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EXAMINATION OF EARLY CHILDHOOD TEACHERS' CREATIVE THINKING TENDENCIES AND CRITICAL THINKING IN DESIGN BASED ACTIVITIES[1]

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Abstract

Creativity and critical thinking are important goals of early childhood curriculum. There are various ways to support these important goals. In the context of this study, our goal is to determine the views of early childhood teachers based on design-based activities. Mixed method was used in the study. The quantitative data examined 88 early childhood teachers' creativity by using Marmara Creative Thinking Tendency Scale. Creativity scores of the teachers differed significantly according to the variables of age, gender and educational level. These scores were grouped as low-medium-high and 12 teachers were selected for semi-structured interviews based on the Creative Thinking Tendency Scale scores. The interview analysis revealed that the teachers did not provide examples directly related design while expressing their ideas on creativity, development areas and critical thinking. When the teachers' examples related to design were examined, teachers mostly included examples from science education. In the last step of the study, the activity plans taken from the three teachers who participated in the interview were examined. When planning design-based activities, teachers included a plan based on the age group of the students and clearly determine the materials to be used. However, teachers did not discuss design parameters and data collection that is critical to support creativity and critical thinking. Design is a relatively new field at early childhood education. Providing teachers with professional development can contribute positively to the implementation of design based activities supporting creativity and critical thinking.

Key Words: Early childhood, creativity, critical thinking, design

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OKUL ÖNCESİ ÖĞRETMENLERİNİN YARATICI DÜŞÜNME EĞİLİMLERİ VE TASARIM TEMELLİ UYGULAMALARDAKİ ELEŞTİREL DÜŞÜNMENIN İNCELENMESİ

Öz

Yaratıcılık ve eleştirel düşünme okul dışı öğrenme öğretim programının önemli öğelerindendir ve bu becerileri desteklemenin birçok farklı örneği bulunmaktadır. Bu çalışma özelinde bu beceriler okul öncesi öğretmenlerinin tasarım temelli aktiviteleri uygulamalarında incelenmiştir. Çalışmada karma yöntem kullanılmıştır. Nicel boyutta 88 okul öncesi öğretmenine Marmara Yaratıcı Düşünme Eğilimleri Ölçeği uygulanmıştır. Öğretmenlerin yaratıcılık puanlarının yaş, cinsiyet ve eğitim durumu değişkenlerine göre anlamlı düzeyde farklılık gösterdiği bulunmuştur. Verilerin analizinden sonra ölçekten alınan puanlar düşük, orta ve yüksek puanlar şeklinde gruplanmıştır. Araştırmanın nitel boyutunda her puan grubundan katılımcılar belirlenmiş ve 12 öğretmene yarı-yapılandırılmış görüşme formu uygulanmıştır. Görüşme analizinde öğretmenlerin yaratıcılık, gelişim alanları ve eleştirel düşünme konularındaki fikirlerini belirtirken tasarıma yönelik örnekler vermediği gözlenmiştir. Öğretmelerin tasarım hakkında görüşleri incelendiğinde ise öğretmenlerin daha çok fen bilimleri alanından örnekler verdiği görülmüştür. Araştırmanın son basamağında görüşmeye katılan üç öğretmenden alınan aktivite planları incelenmiştir. Öğretmenlerin tasarım aktivitelerinde öğrencilerin yaş grubuna göre bir planlama yaptığı ve kullanılacak olan materyalleri net olarak belirlediği görülmektedir. Ancak öğretmenlerin yaratıcılık ve eleştirel düşünmeyi destekleyecek tasarım parametrelerini ve veri toplamayı desteklemediği görülmektedir. Okul öncesi dönemde tasarım temelli uygulamaların incelenmesi yeni bir alandır. Öğretmenlere bu konuda hizmet-içi eğitim verilmesi tasarıma ait detayların erken yaşlardan itibaren tasarım temelli aktivitelerde yaratıcılık ve eleştirel düşünmeyi daha etkili bir şekilde uygulanmasına olumlu katkı sunabilir.

Anahtar Kelimeler: Yaratıcılık, Tasarım Temelli, Eleştirel Düşünme, Okul Öncesi

Introduction

21st century skills require students and teachers new competencies. These competencies have a dimension that calls for seeking and building information, and this dimension is closely related to problem-solving, creativity, and critical thinking (Claro & Ananiadou, 2009). There are several problem types (such as story, decision-making, and design challenges), and each problem type calls upon a particular set of cognitive abilities. Problems encourage modeling, which in turn encourages pupils to use critical thinking (Jonassen, 2011). Jonassen (2011) further said that the setting and problem-type have an impact on creativity. With this idea in mind, the objective of this study is to investigate how creativity and critical thinking are related in the context of design-based learning in early childhood education.

Importance of Critical Thinking and Creativity

The development of the concept of creativity begins in early childhood. The early childhood period defines the period from the birth of the child to the age of 6. In other words, it is in the same scope as the preschool period. This period is critical in many aspects of the child's development. It is a period when social-emotional, motor, and cognitive development are at the highest level and the child is very sensitive to environmental stimuli. It is important that the activities prepared for the education of the child in the pre-school period are planned and implemented in a way that can attract the attention of the child, reveal his creative thinking skills, and support him to be active in the process (Yıldız-Bıçakçı & Gürsoy, 2010).

Together with creativity, critical thinking is another important skill required for the 21st century that includes problem-solving and higher-order thinking skills. It is one of the thinking skills guiding societal connections (Eldeleklioğlu & Özkılıç, 2016). Today's children access information much faster than adults and their societal connections include social media and virtual platforms. Therefore, the accuracy of the information obtained and how this information will be used have great importance. Students need to know how and from where to get the information correctly and to structure and internalize this information in the most meaningful way. In order to support this, students should be given the opportunity to develop their critical thinking skills from an early age (Kurnaz, 2017).

Connected with these, the early childhood education curriculum places creativity at the center. The curriculum supports children's gaining different and original experiences in accordance with their learning methods and environments, and developing their skills to express themselves in this way, by keeping their individual differences (MoNE, 2013). In addition, critical thinking is presented as one of the fundamental ideas (MoNE, 2013). The development of these skills in elementary school depends on supporting these skills starting from the early childhood period. the curriculum underlines that it is critical to ensure teachers must be creative and include these skills in the learning environments accordingly (MoNE, 2013).

The constant focus on creativity, which is also emphasized in OECD reports, emphasizes how crucial it is for 15-year-old students to develop creative thinking, which they can do by actively participating in the development, evaluation, and enhancement of ideas that can result in novel and practical solutions, scientific advancements, and significant expressions of imagination. However, it is crucial to keep in mind that creativity is closely related to 21st century abilities (Claro & Ananiadou, 2009) and OECD reports (Hyslop-Margison et al., 2001; McGuire, 2007). We will go over how this emphasis translates to early childhood studies in the next section.

Solving difficult problems and using critical thinking are significant cognitive abilities that are developing in job advertisements, according to research by Rios et al. (2013) who looked at 140 000 job listings. Numerous educational publications (Bocconi et al., 2016) and policy documents place a strong emphasis on these abilities (European Commission, 2007; National Research Council, 2012). In connection with this, numerous nations began revising their curricula by highlighting the requirement for a new pedagogy (European Commission, 2007). This transformation in Europe has been centered on the science education curricula. The European Commission's 2007 report identified inquiry-based science education as a means of fostering students' capacity for both critical and creative thinking.

Academic studies also present a rise in interest in creativity and critical thinking. For instance, more than 8300 papers mention critical thinking in their abstracts, while nearly 12000 mention creativity in the Web of Science (WoS) database. On the other hand, when we include early childhood or kindergarden/kindergarten in the search query, the number of creative studies drops to 340 studies, and the number of critical studies drops to 125 studies in their abstracts.

In conclusion, there is a rising demand for creativity and critical thinking on a global scale, but the number of studies in early childhood remains relatively lower. Departing from this need, the first objective of this study is to determine the level of creativity for early childhood education teachers. As stated by Jonassen (2011) creativity is linked to the specific context and Shively et al. (2018) underlined the importance of design-based application supporting creativity and critical thinking. Departing from this, we then examined how critical thinking is interpreted in early childhood education through design-based applications.

Importance of Design in Early Childhood Education

According to Alves-Oliveira et al. (2022), a number of initiatives targeted design-based examples to foster children's creativity. In connection with this, there are many curriculum examples discussing the importance of design. The Design & Technology Course in England aims to build generations with the knowledge and abilities to design, make high-quality designs and prototypes, and think creatively. These individuals will be able to critique and develop ideas and designs of others as well as their own (Design & Technology Programs of Study: Key Stage 3, 2013). The objectives outlined in this course are also mirrored in a several curricula in Türkiye. For instance, at the end of the eighth grade, Instructional Technology and Design curriculum requires students to create an original product while addressing an issue (MoNE, 2012).

Students are expected to critically analyze the problem situation in the revised version of this curriculum and create a toy out of electronic garbage (MoNE, 2018a). Students are required to create original projects as part of the fifth and sixth grade curriculum in order to address issues they face on a daily basis (MoNE, 2018b). In this setting, producing unique work directly relates to students' growth as creative and critical thinkers (MoNE, 2018b). The early childhood education program, which is related to these courses, also places a lot of emphasis on problem solving and creativity in various learning goals: "produces solutions to problem situations" and "proposes creative solutions to the problem" (MoNE, 2013). Teachers are also expected to support "children's imagination, creative and critical thinking skills" (MoNE, 2013).

The strong emphasis on design-based examples in curricula increased the number of articles in this field. A recent review research looked at how various target groups study engineering design and design-based learning. This review research demonstrated that there were very few studies undertaken in early childhood education, and the vast majority of design studies were focused on higher education (Delen & Yüksel, 2022). Aguirre-Munuz and Pantoya (2016) note that there is a lack of thorough research on engineering design in early childhood education in relation to this conclusion. Connected with these findings, only two out of 88 early childhood education studies from the 2016–2019 period in Türkiye focused on design-based learning (Ormancı & Cepni, 2019). However, over the past few years, this pattern is changing. 25 kids between the ages of 4 and 7 took part in a 9-hour workshop in Aguirre-Munoz and Pantoya's (2016) design study that covered the basics of design, bioethics, and gene editing. In a different study, Bartholomew et al. (2019) created open-ended design challenges based on well-known children's rhymes (e.g., create a system that will allow the black sheep and its owner to divide the wool into three bags, develop a method to stop the spider from scaling the water spout, develop a system to warn young children when animals start to stray). To summarize, the number of design-based studies is increasing globally but there are fewer examples in early childhood education.

Previous research offered support for showing kids how to solve different design problems. Creativity became a key theme in design-based learning studies as the number of studies grew. Design-based learning, according to Marmon (2019), provides chances for creativity and innovation. In addition, Alves-Oliveira et al. (2022) evaluated studies from 1950 to 2020 with kids between the ages of 5 and 13 and stressed the need of comprehending how treatments and programs may encourage creativity from a young age.

Shively et al. (2018) added that design is a context based experience and there is little known about how to support context-based learning in K-12 education. To explore early childhood teachers' ideas about creative thinking, we conducted interviews. These interviews investigated critical thinking and design based learning. In the final stage, we collected design based activities and investigated how teachers integrate creativity and critical thinking to support developmental areas through design based activities. The research questions in this study were:

1- What was the level of creative thinking tendency for early childhood teachers based on gender, age, level of education, and school type?

2- What were early childhood teachers' ideas concerning creativity, critical thinking and design based learning?

3- How did early childhood teachers support creativity and critical thinking in design-based activities?

To answer the first research question, we worked with early childhood teachers working in an eastern city located in Türkiye. Then, we selected smaller purposeful groups for research question 2 and 3. More details about this process are presented in methods (see Figure 1).

Method

Explanatory sequential design, one of the mixed method designs employed in this study (Subedi, 2016). In the quantitative phase, we examined the creativity of early childhood teachers. Qualitative phase consisted of the interviews and activity plans. During the interviews, teachers were divided into low, moderate, and high creativity groups based on the findings of the quantitative phase. Then we collected design-based activities to examine critical thinking.

Participants

The study's target population was pre-school teachers working in Turkish public schools connected to the Ministry of National Education who were instructing students between the of 60 and 72 months. The sample was chosen using the convenience sampling technique that gives the researcher advantages in terms of time, money, and labor is the practical sampling method (Gurbetolu, 2018). 88 early childhood teachers who work in a city located in eastern Türkiye were chosen as the research sample. Purposive sampling technique was used in the qualitative phase. The participants for the interviews and design-based activities in the qualitative stage were chosen using criteria sampling. As stated by Coyne (1997), the criteria can be developed by the researcher and Marmara Creative Thinking Tendency Scale scores were used in this study as a criterion in the selection of teachers for interviews. The interview group consisted of 12 teachers who received high, medium, and low scores on the scale. The maximum score could be obtained from the scale was 125, and the lowest score in our sample was 50 (the lowest score that could be received from the scale was 25). Based on the results teachers gathered from the scale, we created groups as follows:

-Scale score 50-75: Low group (T7, T8, T11, T12)

-Scale score 76-100: Medium group (T1, T6, T9)

-Scale score 101-125: High group (T2, T3, T4, T5, T10)

There were four teachers in low group, three teachers in medium group and five teachers in the high group. In the final section, several teachers who received high scores were asked to submit a lesson plan related to design based practices. Three teachers (T2, T3, T4) returned seven lesson plans (two teachers shared two lesson plans, one teacher shared three plans), and we analyzed these lesson plans in the final stage. In this step, we only focused on the high creativity group since the activities were collected after interviews. During the interviews, high creativity group presented more details and we asked teachers from this group to present their activities. Figure 1 summarizes the participant group related to each research question (RQ).

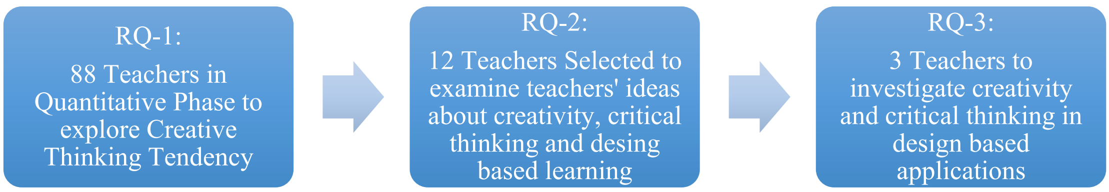

Figure 1. *Participant Group for Each Research Question*

Data Collection Tools

Marmara Creative Thinking Tendency Scale was used to gather quantitative data. Özgenel and Çetin (2017) created the "Marmara Creative Thinking Tendency Scale" to determine teachers' creative thinking tendencies. Necessary permissions were obtained to use the scale and the scale was used in the quantitative data phase. The data acquired from the Marmara Creative Thinking Tendency Scale were analyzed using the SPSS 22 program. Özgenel and Çetin (2017) reported the reliability coefficient cronbach alfa as 0.87. In our study, the reliability coefficient cronbach alfa was 0.95. Then we examined the normality for the distribution. The skewness was -1,165 and the kurtosis was found 1,129. The distribution of the data is normal based on the values presented in Kline (2011). The link between the instructors' scores on the scale and the factors of gender, age, level of education, and school type was examined using an independent samples t-test. Teachers' creativity levels were created based on the scores they received from the scale.

In line with the purpose and sub-purposes of the research (see Figure 1), a semi-structured interview form was used for the participant group. The semi-structured interview form was prepared based on the literature review and expert opinions. The semi-structured interview form was modified by the interview form prepared by Progression and Pedagogy of Design [P2D]: Contextualizing Design based Pedagogy in Teacher Education Programs Erasmus+ project team. First version of the interview form primarily focused on understanding how teachers support design-based practices, critical thinking and plan design based activities. When modifying this form, we added questions related to the early childhood education (e.g. developmental areas). There were four sections in the interview. The first section aimed at determining how teachers support their creative thinking skills in the classroom environment and their ideas about creative thinking. In the second section of the interview form, there were questions to determine their ideas and practices about critical thinking. In the third section of the interview form, focused on teachers' ideas on design-based learning. In the final section, teachers were asked questions about how they make plans in their classroom for design-based learning.

The interviews were conducted face-to-face with the participants and were recorded by voice recorder with the voluntary consent of the participants. All interviews were transcribed and data were coded by two researchers. The researchers used thematic analysis employed an inductive methodology to create conclusions based on the qualitative data (Herzog et al., 2019). In this process, the researchers reduce the amount of raw data; find themes; compare themes; develop codes; and assess the reliability of codes (DeCuir-Gunby et al., 2011). All disagreements between coders were resolved in several meetings and the data were presented based on teachers' creativity scores under the findings.

The activity plans were coded by a rubric that was also prepared during the P2D ERASMUS+ project. This rubric was prepared to analyze design-based activities that were implemented in various countries during the project. Design is an experience supporting creativity and critical thinking (Shively et al., 2018). Departing from this, the rubric investigates how teachers consider important elements of the design process when planning design-based activities. Both researchers coded the activity plans by using the rubric presented in Table 1. Activities coded by both researchers and disagreements were resolved in discussion meetings.

Table 1. *Design based activity evaluation rubric*

Features/ Description	0	1
A- Select design constraints	Teachers fail to select constraints	Teachers select design constraints
B- Define design parameters	Teachers fail to define parameters	Teachers define design parameters
C- Find evidence related to design parameters	Teachers fail to include evidence related to design parameters	Teachers present evidence related to design parameters
D- Define (implicit) criteria for deciding which design is better	Teachers fail to define criteria for deciding which design is better	Teachers discuss how evidence related to parameters would work for the design
E- Identify materials & tools to create the prototype	Teachers do not identify materials & tools to create the prototype	Teachers identify materials & tools to create the prototype
F- Define how the prototype satisfies original goal	Teachers do not define how the prototype satisfies original goal	Teachers present how parameters worked for the design
G- Define how to improve the design product	Teachers do not define how to improve the design product	Teachers define aspects that could be improved in the design product

Ethical Procedures

The research is conducted under the Usak University Ethical Committee Approval (taken on 09.12.2021). All participants signed an informed consent before completing the Marmara Creative Thinking Tendency Scale. In the qualitative part, purposive sampling was used and participants who were willing to participate in the interviews from different attended the interviews. These scores were not shared with the participants. The researchers selected participants based on their scores for the interviews. In the final stage, we requested lesson plans from all teachers in the high group, and only three of them shared their activity plans. We used these lesson plans in the final stage of the analysis.

Results

What was the level of creative thinking tendency for early childhood teachers based on gender, age, level of education, and school type?

In this section, we will first present quantitative results, and then switch to qualitative results.

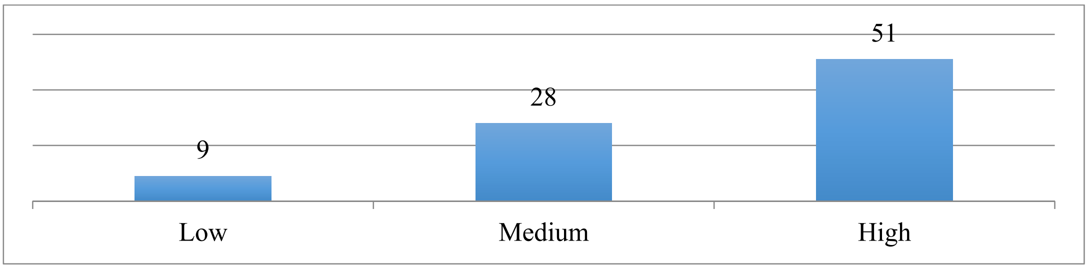

Figure 2. *Early Childhood Teachers' Creative Thinking Tendency Scores*

Figure 2 presents the early childhood teachers' creativity levels based on the Marmara Creative Thinking Tendency Scale. Majority of the teachers in our sample was in the high creativity group and teachers' average score was 97.8 over 125.

Table 2. *Examination of Teacher's Creativity Scores*

Variables		N	$\bar{X}$	Standard Deviation	t	p
Gender	Female	63	3,98	5,57	2,202	,030
	Male	25	3,68	6,68		
School Type	Independent kindergarten	43	4,01	4,56	1,797	,076
	Kindergarten	45	3,78	7,03		
Age	Higher than 30	25	3,67	8,08	-2,236	,028
	Lower than 30	63	3,98	4,79		
Level of Education	Masters	15	4,29	2,73	2,865	,005
	Bachelors	73	3,81	6,22		

After determining the creative tendency, the scores of the teachers were analyzed using the independent sample t-test. Table 2 presents there is a significant difference between the creative thinking tendency of female and male teachers [t_{86} =2,202 p<.05]. The mean score of female teachers ($\bar{X}$=3, 98) is higher than the mean score of male teachers ($\bar{X}$=3, 68). Effect size (Cohen's d) was found as 0,05.The average score of teachers working in independent kindergartens ($\bar{X}$=4,01) is higher than the average score of teachers working in kindergartens ($\bar{X}$=3,78). However, this difference was not statistically significant [t_{86}=1,797 p>0,05]. It has been determined that the average score of the teachers under the age of 30 ($\bar{X}$=3,98) is higher than the average score of the teachers above the 30 ($\bar{X}$=3,67). This difference represents a statistically significant difference [t_{86}= -2,236 p<0,05]. Effect size (Cohen's d) was found as 0,05. It was observed that the average score of teachers who hold a master's degree ($\bar{X}$=4,29) is higher than the average score of teachers only have a bachelor's degree ($\bar{X}$=3,81). This difference is statistically significant [t_{86}=2,865 p<0,05]. Effect size (Cohen's d) was found as 0,10. All effect sizes were small (Cohen, 1988).

What were early childhood teachers' ideas concerning creative thinking, critical thinking and design based learning?

In this section, we will report teachers' ideas on creative thinking, critical thinking and design based learning. The classification of codes is based on the scores teachers' creative thinking tendencies.

Table 3. *Teachers' Ideas about Creative Thinking*

Question	What does creative thinking or creativity mean to you? Please explain.		
Code	Codes from lower scores: Originality (T8, T11, T12) Being yourself (T7)	Codes from medium scores: Originality (T1, T6, T9)	Codes from high scores: Originality (T3, T5, T10) Being yourself (T2, T4)
Question	Which teaching methods and techniques do you use to support creative thinking skills in the classroom? Please give an example.		
Code	Codes from lower scores: Drama (T11) Brainstorming, argumentation, six thinking hats (T7, T8) Questioning (T12) Six thinking hats (T8)	Codes from medium scores: Scamper technique(T1) Drama. Activity completion (T9) Questioning (T6, T9) Learning stations technique, Six thinking hats (T6)	Codes from high scores: Brainstorming, argumentation (T2, T3, T4, T10) Q&A (T4, T5) Design. Completion Works (T10) Learning stations technique (T2, T3, T4) Solving a problem (T5)

Interview analysis presented that teachers' explanations are relatively similar about creativity when compared by their creativity scale scores, and teachers listed numerous activities to support creative thinking (see Table 3). Teachers discussed creativity as a thinking activity (e.g. six thinking hats). Only teachers from the high group mentioned the inclusion of design when discussing teaching methods and techniques to support critical thinking.

Table 4. *Teachers' Ideas about Critical Thinking*

Question	How do you define critical thinking?		
Code	Codes from lower scores: Examination, analysis (T8) Thinking positive-negative (T7) Total thinking, analysis (T11, T12)	Codes from medium scores: Questioning, being objective (T1) Thinking positive-negative (T6) Questioning, different perspective (T9)	Codes from high scores: Original idea (T2) Thinking positive-negative (T3) Total thinking, analysis (T4) Thinking deeply (T5) Thinking different or consequential points, questioning (T10)
Question	Can you support critical thinking when engaging in design based applications? Please explain how.		
Code	Codes from lower scores: By questioning designs (T7, T8, T11, T12)	Codes from medium scores: By doing experiments (T1) By analyzing process and problem situations (T6) By developing perspectives (T9)	Codes from high scores: By showing examples (T2) By questioning designs (T3, T4,T10) By developing perspectives (T5)
Question	How can critical thinking support the design process and products?		
Code	Codes from lower scores: Quality of design and products increases through critical thinking (T11,T12) Developing process and products by analyzing (T7) Identifying and correction of deficiencies (T8)	Codes from medium scores: Developing process and products with different perspective (T1) By evaluation of products (T6) Developing process and products by analyzing (T9)	Codes from high scores: Developing process and products by analyzing (T2) Quality of design and products increases through critical thinking (T3) Identifying and correction of deficiencies (T4) Thinking what worked (T5) By supporting higher-order thinking skills (T10)

Similar to the previous interview questions, we first prompted teachers to define critical thinking (see Table 4). Teachers defined critical thinking as a cognitive process by presenting different aspects (e.g. considering different perspectives) of the thinking process: "Critical thinking is the process of evaluating something with both its good and bad sides and revealing the difference between its good and bad sides (T6)". Another teacher added "To be able to look at events from a different perspective. To question the accuracy of the information presented to us (T9)". In this process, teachers did not state any ideas related to design. On the other hand, when teachers were asked about the role of critical thinking in design-based applications, teachers emphasized different perspectives. Teachers stated that children can develop different perspectives through design, and therefore their critical thinking skills will improve: "For example, students can try different ideas to understand what works and this helps students to begin criticizing their ideas through the mechanism they created. As students criticize, they gain experience so that they can do better. Thus, the quality of the products increases. As in the example of sculpture, they tried different methods in the next art events and came up with better products (T11)".

Teachers in the lower group primarily stated the final design products, but teachers in middle and high groups had a broader perspective by including problem solving and design evaluation: "As children produce, they begin to think better. They immediately develop a solution to the problem. Thanks to the evaluation methods we use, they look critically at their designs automatically. This way it is supported. So there is a difference between the first period and this period. The children started to say their deficiencies before I completed them. I think that shows their progress." Science continued to be at the center of several examples: "Let's assume a child who sees yogurt drink waiting in a glass. As a child, we expect him to first wonder why when water and yogurt separate, rather than accept it outright. Then we expect him to investigate why, in his critical thinking process. The child will then learn the difference in density and gain knowledge as a result of his curiosity. We expect him to benefit from this experience while producing new things and new ideas by transferring this to other examples in his daily life. In other words, we expect him to interpret what he sees in education and transfer it to other parts of life (T2)".

Table 5. *Teachers' Ideas about Design based Learning*

Question	How do you define design based learning?		
Code	Codes from lower scores: Science and art activities (T7,T8 T11, T12) Problem based applications (T11)	Codes from medium scores: STEM (science, engineering, technology, mathematics), Experiment (T1) Problem based applications (T6) Planned applications((T9)	Codes from high scores: STEM, Experiment (T4) Problem based applications (T2,T3,T5,T10)
Question	Which teaching methods should be use in design-based learning?		
Code	Codes from lower scores: Drama, Argumentation methods (T8) Questioning (T7, T11, T12)	Codes from medium scores: Drama, Argumentation methods (T1, T6) Q&A(T9)	Codes from high scores: Methods that develop children (T10) Drama (T3, T4, T5) Argumentation methods (T2, T3, T4, T5) Activity completion, Questioning (T5)
Question	How can different development areas be supported by implementing design-based learning?		
Code	Codes from lower scores: Design affects development of area (T7) Developing different areas (T8) Integration of design and activities (T11,T12)	Codes from medium scores: Integrated activities (T1) Design affects development of area (T6) Integration of design and activities (T9)	Codes from high scores: Integrated activities (T3) Design affects development of area (T2, T4) Developing different areas (T5) Integration in activities (T10)

Next, we asked about teachers' ideas about design-based learning (see Table 5). All groups linked design-based learning to problem solving: "Based on the concept of design, I can try to define it as the creation of solutions and inventions for situations or events that did not exist beforehand or need to be developed (T10)". There was also an emphasis on science: "I think it could be doing experiments in science activities or producing a mechanism (T12)." The connection to science was also prevalent when teachers discussed the activities to support design-based applications. All groups stated argumentation and also included drama activities.

Teachers did not discuss development areas when they were presenting ideas about design-based learning. When teachers were asked specifically about the connection between development areas and design-based learning, teachers started to discuss development areas: "Social-emotional area can be developed if there is a design-based group work. In addition, cognitive areas can improve as thinking skills improve. Language skills can develop as children cooperate among themselves. But we do not implement these very often (T6)". Another teacher also discussed different developmental areas: "Design supports many areas such as creative thinking, motor skills, observation, and using previous knowledge. Therefore, design process also supports the development processes. I use it as often as possible. In any case, the main task of children in pre-school period is to create new ideas, support curiosity, research and questioning. Students should not learn concepts directly and this is why I prefer to use these methods in my activities (Ö2)". Teachers are aware of design based activities, but they presented differences in terms of the frequency of these activities. This could be one reason to explain why design does not become part of their responses when they were asked general questions.

Table 6. *Teachers' Plans about Design-Based Learning*

Question	What do you pay attention to when planning a design-based learning? How do you differentiate design based learning when you compare it with other practices in your classroom?		
Code	Codes from lower scores: A process that produces solutions, An original process (T7) Suitable for children (T8, T11, T12)	Codes from medium scores: Active, supports higher order thinking skills (T1) Problems from daily life, A process that produces solutions (T6) Suitable for children (T9)	Codes from high scores: Open-ended, unstructured (T2) Scientific process (T3) Problems from daily life (T4) Supporting all-round development (T5) Project-based processes (T10) Suitable for children (T3, T4,T10)
Question	When and how do you decide what students should do during the design process?		
Code	Codes from lower scores: Children in a decision-making position (T7, T8, T11) According to the children's need (T12)	Codes from medium scores: Guidance for children who request support (T1) According to the children's need (T6, T9)	Codes from high scores: Decide with kids (T3) According to the children's needs (T2, T4, T5) Advanced planning (T5, T10)
Question	How do you determine the design problem for students?		
Code	Codes from lower scores: Daily life (T7,T8,T11,T12) Connected to ability of the group (T8,T11)	Codes from medium scores: Connected to ability of the group (T1,T6) Daily life (T6) Spontaneous (T9)	Codes from high scores: Daily life (T2,T3,T4,T5,T10) Connected to ability of the group (T10)

Teachers stated the importance of increasing the number of instances: "I honestly don't have much of an idea. I think it should be used more (T7)". But, teachers did not discuss the role of design unless they were prompted to mention design in different questions. In the final section of the interview, we focused on understanding how they can support and planned design-based learning (see Table 6). In this process, we emphasized on how teachers can plan design-based learning in their classrooms by comparing design-based learning with other practices. Teachers in all groups underlined the importance of problems: "While planning a design-based lesson, we first need to identify a problem situation. Then I help them find solutions to this problem and support them in this process. There are not many challenges in art activities, so while doing some different but original product creation activities, they can think for themselves in art and create an original work of art (T6)".

Then we asked teachers about students' role in these activities. Teachers focused on making advanced planning and continuous support during these activities: "I think planning before the process is effective. During the process, I try to ensure that the process is advanced through group decisions, by making regular meetings when students need it (T5)". Another teacher also stated the importance of providing a free environment for students: "They mostly decide on their own in the process. I intervene when they ask (T8)". One of the teachers defined this process as "(not) focusing on a single path in the process (T1)".

Due to the emphasis on problems, we finally asked teachers about how they determine the problems for students. Teachers in different levels stated the importance of daily life problems: "I try to identify the interesting problem situations that students encounter or may encounter in their daily lives (T10)". All groups also added the importance of suitability for the age group.

How did early childhood teachers plan design based activities?

In this section, we evaluated seven activity provided by three teachers from high creative thinking tendency group.

Table 7. *Evaluating Each Activity with Design-Based Activity Evaluation Rubric*

Features/Description	Activity 1	Activity 2	Activity 3	Activity 4	Activity 5	Activity 6	Activity 7
A- Select design constraints	1	1	0	1	0	0	0
B- Define design parameters	0	1	0	0	0	0	0
C- Find evidence related to design parameters	0	1	0	0	0	0	0
D- Define (implicit) criteria for deciding which design is better	1	1	0	0	0	0	0
E- Identify materials & tools to create the prototype	1	1	0	1	1	1	1
F- Define how the prototype satisfies original goal	0	0	0	0	0	0	0
G- Define how to improve the design product	0	1	0	0	0	0	1
Total Score	3	6	0	2	1	1	2

A summary of the coding is provided in Table 7. The results clearly present that teachers do not focus on planning design based learning in a detailed way. The main aspect that was found in the design based activities was the discussion materials. Three activities also included constraints for the design (e.g., focusing on roads, mosques, schools, parks, shops, stadiums in a city planning activity, considering only what birds need in autumn, designing only the surface of the moon). Two activities included the improvements for the design (e.g., how to improve water-proof designs, modifying the forest model). This is an interesting result since the big majority of the activities did not include the parameters and how to collect data related to the parameters. This means students were allowed to a very open design process in which students were not provided enough scaffolding for thinking how they may collect data. Failing to include these crucial aspects can lead to a superficial discussion of creativity and critical thinking. Teachers were not clear about what to expect from the design process, and this means the design experience had vague criteria for students. Students did not know what was clearly expected from them. A detailed description of each activity is provided individually in this section.

Activity 1

In the first activity, teacher primarily focused on stages of the activity to design their dream house. Students were first asked to use their imagination in the planning phase. Children were expected to take an active role in the planning process. Students were asked to think about "roads, mosques, schools, parks, shops, stadiums" in a city. In this way the teacher supported students to consider constraints. Teacher asked students to use salt ceramics. The material used at this stage was a very good choice in terms of its suitability and usefulness for the developmental level of children. The resulting design was a product of children's imagination. But, teacher did not list any parameters. Material choices, and how to improve design products were not discussed.

Activity 2

The development level of the student group was taken into consideration during the design process. This activity also considers constrains well. Students were prompted to think about what birds may need during autumn. During the activity, students were given a piece of paper and asked to draw weather-proof objects that can be used to feed the birds. During this activity, students only drew and children were free to choose materials. The activity mentioned a parameter by asking students to consider weather-proof objects. After completing the design, students were asked to test whether the designs are resistant to cold weather, and how they could be improved by evaluating the missing aspects is discussed with the method of discussion. Overall, this activity fulfilled the majority of the criteria in the rubric.

Activity 3

The third activity was basically a science experiment. The teacher asked students to imagine that students are all scientists and that the classroom is a laboratory. Teacher stated that they were going to do an experiment together. Teacher performed the experiment and presented that when one end of the straw is closed with a finger, the liquid inside does not spill. The teacher continued to discuss the results with the children during the activity and students were not engaged with the design process.

Activity 4

This activity also put the emphasis on science. Teacher introduced Galileo and Galilei's telescope. The teacher continued to explain the telescope function of a telescope and how Galileo used it. The surface of the moon is designed with using aluminum foil. The teacher asked students to design the surface of the moon and the teacher also provides students a specific material. Although teacher discussed the constraints and materials, the teacher did not discuss the parameters (e.g. size). The parameters were missing, and the activity did not focus on how to improve the design product.

Activity 5

In this design activity, teacher first started with an introductory video about rockets and then provided wooden blocks to students. Each group was asked to build a rocket. Students were allowed to use other objects in the class while making their rocket. Students were given a specific time to complete the design and then students name their rockets. Then students were asked "where would you like to go in space with your rocket?". Each student then built the rocket. This design activity also provided the list of materials to students, but never discussed any parameters with the students. Students were not asked to discuss how they could improve their designs.

Activity 6

Activity 6 also focuses on science by making students discuss gravity. Students were given the opportunity to draw and then place their drawings on the wall. Then students were asked to discuss why the paint on their drawing would go down when it is placed on the wall. This activity provided specific materials, but did not consider design related parameters.

Activity 7

In the last activity, students were asked to create a forest by diving into four groups: spring forest, summer forest, autumn forest, and winter forest. Students were given soil to create their forests. Students were allowed to create animal models. Then students described their forests. The teacher did not list specific parameter for the design, but the teacher asked how students can modify their models at the end. Students were allowed to add new materials when revising their designs.

Discussion and Conclusion

Creativity became an important skill for 21st century jobs (Bocconi et al., 2016), and it has become an important skill starting from kindergarten (MoNE, 2013). Early childhood teachers' creativity scale average was 97.8 over 125. This is consistent with other studies reporting high creative thinking tendency score for early childhood teachers (Çoban, 2016; Meral & Şahin, 2019). In our analysis, we found early childhood teachers' creativity differs significantly by age, gender, and education level. It is important to note that, all the effect sizes were small (Cohen, 1988). Previously, Kose et al. (2016) found that creative thinking skills differed significantly by gender, and this difference was in favor of female early childhood teachers. İnceoglu and Kosar (2008) measured the creative thinking skills of computer education and instructional technology teacher candidates, and reported that female teacher candidates are more creative than male teacher candidates. In addition, Ugurlu and Ceylan (2014) reported that teachers with a graduate degree had higher creativity scores. In a more recent study, Çoban and İnan (2019) found that female early childhood teachers had higher scores and teachers creativity scores gradually increase by age when comparing early childhood teachers in their 20s and 30s. However, we did not find significant differences according to school type. Previously, Uzman (2003) also concluded that teachers' creativity levels differ significantly according to the type of school in which they work. Since we worked only in one city, teachers can easily collaborate between each other and this may have cause relatively similar scores for different schools. The creativity scores of teachers working in independent kindergartens were higher in our sample.

In addition, several studies indicate that creativity can be developed when it is supported by the right experiences (Awang & Ramly, 2011; Karpova et al., 2011; Webster, 1990). The common point in these studies is to provide students with a process through which they can express themselves, regardless of their age group. For example, Webster (1990) stated in an example from music education that creativity is not just the work that students put forward at the end, but that the preparation process that students experience while creating the piece and analyzing other pieces are also parts of the creative thinking process. As stated by Jonassen (2011), creativity is linked to the specific context. Moreover, Shively et al. (2018) added that design based experiences can support critical thinking and creativity. In connection with these ideas, we investigated early childhood teachers' ideas and practices related to creativity and critical thinking with an emphasis on design.

Previous design-based learning studies stated that there are very few studies investigating design in early childhood education (Aguirre-Munuz & Pantoya, 2016; Delen & Yüksel, 2022; Ormancı & Cepni, 2019). Several studies presented numerous examples depicting early childhood children being capable of completing complex design challenges (Aguirre-Munuz & Pantoya, 2016; Bartholomew et al., 2019). Teachers play a vital role to support children's development in early childhood and our results showed that early childhood education teachers plan various activities to support developmental areas and consider critical thinking in their activities. Connected with our results, Çoban and İnan (2019) reported that early childhood teachers perceive themselves to be creative. However, how early childhood teachers transform creativity should be carefully evaluated. Although early childhood teachers plan various activities, how they planned these activities presented numerous gaps in design-based learning. Teachers rarely considered limitations for students and teachers did not consider the inclusion of parameters. Missing all these aspects can become confusing for early childhood students. For instance, in activity 6 the teacher only included a science experiment. Students were expected to create a drawing related to gravity, but students did not have any criteria moving forward (e.g., what should be size of the drawing, what were some details that were expected from students). Since gravity is a concept that is hard understood by middle school students (Yılmaz and İnce Aka, 2022), drawing gravity without any clear guidelines can be puzzling for early childhood students. When students do not clearly understand what the design process entails, it would be really hard to prompt the creativity and critical thinking through the design process. A recent review by Puig-Mauriz et al. (2021) reported the scarcity of critical thinking interventions in K-12 education. Our results adds a new perspective to these limited number of studies by depicting the paucity of design details presented to early childhood students to develop their creativity and critical thinking in design-based activities.

In addition, several design-based activities (e.g., Activity 3) only presented a science experiment. This presents a big misconception and adds a new dimension for design-based learning studies. English (2016) stated that science is the dominant discipline for STEM education studies. A recent meta-analysis confirmed this result by reporting science as the primary discipline for design-based learning experimental studies (Delen & Şen, 2023). In addition to the dearth of examples in early childhood education (Aguirre-Munuz & Pantoya, 2016; Delen & Yüksel, 2022; Ormancı & Cepni, 2019), our study highlights that how early childhood teachers define and implement design is worth examining in further studies. As stated by Royalty (2018), design can promote original and creative thinking by teaching design to those who aren't designers, but little is known about how this could be implemented in the classroom.

It is important to underline that teachers in the high creativity group were able to provide a wider range of examples to illustrate the relationship between critical thinking and design-based activities. This could be related to the various connections between critical thinking and creativity (Claro & Ananiadou, 2009; Hyslop-Margison et al., 2001; McGuire, 2007). These skills are also connected in different curriculum documents in Türkiye (MoNE, 2012; MoNE, 2018b). However, teachers did not list any design-based activities when discussing developmental areas or critical thinking. When considering this result with the gaps found in design-based activities, we can conclude that teachers need support to translate “perceived creativity” into action for design-based learning.

Early childhood teachers received high scores in the creativity scale. However, they were not able to present how they could support creativity in design-based activities. Teachers were attentive to students’ age level when planning design-based activities, and the main aspect they emphasized was the selection of materials. However, the design process also investigates how different parameters work. Shanta and Wells (2020) stated that design is inextricably linked to innovation, to solve an ill-defined, authentic problem within the confines of the resources at hand and the parameters of real-world settings. Shanta and Wells (2020) also added that designing solutions for problems should be enforced by limitations and parameters. Engineering education studies continue to emphasize understanding constraints and parameters (Huang et al., 2020), and recent studies have also started to discuss these for teacher education (Gleason & Jaramillo Cherrez, 2021).

To support critical thinking, a complex real-life problem-solving situation can be presented to students (Awang & Ramly, 2011) and teachers in our sample, primarily focused on including problems that are connected to age group and daily life. Critical thinking is defined as the process of evaluating and analyzing a process from different perspectives. This thinking process emerges as an effective cognitive process (Karademir, 2013). One of the most important features of the critical thinking process is being able to ask "why" questions about the judgments made during or as a result of the process (Ekinci & Aybek, 2010). Seferoğlu and Akbıyık (2006) emphasized that teachers who can think critically can support this ability in their classrooms. Early childhood education teachers were discussing the importance of these "why" questions (evaluating the quality of design and products, identifying and correcting deficiencies, thinking about what worked).

Our study only included a sample from one city and we reported small effect sizes. The data were collected after the pandemic and this had an impact on the number of participants and new studies need to focus on bigger study populations. The activities were only collected from the high creativity group and future studies can examine how teachers' perceived creativity might have an impact on design-based learning. Despite these limitations, our study also added a new dimension to the argument that the lack of design-based examples in early childhood education is not the gap. Early childhood education teachers would need more professional development support to understand the fundamentals of the design process. These professional development efforts should consider understanding how early childhood education teachers perceive creativity and critical thinking in design based learning.

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Conflicts of Interest

The authors have no relevant financial or non-financial interests to disclose, and declare that they have no conflict of interest.

References

Aguirre-Muñoz, Z., & Pantoya, M. L. (2016). Engineering literacy and engagement in kindergarten classrooms. *Journal of Engineering Education, 105*(4), 630-654.

Alves-Oliveira, P., Arriaga, P., Xavier, C., Hoffman, G., & Paiva, A. (2022). Creativity landscapes: Systematic review spanning 70 years of creativity interventions for children. *The Journal of Creative Behavior, 56*(1), 16-40.

Awang, H. & Ramly, I. (2008). "Through problem-based learning: Pedagogy and practice in the engineering classroom", *International Journal of Human and Social Sciences, 2*(4), 18–23.

Bartholomew, S. R., Moon, C., Ruesch, E. Y., & Strimel, G. J. (2019). Kindergarten Student's Approaches to Resolving Open-Ended Design Tasks. *Journal of Technology Education, 30*(2), 90-115.

Bocconi, S., Chioccariello, A., Dettori, G., Ferrari, A., Engelhardt, K., Kampylis, P., & Punie, Y. (2016). *Exploring the field of computational thinking as a 21st century skill.* In EDULEARN16 Proceedings (pp. 4725-4733). IATED.

Chantal, P. L., & Markovits, H. (2017). The capacity to generate alternative ideas is more important than inhibition for logical reasoning in preschool-age children. *Memory & Cognition, 45*(2), 208-220.

Claro, M., & Ananiadou, K. (2009). *21st Century Skills and Competences for New Millennium Learners in OECD Countries*. OECD Education Working Papers.

Craft, A. (2003). Creative Thinking in The Early Years of Education. *Early Years, 23*(2), 143–154.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Coyne, I. T. (1997). Sampling in qualitative research. Purposeful and theoretical sampling; merging or clear boundaries? *Journal of advanced nursing, 26*(3), 623-630.

Creswell, J. W. ve Creswell, J. D. (2021). *Araştırma tasarımı: Nitel, nicel ve karma yöntem yaklaşımları (5. Basımdan Çeviri),* E. Karadağ (Çev.), Ankara: Nobel Yayıncılık.

Çoban, Ç. (2016). *Okul Öncesi Öğretmenlerinin Yaratıcılık Düzeylerinin İncelenmesi.* Yayımlanmamış yüksek lisans tezi. Dumlupınar Üniversitesi, Uşak.

DeCuir-Gunby, J. T., Marshall, P. L., & McCulloch, A. W. (2011). Developing and using a codebook for the analysis of interview data: An example from a professional development research project. *Field methods, 23*(2), 136-155.

Delen, İ., & Şen, S. (2023). Effect of design-based learning on achievement in K-12 education: A meta-analysis. *Journal of Research in Science Teaching, 60*(2), 330-356.

Delen, İ., & Yüksel, T. (2022). Understanding trends in engineering design and design-based learning studies with a bibliometric approach. *European Journal of Engineering Education, 47*(6), 1380-1398.

Design and technology programmes of study (2013). *Key stage 3.* Department for Education.

Ekinci, Ö., & Aybek, B. (2010). Öğretmen adaylarının empatik ve eleştirel düşünme eğilimlerinin incelenmesi. *İlköğretim Online, 9*(2), 3-14.

Eskidemir-Meral, S. ve Tezel-Şahin, F. (2019). Okul Öncesi Öğretmenlerinin Yaratıcı Düşünme Eğilimleri. *OPUS–Uluslararası Toplum Araştırmaları Dergisi. 13*(19), 311-331.

European Commission (2007). *Science education now: a renewed pedagogy for the future of Europe. Brussels.* Report by a High Level Group on Science Education.

Forsthuber, B., Motiejunaite, A., & de Almeida Coutinho, A. S. (2011). *Science*

Education in Europe: National Policies, Practices and Research. Education, Audiovisual and Culture Executive Agency, European Commission. Available from EU Bookshop.

Gleason, B., & Jaramillo Cherrez, N. (2021). Design thinking approach to global collaboration and empowered learning: Virtual exchange as innovation in a teacher education course. *TechTrends, 65*(3), 348-358.

Herzog, C., Handke, C., & Hitters, E. (2019). *Analyzing talk and text II: Thematic analysis.* In The Palgrave handbook of methods for media policy research (pp. 385-401). Palgrave Macmillan, Cham.

Heyman, G. D. (2008). Children's critical thinking when learning from others. *Current Directions in Psychological Science, 17*(5), 344-347.

Huang, Z., Peng, A., Yang, T., Deng, S., & He, Y. (2020). A design-based learning approach for fostering sustainability competency in engineering education. *Sustainability, 12*(7), 2958.

Hyslop-Margison, E. J., & Graham, B. (2001). Principles for democratic learning in career education. *Canadian Journal of Education/Revue canadienne de l'éducation,* 341-360.

İnceoğlu, M. M., & Koşar, A. Böte Öğrencilerindeki Yaratıcılık ve Problem Çözme Becerilerinin Karşılaştırılması. *Ege Eğitim Dergisi, 9*(2), 155-172.

Karademir, Ç. A. (2013). *Öğretmen adaylarının sorgulama ve eleştirel düşünme becerilerinin öğretmen öz yeterlik düzeyine etkisi.* Yayımlanmamış Doktora Tezi, Adnan Menderes Üniversitesi Sosyal Bilimler Enstitüsü, Aydın.

Karpova, E., Marcketti, S. & Barker, J. (2011). "The efficacy of teaching creativity: Assessment of student creative thinking before and after exercises", *Clothing and Textiles Research Journal, 29,* 52–66.

Kline, R. B (2011). *Principles and practice of structural equation modeling.* New York: Guilford Press.

Köse, E., Çelik-Ercoşkun, N., Balcı, A. (2016). Okul öncesi ve sınıf öğretmeni adaylarının yaratıcı düşünme ve problem çözme becerilerinin incelenmesi. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi, 40,* 153-170.

Kuhn, M. A., Greenhalgh, S., & McDermott, M. (2016). Using creativity from art and engineering to engage students in science. *Journal of STEM Arts, Crafts, and Constructions, 1*(2), 2.

Kurfiss, J. G. (1988). *Critical Thinking: Theory, Research, Practice, and Possibilities. ASHE-ERIC Higher Education Report No. 2, 1988.* ASHE-ERIC Higher Education Reports, The George Washington University, One Dupont Circle, Suite 630, Dept. RC, Washington, DC 20036-1183.

Marmon, M. (2019). *The emergence of the creativity in STEM: fostering an alternative approach for Science, Technology, Engineering, and Mathematics Instruction through the use of the arts.* In STEAM Education (pp. 101-115). Springer, Cham.

Marshall, C. & Rossman, G. B. (2014). Designing Qualitative Research. New York: Sage.

McGuire, J. M. (2007). Why has the critical thinking movement not come to Korea?. *Asia Pacific Education Review, 8*(2), 224-232.

Meral, S. E., & Şahin, F. T. (2019). Okul öncesi öğretmenlerinin yaratıcı düşünme eğilimleri. *OPUS International Journal of Society Researches, 13*(19), 311-331.

Ministry of National Education (MoNE) (2012). *Ortaokul ve İmam Hatip Ortaokulu BTY Dersi (5, 6, 7 ve 8. Sınıflar) Öğretim Programı.* Ankara.

Ministry of National Education (MoNE) (2013). *Okul öncesi eğitimi programı.* Ankara

Ministry of National Education (MoNE) (2018a). *Milli Eğitim Bakanlığı Bilişim Teknolojileri ve Yazılım* (1-4.Sınıflar) Öğretim Programı. Ankara.

Ministry of National Education (MoNE) (2018b). *Teknoloji ve Tasarım Dersi Öğretim*

*Programı (Ortaokul 7 ve 8. Sınıflar).*Öğretim Programı. Ankara.

Organisation for Economic Co-operation and Development (OECD, 2021). *Draft framework for the assessment of creative thinking in Pisa: Third Draft 2021.* OECD Publisher, Paris (2019).

Ormancı, U. & Cepni, S. (2019). Thematic Analysis of Conducted Studies Regarding Preschool Science Education in Turkey. *Journal of Turkish Science Education, 16*(3), 415-.439.

Özgenel, M., & Çetin, M. (2017). Marmara yaratıcı düşünme eğilimleri ölçeğinin geliştirilmesi: Geçerlik ve güvenirlik çalışması. *Marmara Üniversitesi Atatürk Eğitim Fakültesi Eğitim Bilimleri Dergisi, 46*(46), 113-132.

Puig, B., Crujeiras, B., Mosquera, I., & Blanco, P. (2021). *Integration of Critical Thinking and Scientific Practices to Design-Based Pedagogy.* Design Based Pedagogy Book: Design Based Pedagogical Content Knowledge Across European Teacher Education Programs, 89-127.

Royalty, A. (2018). Design-based pedagogy: Investigating an emerging approach to teaching design to non-designers. *Mechanism and Machine Theory, 125,* 137-145.

Seferoğlu, S. S., & Akbiyik, C. (2006). Eleştirel düşünme ve öğretimi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 30*(30), 193-200.

Shanta, S., & Wells, J. G. (2020). T/E design based learning: assessing student critical Thinking and problem solving abilities. *International Journal of Technology and Design Education,* 1-19.

Shively, K., Stith, K. M., & Rubenstein, L. D. (2018). Measuring what matters: Assessing creativity, critical thinking, and the design process. *Gifted Child Today*, *41*(3), 149-158.

Subedi, D. (2016). Explanatory sequential mixed method design as the third research community of knowledge claim. *American Journal of Educational Research, 4*(7), 570-577.

Uzman, E. (2003). *Okul öncesi eğitim alanında çalışan öğretmenlerin yaratıcı düşünme becerilerinin gelişiminin incelenmesi.* Yayımlanmamış yüksek lisans tezi, Dokuz Eylül Üniversitesi, İzmir.

Üğurlu, C., & Ceylan, N. (2014). Öğretmenlerin örgütsel yaratıcılık ve etik liderlik algılarının incelenmesi. *Mersin Üniversitesi Eğitim Fakültesi Dergisi, 10*(2).

Webster, P. (1990). Creativity as creative thinking. *Music Educators Journal, 76*(9), 22–28

Wendell, K. B., Connolly, K. G., Wright, C. G., Jarvin, L., Rogers, C., Barnett, M., &

Marulcu, I. (2010). *Incorporating engineering design into elementary school science curricula.* American Society for Engineering Education Annual Conference & Exposition, Louisville, KY.

Yılmaz, M, & İnce Aka, E (2022). "Sekizinci Sınıf Öğrencilerinin Fen Bilimleri Dersinde Sürtünme Kuvveti Konusunu Günlük Yaşamla İlişkilendirebilme Düzeyleri." *Gazi Eğitim Bilimleri Dergisi, 8*(2), 228-248.