Design Thinking Model in Early Childhood Education

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ABSTRACT

Click This study aims to investigate the usability of the design thinking model for the education of pre-school children and the effects of the activities performed in line with the design thinking model on children. This research was conducted as a case study of 16 teachers working in a private school. Research data were collected through interviews with teachers and analyzed using the content analysis method. The analysis results demonstrated that the design thinking model could be easily used in the education of pre-school children. The Design Thinking model improves children's creativity, problem-solving, cooperation, communication, curiosity, questioning, and empathy. It allows children to express their ideas freely and supports social, emotional, language, and cognitive developmental domains. Also, the design-oriented learning process appears to actively involve children in the learning process, enable peer learning, and give children self-confidence. On the other hand, while the design thinking model does not seem to be a problem for children aged 4 and 5, children aged 3 have issues in task sharing, being a group, belonging to a group, fulfilling duties and responsibilities. or tap here to enter text.

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Early childhood education, pre-school education, design thinking model.

1. Introduction

Constructivism, viewed as the reconstruction of knowledge by individuals from their own subjective perspectives as a function of learning, social implications, and models (Wheatley, 1991), has been expressed by theorists in various ways. The first is cognitive constructivism, as defined by Piaget, based on the cognitive development theory. Piaget tried to explain the cognitive structures and cognitive development in human beings by using such concepts as assimilation, adaptation, and balance. According to studies, if new information is not adapted to existing cognitive structures, the mind chooses to set a balance by creating new cognitive structures (Philips &Soltis, 2005). In radical constructivism, on the other hand, Ernst von Glasersfeld (2013) emphasized that information is not collected passively. Still, on the contrary, individuals take an active role in the formation and structuring of knowledge. Also, knowledge is not expected to match or be similar to the realities of the outside world in radical constructivism, for experiences may change, and consequently, knowledge may change. Finally, from the standpoint of socio-cultural constructivism, which is based on the views of Vygotsky and Dewey, knowledge represents the midpoint of objective and subjective understandings. Learning is not independent of language and culture, which play significant roles in the learning process (Demirel, 2008; Fer&Cırık 2007; Uzun, 2019).

1.1. Design Thinking Model

The rise of various teaching models that help build knowledge based on constructivism has facilitated the process of building it. One of such models is the design thinking model. Design thinking is a nonlinear process that is not visible at first glance, but enables us to understand individuals, examine possible solutions, and redefine problems to develop new and different solutions (Dam & Siang 2018a). It allows

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individuals to develop new and creative solutions to the problems they encounter with a solution-oriented perspective. Design thinking is not only a method for designers to work with, but a design model utilised by people in all professions, and is used to come up with new solutions to new problems and to catch new opportunities in a well-tried design process (Moggridge, 2010). Design thinking plays a very important role in terms of reconstructing the general framework of a problem with advanced methods that focus the human being, producing different ideas with the brainstorming technique, creating a new design in line with the emerging ideas, and ultimately redefining unidentified or poorly defined problems (Dam & Siang, 2018b)

Brands such as Apple, Google and Samsung, and leading universities such as Stanford, Harvard and MIT often use the design thinking model to come up with innovative ideas (Dam & Siang 2018a). The relevant literature shows that although the design thinking models used today are basically the same, there are different forms with 3 and 7 stages in practice (Yalçın&Erden, 2021; Yalçın, 2020). This study has focused on the usability of the five-staged design thinking model in preschool, as created by Nobel Prize winner Herbert Simon in the field of artificial sciences in 1996.
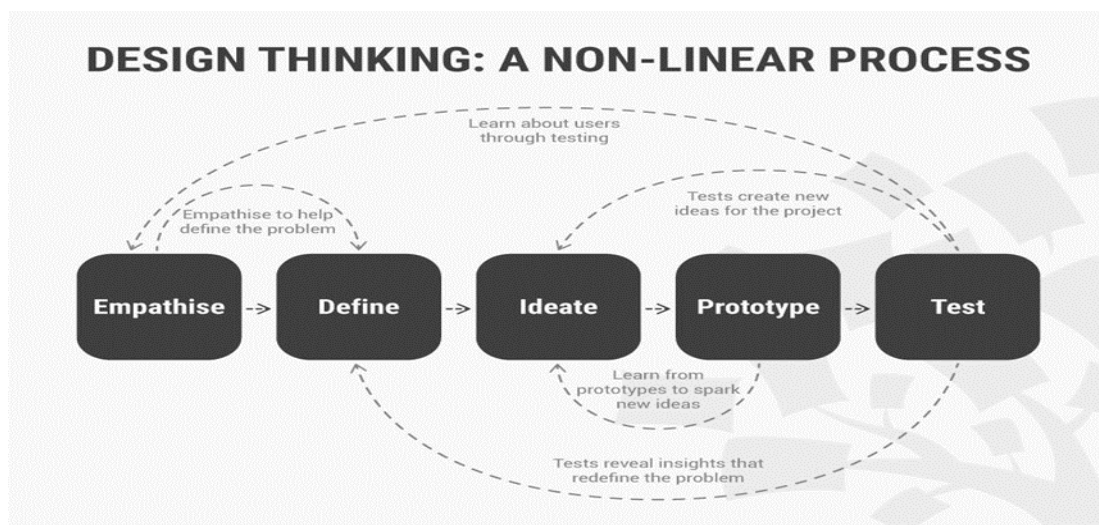

Figure 1. *The stages of design thinking (Dam & Siang, 2018a)*

These five stages can be briefly explained as follows:

- Empathise: It is very important that you empathise with the participants in the programme and know their interests and needs in order to identify the issues involved.Define: It is necessary to define the problems specified in line with the interests and needs of the participants.
- Ideate: By avoiding prejudices and assumptions, innovative solutions that have not been tried before should be developed. Individuals may not want to produce a product where emotions and intuitions are mingled and composed of sources of inspiration. However, while the product is being created, extreme reality and analytical thinking may prevent the emergence of creative ideas and related products. At this stage, design thinking with a holistic approach should be put into practice as a third way.
- Prototype: The best solution should be identified from among the solution-related suggestions for the solution of a problem, and an example of the solution should be constituted.
- Test: The proposed solutions found in this phase are tested. Depending on whether the problem is solved or not, the problem definition, design and prototype phases can be reviewed again.

These stages may not always follow a linear path. A certain sequence is followed, and in some cases, it may occur in parallel. For this reason, these stages should not be perceived as the steps following a hierarchy.

1.2. Problem Situation

As seen in the literature, the design thinking model is generally used with secondary school and older students in educational activities and research. Still, there is no study involving the design thinking model with pre-school children. The relevant studies in the literature include those conducted with different age groups such as primary school students (Dorie, Cardella, &Svarovsky, 2014; Noel &Liub, 2017), secondary school students (Carroll et al., 2010), high school students (Gardner, 2017; Mentzer, Becker, & Sutton, 2015),

and higher education students (Melles, Howard, & Thompson-Whiteside, 2012; Şahin, 2019). In addition, the studies mentioned above also focus on the possible relationships with a variety of concepts such as intelligence (Özekin, 2006), creativity (Erden&Yalçın, 2021; Rauth, Köppen, Jobst, &Meinel, 2010; Yalçın&Erden, 2021; Yalçın, 2020; Yalçın, 2019), engineering-oriented thinking (Dym, Agogino, Eris, Frey, &Leifer, 2005), mood and motivation (Noweski, Scheer, Büttner, von Thienen, Erdmann, &Meinel, 2012), and self-esteem and creativity (Erden&Yalçın, 2021; Şahin, 2019; Yalçın&Erden, 2021; Yalçın, 2020; Yalçın, 2019). The studies in the literature show that the activities prepared according to the design thinking model increase the creativity, cognitive flexibility levels, and self-reporting of the students at the Faculty of Architecture and Design, that in turn, they reduce the negative feelings of the participants (Şahin, 2019), that the activities could be an ideal method to determine the needs of different users and produce appropriate solutions, with or without being aware of the design thinking model (Parlar et al., 2017), that they are likely to increase the academic achievement, decision-making skills and knowledge level of engineering discipline of students in the 7th grade for the force and motion unit in the science course (Ercan, 2014), that the educational programs implemented as to the design thinking model contributed to the development of primary school students in problem-based learning, human-oriented creativity, product development, and testing (Noel &Liub, 2017), that the participants had high awareness in the design process and thought differently from adults in the study, where students' engineering behaviours were examined using the design thinking model, (Dorie, Cardella, &Svarovsky, 2014), and that the design thinking increases motivation at stages such as observation, comprehension, and generating ideas (Kröper et al., 2011).

In addition, the design thinking process in secondary schools has been shown to support children in developing learning techniques and inquiry skills, and to enable peer learning by encouraging teamwork, with children actively participating in the process through which the product creation phase enables rapid learning. The study found that the design thinking process encourages children to express their opinions so that children can make a connection between academic learning and the design-oriented learning process (Carroll et al, 2010), that it showed a statistically significant difference in the test scores of children with high academic achievement, despite an insignificant difference in the low-achieving class (Doppelt, Mehalik, Schunn, Silk, &Krysinski, 2008), and that high school students gain scientific understanding of genetics and gene transfer, and transfer their scientific understanding to new and different subjects (Ellefson, Brinker, Vernacchio, &Schunn, 2008).Additionally, Wendell (2008) stressed the importance of design thinking for science education, its relationship with different educational approaches, and relevant information about the use of design thinking in science teaching. Finally, Fortus et al. (2004) reported in their study with high school students that children's learning levels increased significantly with the design thinking learning model, that this instructional model helps children construct knowledge, that it can be a foundation for science instruction for all children, and that the school curriculum can be managed with the design thinking model.However, no research has been found in the literature that examines an applied design thinking model with pre-school children or the applicability of the model with pre-school children.

1.3. The Significance of This Study

A variety of studies, including the design thinking model, were encountered in the literature review. However, it appears that the design thinking model has generally been used with middle school and older students in educational activities and educational research, but on the other hand, no study has involved the design thinking model with pre-school children (Carroll et al., 2010; Dorie, Cardella&Svarovsky, 2014; Doppelt, Mehalik, Schunn, Silk &Krysinski, 2008; Ercan, 2014; Ellefson, Brinker, Vernacchio&Schunn, 2008; Fortus et al., 2004; Kröper et al., 2011; Noel &Liub, 2017; Parlar et al., 2017; Şahin, 2019; Wendell, 2008)

This study aims to examine the usability of the design thinking model, which is generally used in the engineering, design and architecture faculties of industry and universities as well as R&D activities of different companies, in the education of pre-school children, and the effects of the activities conducted with the design thinking model on the developmental domains of pre-school children concerning the example of Süperbaba schools.

2. Methodology

2.1. Research Model

Conducted to determine the usability of the design thinking model in the education of pre-school children, this research was carried out with a case study method, which is a type of qualitative research designs. A qualitative research design is planned to contribute to the foundation of knowledge, develop field-specific applications, determine the value of something, and emphasize a specific problem (Merriam &Grenier, 2019). Case studies are meant to describe and examine a limited system in depth. The main feature that distinguishes case studies from other qualitative studies is their limitation, and the fact that the subject studied remains within a framework (Creswell, 2013). This study aims to explore whether the design thinking model could be used in pre-school education.

2.2. Participants

The study population is constituted by a pre-school education institution named 'Süperbaba Schools', operating under the Ministry of Family, Labour and Social Services in Kilis, Turkey, in the academic year of 2020-2021. The study's sample group consisted of 16 volunteer teachers working in Süperbaba Schools and applying the design thinking model in their classrooms. All of the teachers who use the design thinking model at the school participated in the study. The participants of the study were selected through criterion sampling, which is a type of purposive sampling. Criterion sampling examines all situations that meet a predetermined set of criteria (Baltacı, 2019). The criteria are created by a researcher or a previously prepared criteria list can be used (Marshall &Rossman, 2014). The criterion determined in this study is whether the design thinking model is applied in the activities. Table 1 presents the demographic information of the sample group.

Table 1. *Demographics of the Participants*

Teachers	Age	Gender	Teaching Experience	Education status	Teaching experience with design thinking model	The age group he/she teaches
Gül	26	F	4	University	2	5
Filiz	26	F	4	University	2	5
Eda	26	F	4	University	2	5
Zeynep	26	F	3	University	2	4
Sinem	22	F	3	University	1	3
Tuğçe	22	F	3	University	1	3
Ela	24	F	2	University	2	4
Elif	23	F	2	University	2	3
Begum	22	F	1	University	1	4
Arzu	22	F	1	University	1	4
Canan	24	F	2	University	2	4
Meltem	23	F	2	University	2	3
Zeliha	22	F	1	University	1	4
Hüseyin	22	M	2	University	1	5
Fatma	24	F	2	University	2	4
Kübra	22	F	1	University	1	4

When Table 1 is examined, 16 teachers participating in the study were between the ages of 22 and 26, 15 were female and one was male, their teaching experience ranged from 1 to 4 years, their teaching experience ranged from 1 to 2 years with the design thinking model. It is seen that they give education to children of

age. Also, in accordance with ethical rules, the information of the participants was protected and pseudo names were used to ensure the confidentiality of the participants in the abovementioned information.

2.3. Süperbaba Schools

It is a pre-school institution that offers education and care services, including breakfast, lunch, and mid-afternoon meals, between 8 am and 5 pm. Education activities in Süperbaba Schools are divided into two parts as morning and afternoon. Morning activities mostly consist of those in the classroom, especially following the design thinking model (Dam & Siang 2018) for children's cognitive, social-emotional, and language development. The design thinking model is applied in eight classes with children aged 3-6. There are activities and workshops in the afternoon, mostly including garden and indoor playground activities to develop children's social skills and artistic perspectives. The basic principle of Süperbaba Schools is to be able to build childhood with an education that combines science-art and character education. Süperbaba Schools generally have children from families with medium socio-economic status.

2.4. Application Process of Design Thinking Model

Design thinking model is applied in small groups of 3-4 people depending on the number of children in classrooms. Small group activities include creating different products after being divided into groups according to their age, developmental stages, interests, and abilities (MoNE, 2013). Small activity groups were formed by paying utmost attention to making heterogeneous groups according to the children's age, developmental stages, interests, and abilities. In this way, children have been given the opportunity to achieve the same acquisitions in different ways. Figure 2 presents the general overview of the pre-implementation preparation process.
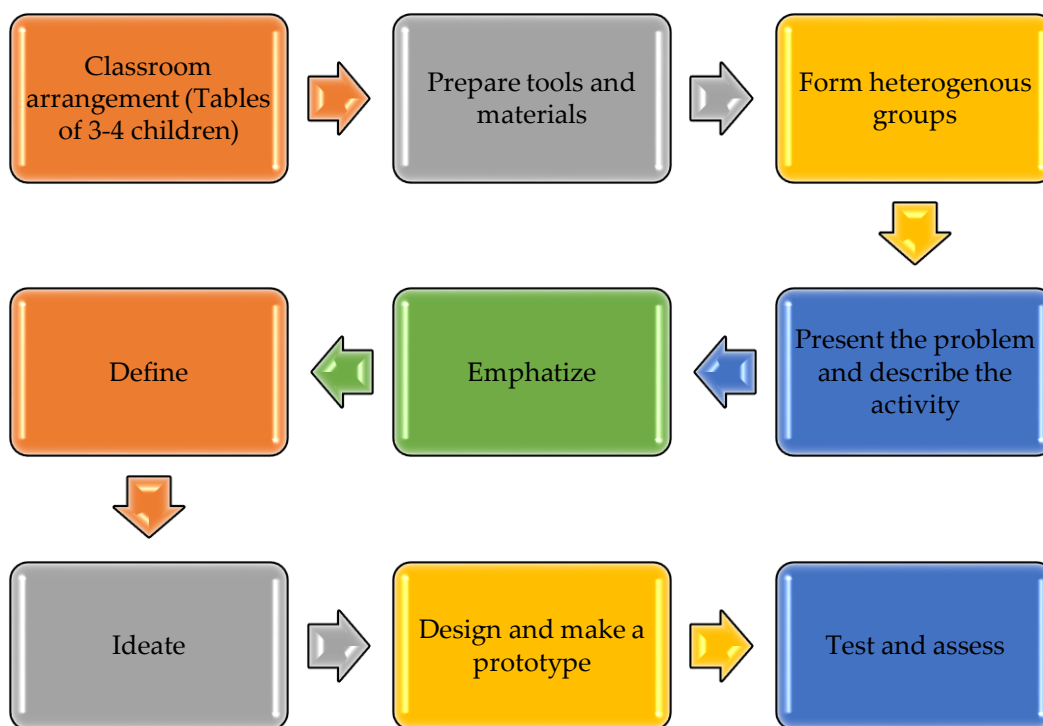

Figure 2. *Application stages of the design thinking model in a pre-school classroom*

Arranging the physical layout of the application area:

Tables and chairs for children to sit should be prepared for three or four children, depending on the class size. It is important that the groups are distant from each other to make them focus their attention on the activity and the process.

Preparation of necessary tools and materials for the activity:

The teachers can prepare the materials for the activity before the application. Depending on the type of activity, children participating in the practice may be allowed to collect materials themselves from the classroom or the school garden.

Forming heterogeneous groups:

Heterogeneous groups are formed for the small-group activities according to the children's age, development levels, interests, and abilities. In this way, children are given the opportunity to achieve the same acquisitions in different ways.

Presentation of the problem and introduction of the activity:

The teacher explains the problem or situation to the children. The activity is introduced.

Empathize:

At this stage, it is aimed to make children notice the problem or situation, and determine the extent of their sense of empathy as to "What would I feel if I were in the same situation?".

Define:

Children who empathize with the problem in the activity are expected to describe the problem/situation in general terms. A literal description of the situation is important to come up with a solution.

Ideate:

At this stage, ideas are generated for possible solutions to the problem or situation. At this stage where communication is intense, children are encouraged to express their views and to come up with different ideas.

Design and make a prototype:

The groups identify and illustrate the best solution found during the idea generation phase. The prototypes are made by trying to stick to the children's drawings.

Test and assess:

It is the stage in which each group explains their designed product to other groups. The contribution of the products to the solution of the problem is discussed and similar/different aspects between the designs are examined. The resulting product is examined in terms of operability and durability, and a process-oriented evaluation is made. Communication, cooperation, and interaction are important throughout the process.

2.5. Data Collection Tool

Interviews can be conducted with different techniques, such as structured, semi-structured, unstructured, and focus group interviews (Marshall, 1996). The interview form developed and designed by the researcher was evaluated in accordance with the opinions of seven experts in the field of preschool education; the reliability of the study was increased by evaluating the validity of the interview questions and their suitability for the study. The interview form consists of 10 basic questions and drilling questions. Questions are included in the interview form, "Question 4- What effect do you think the activities carried out with the design thinking model have on children?".

2.6. Data Collection

Semi-structured interviews were performed to collect the teachers' views and experiences regarding the applicability of the design thinking model in pre-school children's education. The interviews were conducted one-on-one in the teachers' room, where teachers would not be distracted. Interviews lasted at least 24 and at most 32 minutes. Since the teachers did not allow voice recording, the researcher wrote and noted the interview data, and possible data loss was prevented.

2.7. Validity and Reliability in Qualitative Research

In order to increase the validity and reliability of the present study, all participants were asked to confirm their participation during the interview. The researcher objectively stated the study process clearly and comprehensibly. Also, the reliability of the study was further increased by explaining the demographic information of teachers participating in the study in detail. The facts that the findings and results obtained from the data collected in the research were compatible with the study's theoretical framework, and that the results were supported with similar results of the related studies are other factors that increase the reliability

(Golafshani, 2003; Maxwell, 2008). In this regard, the reliability of the study results was increased by supporting them with the results of similar studies in the literature.

On the other hand, the facts that data obtained through qualitative data collection techniques were systematically included in the research, that participant confirmation and expert opinion were obtained, and that the appropriate methods of data collection and analysis were selected in accordance with the theoretical framework before the applications in the study began can also be listed as important steps contributing to internal reliability in this study (Baltacı, 2017; Merriam &Grenier, 2019; Neuman& Robson, 2014).

2.8. Data Analysis

The data obtained from the interviews were transcribed and analysed by content analysis in which codes, categories, and themes were created (Merriam &Grenier, 2019). In this analysis method, an in-depth analysis is performed by organizing, classifying and comparing texts, and drawing theoretical results (Cohen, Manion, & Morrison, 2007). In the present study, the data were supported by making direct quotations in the results, conclusion and discussion section of the study regarding the specific examples of teacher experiences and applications during the implementation of the design thinking model.

2.9. Ethical

In this study, all rules stated to be followed within the scope of "Higher Education Institutions Scientific Research and Publication Ethics Directive" were followed.

Ethical Review Board Name: Kilis 7 Aralık University Ethics Committee

Date of Ethics Evaluation Decision: 13.11.2019 Ethics Assessment Document Issue Number: 2019/20

3. Result

Relevant codes, categories, and themes were created according to the content analysis of the data. As a result of the analyses, the usability of the design thinking model in the education of pre-school children and the effects of the design-thinking-based activities on pre-school children were examined under the themes of creative thinking, problem-solving, communication, cooperation, feedback, developmental areas, and teacher competencies.

Table 2. *Design thinking model in preschool*

Themes	Categories	Codes	f
Creative thinking	Active participation	Freely expressing opinion	7
		Participation in events	6
		Communication and interaction	6
		Interesting activities	4
	Transforming knowledge into practice	Generating different solutions	6
		Productivity	5
		Use your imagination	4
	Empathize	Inquiry skill	5
		Changes in children throughout the process	3
Problem Solving	Productivity	Alternative ways of solution	6
		Increased skills	5
		Practical solutions	3
		Self-confidence	2
	Daily life problems	Real-life problems	5
		Concretization	3
		Drawing on previous experiences for new situations	3
	Brainstorming	Active participation	6
		Inquiry skills	3
		Developing a sense of curiosity	2
Communication	Small group activity	Language use	6
		The ability to take responsibility	5
		Communication problems	3
		Listening skills	3

	Suitable environment / opportunities	Language use	6
		Generating ideas	5
Cooperation	Sense of belonging to a group	Being aware of responsibilities	8
		Acting with the group	5
		Social cohesion	5
	Duties and responsibilities	Being aware of responsibilities	8
		Taking part in the implementation process	6
Feedback	Parent feedback	Problem solving	9
		Generating ideas	8
		The ability to transfer knowledge to real life	7
		Creative solutions	4
		Changes in children throughout the process	3
	Feedback from children	Problem solving	9
		Creative solutions	4
		Egocentric	2
		Use of materials suitable for the purpose	2
		Belonging to the group	2
		Showing respect to other children's ideas	2
		Similar/identical ideas	2
Developmental domains	Social and emotional domain	Fulfilling responsibilities	13
		Small group activity	10
		Empathy	6
		Inter-disciplinary	5
	Cognitive development	Problem solving	14
		Active participation	12
		Creativity	10
		Brainstorming	6
		Meaningful learning	3
	Language development	Communication	10
		Cooperation	8
Teachers' competence	Application process	Mentor	7
		Motivator	6
		Observant	5
		Encouraging	4
		Cooperative	2
	Classroom environment	Fun-loving	6
		Mild classroom atmosphere	3

Creative Thinking

The results show that one of the most important effects of the activities conducted with the design thinking model on pre-school children is creativity. Some of the sample opinions of the teachers participating in the study are as follows: teacher Elif said, "They immediately generate ideas in the difficulties they encounter. Design thinking provides benefits in many areas such as creative thinking, empathy, being active in the process, and using imagination. For example, when the play dough seems drying, they wrap it in a wet wipe and put it in its box so that it will not dry out." On the other hand, Teacher Fatma said "I think design thinking helps children be productive and creative, to question and develop their sense of curiosity".

Similarly, according to Teacher Kübra, "The children are able to generate ideas and solve problems they face in daily life from a different point of view", and Teacher Gül said, "I would say that children generate different, innovative and scientific solutions to problems more quickly. For example, when asked, 'Turtles walk very slowly. What can we do to make them walk faster?', the children answered, 'We can produce skates, skateboards, cars, etc. for turtles'". Building on this, it can be assumed that activities carried out with the design thinking model develop creativity in children, encourage children to generate new and creative ideas, and enable them to be solution-oriented, curious, and questioning beings.

Problem Solving

The results show that another important effect of the activities performed with the design thinking model on children is the development of problem-solving skills. Some sample opinions of the teachers who participated in the study are as follows: Teacher Begüm said, "Through design thinking, children have learned that there is always a solution to any difficulties they encounter. They become incredibly happy as they come up with solutions", and Teacher Kübra added, "Design thinking enables children to think differently, to cope with the problems they may encounter in their daily lives, to be solution-oriented, and to put them into design to concretize". Similarly, Teacher Filiz said, "I have noticed that while children are playing games in the leisure time, if they see a broken toy, they try to repair it in different ways, saying, 'Let's find a solution!'. I have also noticed that they ask each other questions just like the problem-based questions I often ask them".

About her relevant experience, Teacher Zeynep presented a dialogue with the children in her classroom during the implementation of the design-oriented learning model given as follows:

"They can make an association and empathize when faced with a problem similar to what they have experienced before. It becomes easier for them to understand the situation and come up with solutions. For example, once I said, 'In my classroom are four tables. One of the tables' legs is longer than the others' legs. I could not bring the four tables together. How can I put the tables side by side', turning to the kids, I continued saying, 'How can I make their length the same?' to enable them to think and come up with solutions. After the children thought for a while with their groupmates, I had the following dialogue with them:

> C1. "Let's cut the legs of the long table and make it equal with the other tables."
> C2. "No. We are just kids. It's dangerous for us to use such tools. Let's find another solution."
> C3. "We can make the legs of the short tables as long as the long-legged table."
> T. How?
> C. We can fold some paper and put it under the tables.
> T. What else?
> C. We can put some of our wooden Legos.

Design thinking helps children to come up with solutions to problems they encounter in real life or to improve their imagination." the teacher expressed a memory.

On this basis, it can be assumed that the design-based learning process actively involves children in the process, shows children that there can be more than one solution to a problem, enables children in groups to support each other through peer learning, encourages children to express their thoughts freely, and makes children feel happy and confident when they find solutions to problems.Communication

In the present study, the activities carried out with the design thinking model appeared to have another important impact: communication skills. Some sample opinions of the teachers are as follows: Teacher Canan said, "They express themselves more easily during the process", just like Teacher Eda who said, "I think the design thinking process encourages every child to think innovatively. Finding a solution and learning to empathize is a very good method for children's development. And every child communicates with each other in this process. I think this is a very positive process for the children socially." Teacher Fatma added, "One of the most important contributions of the Design Thinking process is that the children have the opportunity to express themselves freely.. Friendships are getting stronger, their vocabulary improves as they use verbal communication to express themselves," and according to Teacher Ela, "Children who have difficulty expressing themselves can do it better after a few weeks. Even the children with developmental delay are now beginning to express themselves better. Children are in constant communication and interaction in a small group. Naturally, disadvantaged children find the opportunity to express themselves in this process". Teacher Naz said, "It is possible to see that the children with speech retardation express themselves better; their self-confidence and comprehension skills improved. For example, introverted children can now express themselves better. They can express their thoughts and ideas freely,"; and these findings evidently support the previous finding. Consequently, it could be asserted that the design thinking model provides children with a free space where children have the opportunity to express themselves freely. Perhaps most importantly, children who have language delays and problems with speaking skills more than

their peers will have the opportunity to gain self-confidence, express themselves better, and develop their language and speaking skills.

Cooperation

Another important result of the study regarding the effect of the activities performed with the design thinking model on children is the ability to cooperate. Some sample views of the teachers involved in the study are as follows: Teacher Fatma said, "Those who usually do individual activities have started to act with and tend to belong to the group. They fulfil their responsibilities as a carrier, an architect and a spokesperson within the group." According to Teacher Hüseyin, "In the process, children develop their empathy skills and work in groups and in cooperation rather than staying alone." Similarly, Teacher Meltem said, "Tasks can be shared in the design thinking model and a group work emerges", and as stated by Teacher Canan, "Over time, the activities in the design thinking process have been implemented better. For example, children who insisted on doing such activities individually rather than in a group were later able to work more comfortably in groups at the end of the fifth week. They were also able to express their ideas more comfortably and learn to listen to their friends in the group." In this regard, it can be argued that children acquire important skills such as acting with a group rather than individually, the sense of belonging to a group, respecting decisions within the group, fulfilling duties and responsibilities in the group, and showing empathy.

Feedback

Feedback was received from teachers about the applicability of the design thinking model in pre-school education and its effects on children. Some sample expressions given by the teachers are as follows: Teacher Fatma said, "During the process, I saw that children used the materials appropriately, could express their opinions easily, and created the identical or similar prototypes in line with their ideas. For example, I have received creative feedback from the children such as guessing and writing down the rest of the story on new sheets of paper instead of the torn pages of a book or drawing and pasting pictures according to the story." Teacher Huseyin said, "In our classroom, the protective board of the heater was broken one day. The children immediately gave their opinions to solve the problem and they said, 'We can fix it with tape,' adding that the ends coming out of the board were dangerous and that they would cover the sharp ends with paper so they would not harm them."Mentioning a similar occasion, Teacher Gül said, "A mat fell from the building on the protection net of the school garden and the children said, "Miss, let's figure out how to solve the problem." At that moment, we thought and found a solution. And we picked the mat from there with the help of a long stick", and Teacher Begüm said, "The children come up with solutions for the situations they encounter at home. Parents are very happy about it. They think that the ideas generated by the children are very creative". Teacher Zeliha said, "When children come across a problem at home, they come up with their solutions and design them with the materials available at home. Later, they explain the product they have made to their family". It can, therefore, be stated that children can make a connection with what they learn at school and their real lives and use what they learn at school in various problems at home. In other words, the design thinking model results in permanent behavioural change in children; that is, learning occurs in children.

Developmental Domains

Based on the results, it can be concluded that the activities carried out with the design thinking model have significant contributions to the developmental domain in pre-school children. Some sample opinions of the teachers are as follows: Teacher Sinem said, "Design thinking positively affects children's cognitive, motor, and language development", and Teacher Fatma said, "We can say that design thinking model is a program aimed at increasing the thinking and producing potential of children. It guides our children in the sense that they produce rather than consume." Similarly, teacher Zeliha said, "We can see very clearly that the application process strengthens the children's curiosity and interest in research," and teacher Elif added, "Instead of teaching the basic disciplines independently, it is a multifaceted method of inquiry, which means knowledge is not used in the singular but in the plural.The implementation process aims a fluent, productive, and planned progress." Teacher Zeliha also said, "I think design thinking helps children to be productive and creative, ask questions and develop their sense of curiosity," and teacher Sinem added, "In this process, children develop their empathy skills and learn to work together in groups instead of staying

alone."TeacherFiliz said, "They become individuals who are aware and fulfil their responsibilities in the process. They become active not only physically but also mentally, in which case, the process is no longer boring but fun for children." Teacher Kübra said, "The application process enables children to be active. In addition, their social skills of communicating, cooperating, and acting in a group improve. Their emotional skills improve as they show empathy. Their minds are constantly active in the process. They brainstorm and come up with different and new solutions. In other words, the design thinking model also supports the cognitive-developmental domain of children.". Based on this, it can be assumed that the design thinking model is effective in the social, emotional, language and cognitive development as well as the development of fine motor muscles in children.

Teachers' Competence

The participant views on the design thinking model regarding the implementers, teacher competencies, and teachers' position in the application process revealed the following findings. Teacher Hüseyin said, "Teachers can help children by presenting relevant examples to those who have difficulty in finding ideas, or by explaining the problem to those who do not fully understand the problem with different examples as well as guiding them." Teacher Arzu said, "I am more in the position of a guide as a requirement of the design-oriented learning process. I get children to think with open-ended questions without directing them much." Similarly, Teacher Zeliha said, "When I help my students to carry out thinking-oriented activities, I teach them more successful and practical methods within the framework of certain rules and discipline, or try to instil in them this way of design thinking as an observer and a collaborator to increase motivation and highlight their skills in this process", and Teacher Eda said, "First of all, I talk to the children about the problem, and we chat. If there is something I have to show, I show them its picture. I also get the kids to watch videos on this topic. After the kids have expanded their knowledge, I try to ask them open-ended questions and get them to come up with innovative solutions. At the beginning and at the end of the activity, I am more passive in the active process", and finally, according to teacher Meltem: "A teacher's job is to act as an observer, to get the children's opinion on what each group is doing by asking questions, and to support the children where they need it and, above all, to act as a guide".On the basis of such data, teacher competencies for the design thinking model can be listed as being a guide and an observer as well as being entertaining, friendly, and motivating.

In addition to the situations expressed in the themes above, the participants also talked about different situations experienced in the design-oriented implementation process. One of them indicates that especially three-year-old children have problems in task sharing, being a group, sense of belonging to a group, fulfilling duties and responsibilities within the group, and distribution of group tasks. For example, Teacher Meltem expressed her negative experiences regarding the application of the design thinking model in pre-school children, saying, "Egocentric characteristics of children at the age of three, which is due to their developmental stage, can cause problems in the distribution of tasks", just like Teacher Tuğçe who said, "After a certain period of time, children can start to find similar solutions"; both comments indicate the egocentric characteristics of the children aged three, which can be regarded as a highly probable explanation. No other similar or different kind of negative situations were mentioned in the four and five-aged group of children regarding the applicability of the design thinking model in pre-school education.

4. Discussion

The research first concluded that the activities planned with the design-oriented thinking model encouraged preschool pre-school children to produce new and creative ideas and develop their creativity, curiosity, and research.

In addition, the design-based learning process actively involves children in the process, shows children that there can be more than one solution to a problem, allows children in groups to support each other in a process where peer learning can be achieved, encourages children to express their thoughts freely, and makes children feel happy and confident when they find solutions to problems. The current study also concludes that the Design Thinking model provides children with a free space and enables children with developmental delays in speech and language compared to their peers to gain confidence, express themselves better and develop their speech and language skills.

The teachers' views led us to conclude that the children gained important skills in the design-based learning process, such as acting with a group rather than remaining alone, belonging to a group, respecting decisions within the group, fulfilling their duties and responsibilities within the group, and showing empathy.In addition, it can be stated that children can transfer what they learn at school to their real lives and use what they learn at school for other problems at home. The design thinking model causes permanent behavioural changes in children; that is, learning occurs in children.

Finally, the design thinking model has been found effective in developing social-emotional, language, and cognitive skills, and of fine motor muscles of children and supports the developmental domains of children. In addition, features such as being a guide, an observer, and fun, friendly, and motivating emerged as teacher competencies of the design thinking model. The relationship between the design thinking model and other factors was examined in relevant studies in the literature, including those conducted with different age groups such as primary school students (Dorie, Cardella, &Svarovsky, 2014; Noel &Liub, 2017), secondary school students (Carroll et al., 2010), high school students (Gardner, 2017; Mentzer, Becker, & Sutton, 2015), and higher education students (Melles, Howard, & Thompson-Whiteside, 2012; Şahin, 2019). Also, the studies mentioned above focus on the possible relationships with a variety of concepts such as intelligence (Özekin, 2006), creativity (Rauth, Köppen, Jobst, &Meinel, 2010), engineering-oriented thinking (Dym, Agogino, Eris, Frey, &Leifer, 2005), mood and motivation (Noweski, Scheer, Büttner, von Thienen, Erdmann, &Meinel, 2012), besides self-esteem and creativity (Şahin, 2019).

Several researchers of the studies in the literature concluded that activities prepared according to the design thinking model increase students' creativity, cognitive flexibility, and self-evaluation and reduce their negative emotions (Şahin, 2019), that the design thinking model can be an ideal method to identify the needs of different users and develop appropriate solutions (Parlar et al., 2017) and that science education based on design thinking increases students' academic performance, decision-making ability, and knowledge of the engineering discipline (Ercan, 2014). According to some other studies, the design thinking model contributes to the development of problem-based learning, human-centred creativity, product development, and testing (Noel &Liub, 2017). Design thinking increases motivation in stages such as observation, understanding, and imagination. (Kröper et al., 2011). It has also been asserted that the design thinking process supports children in questioning, teamwork, peer learning, and active participation (Carroll et al., 2010), and that high school students gain scientific understanding on genetics and gene transfer, and can make use of their scientific insights in new and different subjects (Ellefson, Brinker, Vernacchio, &Schunn, 2008).

The study by Fortus et al. (2004) emphasized that the learning ability of high school students increased significantly with the design-based learning model, that design-based learning helped children construct knowledge, that this teaching model could be the basis for science education for all children, and that the curriculum could be applied with the design thinking model.It is apparent in various studies that the design thinking model can be applied in education due to its important benefits for the participants. Likewise, the results of this study seem to support those in the literature. Hence, it is evident that using the design thinking model in pre-school education will most likely provide serious benefits to children in a developmentally critical period. It can be used easily, especially for children aged 4 and 5, as the model proves beneficial in terms of children's social, emotional, language, and cognitive development.

Last but not least, the results of this study also draw attention to gains such as acting with the group, belonging to the group, respecting group decisions, fulfilling duties and responsibilities within the group, and showing empathy. Belonging has been asserted as a basic requirement by many theories and theorists (Ersanlı&Koçyiğit, 2013). Considering close relationships as a precondition for human development to survive, Bowlby suggested that close emotional ties are fundamental in development and that the individuals initially need to establish a relationship with their families (Ecke, Chope, &Emmelkaamp, 2006). According to Maslow, people generally want to establish close relationships with others and to be in a group when their physiological needs and safety needs are met (Maslow, 1943; Boeree, 2006; Maslow, 1954). Belonging to a group, interpersonal relationships and the sense of being part of these relationships are very important for developing closeness and adapting to other circumstances in life (Shifron, 2010). In a similar sense, relevant results in the literature reveal that individuals' belonging to a group is extremely important for human life. According to the results of this study, it can be argued that the design-oriented thinking

model is a very remarkable educational process in making individuals gain the sense of belonging, which is a critically important element for the whole of human life.

In this study, a few negative results were also obtained regarding the applicability of the design thinking model in pre-school education. It was, therefore, concluded that especially three-year-old children experienced problems in sharing tasks, being a group, belonging to a group, fulfilling duties and responsibilities within the group, and distribution of group tasks, though the problems tended to decrease in time. The relevant literature reports the well-known fact that preschool children do not show empathy due to their egocentric way of thinking (Gerrig& Zimbardo, 2017) and cannot recognize that other people may think differently from them (Atkinson, Smith, Bem, Nolen, 2010). In this regard, the fact that the group of three-year-old children in this study exhibited egocentric characteristics in relation to their developmental stage can be considered as a quite possible reason for the negative situation. On the other hand, no similar or different negative situation was found in the group of four- and five-year-old children in relation to the applicability of the formative thinking model in preschool education, which is quite important as an indicator of the applicability and effectiveness of the formative thinking model in preschool education (Yalçın, 2020; Yalçın&Erden, 2021).

5. Limitations

• This study is limited to the qualitative findings from the semi-structured interviews with the teachers who participated in the study.

6. Recommendations

• Considering the limitations of this study, another study can be planned in which data will be collected both quantitatively and qualitatively.In this way, more comprehensive research results could be obtained by making a method, data and observer triangulation.
• In addition, pre-school teachers can contribute to the multifaceted development of children by frequently using activities planned according to the design thinking model.

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