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INNOVATION POTENTIAL OF TOYS MADE IN STEAM MAKERSPACES: REFLECTIONS FROM TEACHERS

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Abstract

This research endeavors to investigate the innovative potential of toys produced within STEAM Makerspaces, as perceived by teachers, utilizing a concurrent parallel mixed-method approach. Quantitative and qualitative data were simultaneously collected to provide a comprehensive understanding. A quasi-experimental design underpinned the quantitative portion of the study, while qualitative methods encompassed observations, document analysis, and structured interviews. The study involved 25 preschool educators from Turkey who had participated in STEAM Makerspace activities. The "STEAM-Teacher Interview Form", "STEAM Engineering Design Observation Form", "STEAM Engineering Design Process Photographs", and "Innovative Thinking Disposition Scale for Preschool Teachers", developed by Bilir, Akbaş and Darıca (2023) with established validity and reliability, were employed as data collection instruments. T-tests were utilized to examine the pretest-posttest scores in the quantitative phase, while thematic content analysis was applied to interpret the qualitative data. The results suggest that the toys produced within STEAM Makerspaces possess innovative potential, serving as a reflection of educators' cognitive abilities, particularly in terms of imagination and creativity.

Keywords: STEAM; preschool educators; preschool education; steam makerspaces; innovation

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1. Introduction

The STEAM education methodology, lauded for its interdisciplinary and comprehensive perspective, has a prominent role in all stages of formal and informal learning processes, including early childhood. This period of early development is critically important, allowing children to comprehend STEAM concepts, experience STEAM disciplines through an interdisciplinary lens, and apply these acquired skills throughout their lives (DeJarnette, 2018; Mercan, & Kandır, 2022; Wahyuningsih et al, 2020; Hunter-Doniger, 2021).

For the effective implementation and proliferation of the STEAM education model in both formal and informal pedagogical scenarios, it is essential to foster suitable learning environments. STEAM Makerspaces represent such interactive spaces designed for diverse objectives, where children can socially collaborate with peers or adults, fostering age-appropriate exploration and innovation (Feinstein, De Cellis & Harris, 2016; Peppler, Halverson & Kafai, 2016; Ramey, Stevens, & Uttal, 2018; Scaradozzi et al, 2019). Hence, the emphasis is on amplifying and enriching the number of STEAM Makerspaces in early childhood learning settings, both within and beyond school boundaries (Papadakis, Kalogiannakis, & Gözüm, 2022).

As outlined by Marsh et al. (2017), while STEAM Makerspaces bear resemblances to traditional crafts, their distinctive characteristic lies in fostering community cooperation, sharing, and solidarity. Within this environment, individuals acquire cognitive abilities such as innovative thinking, problem-solving, creative and critical thinking, alongside numerous social collaboration and unity skills (Hughes et al, 2019; Peppler, Halverson, & Kafaı 2016; Scaradozzi et al, 2019). An examination of related literature reveals that STEAM Makerspaces indeed bolster children's 21st-century skills, vital for nurturing individuals equipped for contemporary times and stimulating societal and economic advancement (Feinstein, De Cellis & Harris, 2016; Peppler, Halverson, & Kafaı 2016).

Preschool teachers hold pivotal roles in early childhood development, being instrumental in raising individuals suited for our contemporary era, thereby facilitating personal and societal progress. Teachers are essential to the propagation of the STEAM approach, vital for fostering contemporary skills, enhancing STEAM Makerspaces, facilitating access for all children, and ensuring social collaborations (Sheffield & Koul, 2020; Gözüm & Güneş, 2018). Similarly, they guide the cultivation of capable individuals required in today's society and assist in the creation of innovative individuals and communities. Only teachers with innovative mindsets can inculcate innovative thinking in children, triggering change, transformation, and reflection (Bilir, 2021). A key responsibility of teachers in this process is to frequently incorporate play, considering the developmental stages of children (Gözüm, 2020).

During early childhood, play represents the fundamental medium for children's self-expression and learning. Children derive pleasure, joy, and self-representation from play, often resorting to it. For children of this age group, the most effective means of interacting with peers, articulating their emotions, and expressing themselves is through play materials or toys. Despite variations in toys based on age, cultural context, or individual differences, a common factor is the universal need for play among children, emphasizing the critical importance of toys (Ayan & Memiş, 2012; Ulutaş, 2011; Vatandaş, 2020; Whitebread & Basilio, 2013).

1.1. STEAM Makerspace and Toys

Societal transformations have been brought about by various factors such as shifts in social and cultural landscapes, lifestyles, values, beliefs, digitization, urbanization, industrialization, among others. With these changes in societal lifestyles, the dynamics of children's engagement with games and toys have also evolved. Where street games and natural materials once predominated, structured games and toys have gradually taken their place. Currently, in the digital age, the outlook on games and toys has undergone a transformation, with digital games gaining prominence and catering to children of all age groups (Gözüm & Kandır, 2022) This shift underscores how societal innovation is mirrored in the evolution of toys. Yücel (2021), in his study examining the transformation process of the Lego toy company in terms of toy innovation, posited that Lego's open innovation model, which significantly contributes to the company's economic growth, embodies a sustainable and innovative perspective. Innovative toys can foster creative, reflective thinking in children, empowering them to adapt, change, and transform. Consequently, it is of utmost importance for modern toy companies to manufacture toys that encourage children to engage in creative, open-ended, innovative designs, rather than restrictive, single-purpose toys, in order to cater to the demands of the contemporary age.

STEAM Makerspaces stimulate children's interest by providing an environment rich in diverse, engaging play materials and activities, fostering discovery, imagination, creativity, innovation, and problem-solving skills (Feinstein, De Cellis & Harris, 2016). Therefore, preschool teachers should facilitate STEAM Makerspaces that promote experiential learning (Feinstein, De Cellis & Harris, 2016; Marsh et al., 2017; Gözüm & Demir, 2021). Additionally, teachers play a crucial role as mentors, inspiring children, recognizing, creating, and proliferating STEAM Makerspace learning environments (Johnston, Kervin, & Wyeth, 2022; Hughes et al, 2016; Gözüm, 2020a) Shively, Hitchens, & Hitchens, 2021). The diverse and stimulating environment of a STEAM Makerspace can provide children with opportunities to play, spend quality time with toys, create new toy designs, and develop innovative solutions, enabling them to transform, adapt, and reflect.

1.2. STEAM-Makerspace and Innovation

STEAM Makerspaces constitute dynamic learning environments that are tailored to meet the contemporary needs, offering a stimulus-rich setting where children can learn through exploration, collaboration, and inventive project work (Feinstein, De Cellis & Harris, 2016; Peppler, Halverson & Kafai, 2016; Ramey, Stevens, & Uttal, 2018). These Makerspaces facilitate the development of children's imagination and creativity, as children actively interact with the materials, tinkering, manipulating, and transforming them into multiple innovative products. The emphasis here lies not on the end products but on the experiences garnered throughout the creative process. As children engage with the materials, they incorporate their creativity and imagination, leading to the generation of innovative ideas. To a child, a moving Lego piece can assume multiple identities, ranging from a robot arm, a car wheel, a building slide, to a pair of glasses (Gözüm, 2020; Gözüm, 2019).

STEAM Makerspaces, whether established within schools or in outdoor spaces like school gardens, botanical gardens, and other publicly accessible areas, offer a conducive environment for children to nurture their creative and critical thinking skills, thereby fostering an innovative mindset from early childhood. In such versatile settings, which could range from a school workshop, a toy museum, to a children's library, children gain a wealth of experiences. STEAM Makerspaces situated not only indoors but also outdoors allow children to frequently engage with these spaces, interact with their peers, and familiarize themselves with various STEAM materials (Kandır, Can Yaşar, Gözüm, & Mercan, 2022).

The concept of innovation is typically synonymous with novelty and inventive thinking (Bilir, 2021; Bilir, Akbaş & Darıca, 2023). In STEAM Makerspaces, open-ended materials and an interdisciplinary learning environment are provided to stimulate children's innovative thinking. These spaces play a significant role in helping children understand STEAM concepts, develop STEAM skills, and enhance their interest in STEAM fields. Children equipped with STEAM concepts and skills can engage in interdisciplinary thinking and develop a holistic perspective (Mercan, 2019). As a result, children not only acquire the fundamental skills required by contemporary societies but also evolve into competent citizens capable of meeting future needs. This can only be achieved through innovative and entrepreneurial thinking.

In light of these considerations, this research seeks to explore the innovation potential of toys created in STEAM Makerspaces, as perceived and experienced by teachers. The research is grounded in STEAM Makerspace experiences where teachers partake in the design of future toys. The study incorporates the toy museum trip observation, which facilitates readiness for this experience, the future toy design process in the STEAM Makerspace, and the teachers' experiences and perspectives on the design processes.

2. Method

2.1.1. Research design

The study employs a mixed-methods research approach, wherein both qualitative and quantitative data are collected concurrently. The research unfolded in a simultaneous parallel mixed design, whereby qualitative and quantitative data were gathered simultaneously (refer to Figure 1).

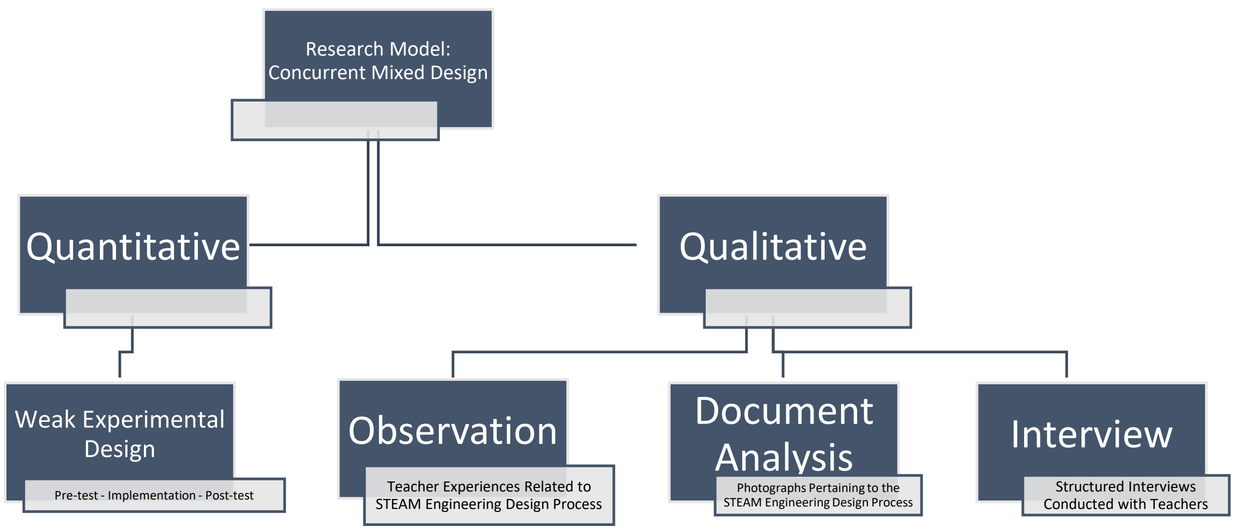


Figure 1. Research Model

The study's quantitative segment utilized a quasi-experimental design, while the qualitative section incorporated document analysis, observation, and interview techniques. In this regard, a pre-test was administered to the teachers, followed by STEAM education training, a visit to the Gaziantep Toy Museum (where teachers were asked to carry out observations), and the implementation of STEAM activities centered around engineering design in the STEAM Makerspace, culminating in a post-test. Subsequent to the post-test, face-to-face interviews with the teachers were conducted utilizing an interview form.

2.2. Participant

The study sample comprised 25 preschool teachers from various provinces across Turkey, all of whom voluntarily engaged in STEAM Makerspace activities. The demographic details of the participants are provided in Table 1.

Table 1. Demographic information of the participants

Teachers	Age	Gender	Seniority Years	Teachers	Age	Gender	Seniority	Teachers	Age	Gender	Seniority Years
T1	24	Female	1-5	T11	32	Male	5-10	T21	32	Female	5-10
T2	25	Female	1-5	T12	37	Female	10-15	T22	36	Female	10-15
T3	23	Female	1-5	T13	28	Female	1-5	T23	25	Female	1-5
T4	28	Female	5-10	T14	29	Female	5-10	T24	26	Female	1-5
T5	27	Male	5-10	T15	25	Male	1-5	T25	29	Male	5-10
T6	32	Female	5-10	T16	31	Female	10-15				
T7	34	Female	5-10	T17	45	Female	15-20				
T8	26	Female	5-10	T18	39	Female	10-15				
T9	35	Female	10-15	T19	43	Male	15-20				
T10	36	Female	10-15	T20	45	Female	15-20				

2.3. Data collection tool of the research

This study employed several data collection tools: "STEAM-Teacher Interview Form", "STEAM Engineering Design Observation Form", photographs from the STEAM Engineering Design Process, and the "Innovative Thinking Disposition Scale for Preschool Teachers", a validated and reliable scale developed by Bilir, Akbaş and Darıca (2023). The "STEAM-Teacher Interview Form" includes seven open-ended queries, designed to capture teachers' perspectives on their experiences with STEAM toy design. These questions delve into topics such as teachers' preferences in toy selection, the interplay between toys and innovation, and the connection between STEAM, toy design, and innovation. The "STEAM Engineering Design Observation Form" is an instrument developed by the researchers. It comprises STEAM engineering design steps that reflect the teachers' STEAM experiences while crafting innovative toys. The form follows the sequence of ask, imagine, plan, create, improve, and reflect. Photographs of the STEAM engineering design process serve as vital documents for analysis. The study scrutinizes planning sketches from the STEAM engineering design process, and photos from the three-dimensional designs of the creation phase. The "Innovative Thinking Disposition Scale for Preschool Teachers" is a scale developed by Bilir, Akbaş and Darıca (2023), consisting of ten Likert-type items intended to gauge teachers' disposition towards innovative thinking. The unidimensional scale accounted for 38% of the variance, with a Cronbach's Alpha coefficient of .85, according to the Exploratory Factor Analysis results. Confirmatory Factor Analysis yielded a CMIN/DF of 2.411, CFI of .98, GFI of .96, NNFI of .97, and RMSEA of .059. Criterion validity demonstrated a .674 positive moderate correlation with the Individual Innovativeness Scale and a -.307 negative moderate correlation with the Resistance to Change Scale. Test-retest reliability analysis found stability, with a high reliability coefficient of 92%. Content validity tests were applied to the scale, and items with a Content Validity Ratio (CVR) above 0.7 were retained. Construct validity was determined via the Kaiser-Meyer-Olkin (KMO) measure, resulting in a high value of .90, surpassing the acceptable limit of .70. The scale's reliability was affirmed with a Cronbach alpha coefficient of .85.

2.4. Data collection process

The data were garnered at the Gaziantep Toy Museum and STEAM Makerspace in June 2023. The research process entailed concurrent collection of both quantitative and qualitative data during the various stages of the study involving preschool teachers. The steps included:,

- Administering the pre-test
- Delivering STEAM education/ imparting STEAM information
- Accumulating observation forms related to the Toy Museum Visit-Observation study as a form of documentary evidence
- Implementation: Carrying out engineering-focused STEAM toy design with teachers at Makerspace
- Observing teacher experiences related to the STEAM engineering design process using the corresponding observation form

- Gathering photographs of the planning and creation phases of the STEAM engineering design process as documentary evidence
- Capturing preschool teachers' perspectives on Makerspace: Engineering-focused STEAM toy design
- Administering the post-test and conducting subsequent interviews
- Each step was followed in sequence, ensuring a thorough collection and analysis process.

2.5. Data analysis

In the data analysis process, for the quantitative aspect of the experimental design, we examined the significance of differences between pre-test and post-test scores. For the qualitative aspect of the study, the collected data were categorized and presented through a thematic content analysis, forming specific themes and sub-themes.

3. Results

3.1. Quantitative Findings

Provide dates defining the periods of recruitment and follow-up and the primary sources of the potential subjects, where appropriate. If these dates differ by group, provide the values for each group.

Table 1. Dependent t test results of preschool teachers' innovation scores

Test	X	N	sd	df	t	p
Pre-test	41.60	23	3.53	22	4.715	.000
Post-test	44.56	23	3.61			

Table 1 presents the innovation scores of the preschool teachers. Prior to the implementation, the mean score was 41.60. After the implementation, the post-test mean score increased to 44.56. Following the training provided to the preschool teachers, a statistically significant difference was found between the two groups ($t(22) = 4.715$; $p < .001$). Given that this significant difference was in favor of the post-test, it can be inferred that the STEAM Makerspace toy-making activity effectively enhanced the innovation skills of the preschool teachers.

1.1. Qualitative Findings

1.1.1. Toy museum visit and observation form - Themes Related to Toys

Following the teachers' visit and subsequent observational study at the Toy Museum, their completed observation forms were evaluated as source documents. The findings derived from this document analysis have been organized under five sub-themes. These sub-themes, which together form the key themes of the analysis, are illustrated in Figure 1.

Reflections of Everyday Life: The sub-theme related to everyday life comprised participants' views on various elements, including kitchen utensils (made of copper, metal, etc.), model representations of different professions, dolls, cars, and household tools.

"The Toy Museum's exhibits, particularly those portraying everyday materials, were quite striking. Toys related to different professions (butcher, tailor, etc.) were exhibited in great detail." (Participant T11)

"There were kitchen utensils made from copper and metal that reflected daily life." (Participant T7)

"Dolls were among the toys presented from different periods and cultures." (Participant T19)

Economic and Social Conditions: The participants expressed views related to the sub-theme of the economic and social conditions, noting that toys from developed countries were more diverse, aesthetic, and detailed (presence of detailed and varied toys in countries such as Germany, England, and France).

"Toys from developed or economically strong countries were more diverse and have existed for a long time. I saw detailed and functional toys dating back to the 1800s. The economic conditions of the countries were reflected in the toy industry." (Participant T8)

Toys Associated with Nature and Natural Life: The participants expressed views related to the sub-theme of toys associated with nature and natural life, such as animals (monkeys, pets, etc.).

"There were toys reflecting natural life. Particularly, the ones representing various types of monkeys were intriguing." (Participant T11)

Terrifying and/or Fantastic: The participants expressed views on the sub-theme associated with terrifying or fantastic elements, such as the initial cloth draft of Mickey Mouse, and other unrealistic elements.

"There were toys with unrealistic elements or those that could be described as terrifying. Especially, the initial cloth dolls and the first cloth version of Mickey Mouse were truly terrifying." (Participant T15)

War and/or State of Emergency: The participants expressed their views on the sub-theme related to the concept of war reflected in toys, such as weapons, soldiers, etc.

"Toys showed the societal conditions of a country. For example, I saw weapons, swords, or soldiers from the war period." (Participant T5)

Figure 1. Sub-themes related to toys

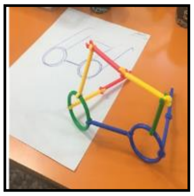
3.1.1. Design process - Themes Related to Design

The findings obtained from the application of the "STEAM Engineering Design Observation Form" are presented under this heading. In this context, the sub-themes related to design were categorized into five key areas: "presence of digitalized toys", "toys in natural life", "existence of games but absence of toys", "traditional toys", and "life in space".

Additionally, photographs capturing the STEAM engineering design process (specifically during the planning and creation stages) were examined as primary documents and presented within this section.

3.1.1.1. Sub-theme 1: Presence of Digitalized Toys

Various digitalized toys were conceived and designed, including a plant recognition necklace, a time-responsive car, a robotic companion capable of emoting and understanding emotions, solar-powered vehicles, digital teleportation glasses, smart building blocks on a virtual table, a game world realized through virtual glasses, and a device that blends colors in nature. The design process for these digitalized toys is illustrated in Figure 2.



Virtual Glasses:

"With virtual glasses, it is possible to experience different environments. When you put on these glasses, you can travel through multiple environments." (Participant T6)

Material: STEAM engineering material, construction toys Reason for Choice: portability, rotatability, multi-purpose nature

Plant Recognition Necklace:

"This is a digital necklace because it is a digital necklace that reflects the features of plants. Its features include increasing ecological awareness and being easily portable." (Participant T21)

Material: Magformers from the science center, a magnetic and transparent product, chain from the art center

Reason for Choice: portability, aesthetics, suitability for purpose

Emotion Understanding and Experiencing Robot Friend:

"I designed a digital toy that can be developed as a solution to children's increasing loneliness over time, because children are becoming increasingly isolated and they need friends who will understand their feelings." (Participant T11)

Material: STEAM engineering materials, Legos and construction materials

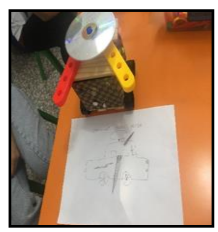
Reason for Choice: rotatable, portable, and colorful

Time-Traveling Flying Car:

"I designed a car that can fly over time. This digital vehicle moves in time, thus making it possible for individuals to teleport to different times." (Participant T8)

Materials: CD from the technology field, Legos from the engineering field

Reason for choice: ability to move, portability



Digital Car:

"I designed a digital car. This car is the car of the future. It has a solar panel on top. As it is played with, the energy generated from its wheels and the sun charges its batteries." (Participant T17)

Materials: STEAM engineering materials

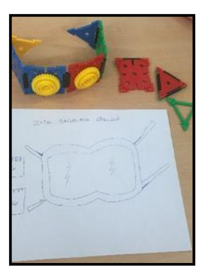
Reason for choice: ability to move, capability to establish connections

Digital Teleportation Glasses:

"I believe that people will be able to teleport in the future. Individuals who wear these glasses can teleport." (Participant T12)

Materials: STEAM engineering materials

Reason for choice: ability to move, capability to establish connections



Smart Building Blocks on Virtual Table:

"I believe that digitization will become even more important in the future. Therefore, I designed a virtual table. Various objects will gather on the virtual table and can be used as needed." (Participant T3)

Materials: STEAM engineering materials

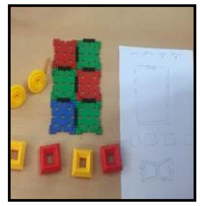
Reason for choice: ability to move, capability to establish connections

Virtual Reality Game World:

"Digital games will continue to hold great significance in the future. It's possible for children to enter and experience the game world with virtual glasses." (Participant T14)

Materials: STEAM engineering materials

Reason for choice: ability to move, capability to establish connections



Digital Toy Transformable with Moving Arms:

"Toys in the future will also be digital. This design is a digital toy that can transform with moving arms. The movable arms can be used for simulation, and the toy can transform in different environments." (Participant T1)

Materials: STEAM engineering materials, connection parts

Reason for choice: ability to move, capability to establish connections, portability

Digital Machine that Produces Colors by Mixing the Colors of Plants in Nature:

"The importance of nature will be understood more in the future. Therefore, there might be a return to nature. However, digitization is also gaining importance. For this reason, I designed a toy that integrates nature with technology. It's a digital machine that produces colors by mixing the colors of plants in nature." (Participant T7)

Materials: Connection parts, STEAM engineering and building construction materials

Reason for choice: colors, ability to establish connections, portability

Artificial Intelligence-Powered Farming Machine:

"Technology integrated with the return to nature will lead to the development of new tools. I designed a farming machine that operates with artificial intelligence.

The AI tablet used in agriculture operates with a solar panel, it shows the products that can be produced according to the properties of the soil when the tablet is left on the ground and it transmits as much water, sunlight, etc. as needed until the harvest time." (Participant T23)

Materials: Legos

Reason for choice: ability to present patterns, portability, ability to establish connections

Digital Tetris or Digital Workshops:

"Digital games will continue to gain momentum. I designed a digital workshop. It's like the old-time Tetris but digital. It could shape the form of digital game tools in the future." (Participant T15)

Materials: Legos, wooden blocks

Reason for choice: ability to create a flat surface, ability to present color differentiation

Figure 2. Findings related to the sub-theme of digitalized toys

3.1.1.2. Subtheme 2: Toys from natural life

In this context, the design process for ecological structures and natural toys (pine cones, stones, branches, etc.) is shown in Figure 3.

Ecological Building:

"A toy that collects, converts, and uses its own water, stores energy, and utilizes natural energy in sufficient amounts." (Participant T8)

Materials: Legos, STEAM engineering materials Transparent unit cubes from the Mathematics Center

Reason for choice: Ability to construct, portability, representation

Solar Energy Powered Vehicle:

"A digital car that can move with solar energy and stores and converts its own energy." (Participant T2)

Materials: Wooden blocks, connecting parts, Legos

Reason for choice: Ability to connect, stabilize, representation

Figure 3. Findings related to the sub-theme of toys from natural life

3.1.1.3. Sub-theme 3 - There are no toys, there is play

Children turn every material in their immediate surroundings into toys, play is always present, industrialized toys are not in the future, the design process is shown in Figure 4.

There is No Toy, Only Play:

"A child can make anything around them into a toy. Over time, industrialized toys will disappear, but play will always exist. For example, during an earthquake, children transformed even the concrete around them into toys." (Participant T13)

Materials: Legos

Reason for choice: Ability to provide representative toys

Figure 4. Findings related to the sub-theme "There are no toys, there are games

3.1.1.4. Sub-theme 4 - Traditional toys

The design process for the acceleration of traditional toys in contrast to digitalization is shown in Figure 5.

Traditional Toys:

"I believe that, contrary to digitization, traditional toys will proliferate. Children will play traditional games with traditional toys on the streets or in outdoor spaces." (Participant T20)

Materials: Wooden block Connection parts Legos STEAM engineering design

Reason for choice: Creating a football field, ball, etc.

Figure 5. Findings related to the sub-theme of traditional toys

3.1.1.5. Sub-theme 5 - Life in space

A different way of life, life on a new planet and the design process for appropriate games and toys are shown in Figure 6.

Space Station:

"In the future, life will exist on another planet. Materials from life in space and space stations could become children's toys." (Participant T9)

Materials: Engineering materials and legos Beads from the art center

Reason for choice: Ability to represent planets and space.

Figure 6. Findings related to the sub-theme of life in space

3.1.1.6. Interview process - Themes Related to the Interview

In the interview conducted with preschool teachers on STEAM design process, toys and innovation, two sub-themes were formed: toys, makerspace and innovation and STEAM, makerspace and toys.

Toys, Makerspace and Innovation

In the sub-theme of toys, makerspace and innovation, teachers emphasized imagination, creativity and collaboration. In this context, the views of the participants are as follows:

"STEAM makerspace is a stimulus-rich environment. It hosts various materials. "A stimulus-rich environment increases innovation" (Participant T9)

"Materials from everyday life and natural materials support innovation" (Participant T11)

"Makerspace environment supports imagination, productivity, versatile thinking, innovative thinking and creativity" (Participant T17)

"In an increasingly digitalized world, the effect of digitalization should be considered in the design of toys" "Material diversity supports creativity" (Participant T21)

"Working with a group in a Makerspace environment supported cooperation and collaboration, and allowed us to share different ideas" (Participant T22)

3.1.1.7. STEAM, Makerspace and Toys

In the STEAM, makerspace and toy sub-theme, participants expressed their views on thinking skills, design, digitalization, STEAM disciplines as follows:

"Design can be explained as creating a new product, transferring your dreams to life, making original works" (Participant T3)

"Problem solving skills are supported while designing innovative toys in Makerspace environment" (Participant T9)

"Cognitive skills, such as creativity, scientific thinking, imagination, develop while designing toys" (Participant T15)

"I acquired STEAM concepts in the innovative toy design experience. I gained different experiences in STEAM disciplines of engineering, mathematics, art and science." (Participant T21)

"I think digitalization: the use of technology, virtual reality, artificial intelligence concepts are essential for innovative toys" (Participant T23)

"STEAM makerspace innovative toy design experience develops emotional skills: self-sufficiency, aesthetics, enjoyment, interest" (Participant T24)

4. Discussion and Conclusion

This research endeavored to investigate the innovative potential of STEAM Makerspace toys from the perspective of teachers, along with the impact on preschool teachers' innovative thinking skills. The study is distinctive for its adoption of a simultaneous parallel mixed design, delivering qualitative and quantitative data concurrently.

The quantitative results of the research substantiate that a STEAM-oriented engineering design process (implementation) augments preschool teachers' innovative thinking capabilities. A survey of the existing literature reveals numerous studies encompassing areas such as STEAM, STEAM Makerspaces, the engineering design process, early childhood education, preschool teachers, toys, and innovative thinking from both domestic and international perspectives. However, it's noteworthy that these studies tend to treat these subjects independently, with a distinct lack of research associating innovation, STEAM makerspaces, preschool teachers, and toys. Consequently, the present study is poised to make a significant contribution to the academic discourse.

In harmony with the quantitative findings, the qualitative results derived from diverse data collection instruments also shed light on the innovative potential of STEAM Makerspace toys, as perceived by the teachers. In this regard, the preschool teachers involved in the study opined that while toys evolve in response to social and economic shifts, their existence remains a constant in children's lives. Having experienced first-hand the evolution of toys across different cultures and epochs at the toy museum, the teachers then expressed their vision for the future of toys through the STEAM design process (Papadakis, Kalogiannakis, & Gözüm, 2022; Gözüm, Papadakis, & Kalogiannakis, 2022).

The teachers acknowledged the beneficial influence of the makerspace as a learning environment teeming with rich stimuli, an array of materials, and easy access to these resources, thereby enhancing their imagination and creativity. All the teachers participating in the study conceptualized, crafted, and shared their envisioned designs throughout the STEAM design process. Within this context, it was observed that teachers primarily envision future toys as digitalized, with some also predicting future toys as traditional, spatial, nature-derived, or game-centric without actual toys (Gözüm, 2022; Papadakis et. Al, 2022).

A review of the existing literature validates the findings of this research. Previous studies highlight the efficacy of STEAM Makerspaces as a learning environment, its contributions to hands-on learning and experiential engagement, as well as its potential to bolster children's imagination, creativity, and cognitive abilities (Johnston, Kervin, & Wyeth, 2022; Hughes et al., 2016; Hughes et al., 2019; Marsh et al., 2017; Papadakis, Kalogiannakis, & Gözüm, 2022; Gözüm, Papadakis, & Kalogiannakis, 2022). Concurrently, numerous studies underscore the vital role teachers play in guiding and leading, along with the importance of offering opportunities and possibilities to children (Marsh et al., 2017; Sheffield & Koul, 2020; Shively, Hitchens, & Hitchens, 2021; Mercan et al., 2022).

Considering that play and toys are ubiquitous phenomena transcending time and space for children, teachers' interpretation and understanding of play and toys assume paramount importance. In this context, while the study surfaced divergent viewpoints of preschool teachers (such as digital toys, natural toys, traditional toys, extraterrestrial life and toys, and the existence of games without toys), it was noted that all teachers underscored the importance of toys and associated toys with innovative and creative thinking (Gözüm, 2022).

5. Recommendations

In light of these findings, several recommendations for future research are proposed:

- There is a pronounced need for further practice and research regarding the utilization of STEAM Makerspaces during early years, both within and outside formal educational settings.
- Investigations reflecting children's experiences associated with STEAM Makerspaces are warranted.
- The qualitative and quantitative expansion of STEAM makerspaces is pivotal. In this regard, initiatives that foster collaboration between families, schools, and communities could be beneficial.

Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest.

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