre-test scores of the experimental and control group children, indicating that the cognitive tempos of the groups are statistically equivalent.

The following results were obtained in the research conducted to examine the effect of coding activities on the cognitive tempo of children aged 5-6. Post-test scores and error numbers of children in the experimental and control groups regarding KRISP – Form A were analyzed with the Mann-Whitney U test, and the results are presented in Table 4.

Table 4.

Mann Whitney U Test Results Regarding Post-test Scores of Experimental and Control Groups

KRISP-A Form	Groups	n	X	S.S.	Mean Rank	Rank Sum	U	p
Response Time	Experiment Group	13	51.44	14.08	15.15	197.00	50.00	.128
	Control Group	12	45.11	20.40	10.67	128.00		
	Total	25						
Number of Errors	Experimental Group	13	2.69	1.31	12.50	162.50	71.50	.718
	Control Group	12	2.91	1.78	13.54	162.50		
	Total	25						

p<.05*

According to the results in Table 4, there is no statistically significant difference among the post-test scores of the experimental and control groups regarding response time (U=50.00, p>.05). It was observed that there was no statistically significant difference among the post-test mean scores of the experimental and control groups regarding the number of errors (U=71.50, p>.05). Therefore, it can be said that coding activities have no effect on the post-test response time and number of errors of the experimental and control groups.

The pre-test and post-test scores of the experimental group children regarding response time and number of errors were analyzed with the Wilcoxon Signed-Rank Test and the results are given in Table 5.

Table 5.

Wilcoxon Signed Rank Test Results for Pretest and Posttest Scores of the Experimental Group

KRISP-A Form		n	Mean Rank	Rank Sum	z	p
Response Time	Negative rank	10	7.70	77.00	-2.201	**.028***
	Positive rank	3	4.67	14.00		
	Equal	0				
	Total	13				
Number of Errors	Negative Rank	5	6.00	30.00	-.905	.365
	Positive Rank	4	3.75	15.00		
	Equal	4				
	Total	13				

p<.05*

As seen in Table 5, a statistically significant differentation was observed between the pre-test and post-test scores regarding the response time of the children in the experimental group (z = -2.201, p <.05). No statistically significant differentation was observed between the pre-test and post-test scores regarding the number of errors of the children in the experimental group (z = -.905, p>.01). The response time of the children who received coding activities decreased after the application, and no change was observed in the number of errors.

Pre- and post-test scores of control group children regarding response time and number of errors were analyzed with the Wilcoxon Signed-Rank Test and the results are given in Table 6.

Table 6.

Wilcoxon Signed Rank Test Results for Pre-test and Post-test Scores of the Control Group

KRISP-A Form		**n**	**Mean Rank**	**Rank Sum**	**z**	**p**
Response Time	Negative rank	9	7.78	70.00	-2.432	**.015***
	Positive rank	3	2.67	8.00		
	Equal	0				
	Total	12				
Number of Errors	Negative Rank	9	6.22	56.00	-2.059	**.039***
	Positive Rank	2	5.00	10.00		
	Equal	1				
	Total	12				

p<.05*

When Table 6 is examined, it is seen that there is a statistically significant difference in response time (z = -2.432, p <.05) and number of errors (z = -2.059, p <.05) between the pre-test and post-test scores of the control group children. There was a decrease in the response times and number of errors of children who received a traditional preschool education program.

DISCUSSION

In the study, the effects of coding activities conducted for preschool children on their cognitive tempo were examined. Coding sessions were carried out in a total of 20 different sessions, twice a week for 10 weeks. As a result of the research, the post-test scores of the children in the experimental and control groups using KRISP - Form A were examined, and no statistically significant difference was observed between the post-test scores concerning the response time of the experimental and control groups. As a result of the analysis in terms of the number of errors, no statistically significant difference was found between the post-test average scores of the experimental and control groups.

As a result of the analysis conducted to determine whether there was a statistically significant difference between the pre-test and post-test scores regarding the response time and number of errors of

the children in the experimental group, it was concluded that there was a statistically significant difference between the pre-test and post-test scores regarding the response time of the children in the experimental group. However, it was determined that there was no statistically significant difference between the pre-test and post-test scores regarding the number of errors of the children in the experimental group. Based on these two findings of the study, the response time of children who received coding activities decreased after the application and no change was observed in the number of errors. In other words, coding activities shortened the response time of preschool children and supported children to respond faster.

Yüce (2023), in his experimental design study examining the effect of SCAMPER activities on the cognitive tempo of preschool children, revealed that SCAMPER activities reduced the response time and number of errors of the experimental group children, in other words, SCAMPER activities positively affected the cognitive tempo of preschool children. It is known that the SCAMPER technique is a technique that enables the child to find more than one solution when faced with any problem situation and encourages the child to find creative solutions. Coding activities also increase children's creativity, enable them to acquire problem-solving and analytical thinking skills, and enable them to produce solutions to an existing problem using different skills. When looked at in this context, it can be seen that SCAMPER technique and Coding applications contain similar gains. It seems that the results of the study conducted by Yüce (2023) support this finding of the research.

The analysis conducted to determine whether there is a statistically significant difference between pre-test and post-test scores of the control group children in terms of response time and the number of errors revealed that there is a statistically significant difference. In other words, a decrease in response time and the number of errors was found in the control group children.

Seçer and colleagues (2009) found, among the results obtained from their study examining the cognitive tempo of a total of 1276 children aged between 4 and 7 attending preschool education in terms of different variables, that there is a decrease in the number of errors as the children's ages advance. This suggests that the higher average age of the children in the control group compared to those in the experimental group may also have an impact on this finding of the research.

In experimental design research, although no differences are anticipated between the pre-test and post-test scores of the control group, the children in the control group actively continued to receive preschool education throughout the implementation period. It is assumed among the hypotheses that the gains achieved during this period may have a positive impact on the cognitive tempo of preschool children. In this study, a statistically significant difference was observed in the response time and number of errors in the control group. In Ergin's (2020) study, which investigated the impact of activities in Tübitak's "Meraklı Minik Dergisi" on the cognitive tempo of children in the 48-60 month preschool period, it was revealed that the response times of children in the control group also decreased in the post-test.

In his 2019 study, Konyaoğlu aimed to examine the impact of robotic coding education on the problem-solving skills of middle school children. He designed a five-week experimental research, and the results of the study revealed that the five-week robotic coding education had a statistically positive effect on the problem-solving skills of the children.

CONCLUSION

As a result, this study examines the effects of coding activities on the cognitive tempo of preschool children, aiming to increase their imagination and creativity, improve problem-solving skills, enable the

generation of different solutions to existing problem situations, and support cognitive thinking skills by transferring these solutions to similar problem situations. It was determined that there was a decrease in the response time of the experimental group children who received coding activities. In other words, coding activities supported the ability of preschool children to respond faster.

SUGGESTIONS

The recommendations based on the results of the research are as follows:

- The impact of coding activities on the cognitive tempo of preschool children has been in
- vestigated in the study. In parallel with this research, experimental studies can be conducted to examine the effects of coding activities on other cognitive styles.
- The study group of the research consists of preschool children. It is known that coding activities are also used with children in primary and secondary education. Therefore, studies can be conducted by creating different study groups with diverse characteristics, examining the impact of coding activities on cognitive tempo in primary and secondary school-age children.
- In this study, coding activities have been broadly addressed to create a program. Specific types of coding activities such as robotics coding, block coding, screenless coding, etc., can be customized to create programs, and the effects of these programs on children's cognitive tempos can be investigated.
- Preschool teachers can be provided with training on how to create activities for children with different cognitive tempos. Specifically, training can focus on developing activities that enhance the attention span and encourage accurate responses for impulsive children.

Ethics Committee Approval

This research was found ethically appropriate by the Selçuk University Faculty of Health Sciences Non-invasive Clinical Research Ethics Committee decision dated 31.03.2022 and numbered 2022/271.

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