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STEAM Makerspace Reflections from Teachers and Children

Zerrin Mercan[1], Ali İbrahim Can Gözüm[2], Büşra Bilir[3]*, Mihriban Özcan[4]

[1]Bartın University, Turkey
[2]Kafkas University, Turkey
[3, 4]Hasan Kalyoncu University, Turkey

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Author's Email :
zmercan@bartin.edu.tr,
a-ibrahimcan@kafkas.edu.tr,
busra.bilir@hku.edu.tr,
mihriban.ozcan@hku.edu.tr

Author's Orcid :

0000-0002-9263-4363,
0000-0002-7765-4403,
0000-0002-6240-8218,
0000-0001-6109-0132

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Abstract

Makerspaces function as dynamic learning environments abundant in stimuli that enhance and augment Science, Technology, Engineering, Art, and Mathematics (STEAM) education. These collaborative spaces serve as crucibles for children's learning where they gather, guided by their interests, to work, play, experiment, explore, and create in unison. This study endeavors to investigate teachers' perspectives on the utilization of STEAM makerspaces and further observe children's engagement within these contexts. Our research employed a phenomenological approach, a qualitative research methodology. Data were collected using nominal focus group interviews and direct observation techniques. The study findings underscored the significant role of STEAM makerspaces as stimulating learning environments. These spaces were found to foster children's creativity and imagination through the diverse range of materials they house. Furthermore, the comfortable and inclusive atmosphere within the STEAM makerspaces promoted a sense of belonging amongst the children, contributing to their social and emotional wellbeing. The study also emphasized that STEAM makerspaces cater to comprehensive developmental facets, specifically enhancing cognitive development, creativity, imagination, and self-confidence in children. Moreover, these innovative learning environments encourage active child participation, providing an array of opportunities for hands-on, experiential learning.

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Introduction

Makerspaces are dynamic, collaborative environments that facilitate exploration, teamwork, creativity, and problem-solving. These spaces can be supported by technology or be more tool-oriented, functioning as an assembly point for artists, inventors, and other creative minds to generate unique individual and collaborative works. Makerspaces encapsulate a vast array of components, ranging from high-tech apparatus to basic knitting and craft materials (Dousay, 2017; Sheffield, Koul, 2020).

Inhabitants of makerspaces, known as 'makers,' are curious, inventive, and imaginative individuals who congregate and cooperate within these spaces. Although various projects and productions are crafted here, the primary purpose of a makerspace extends beyond mere product creation or invention. These areas advocate for process-oriented learning over result-oriented experiences, offering a platform for experimental engagement with a variety of tools and materials through tactile learning experiences. The collaborative nature of these experimentations further enhances the process (Benton et al., 2013).

Makerspaces can be situated within or outside school premises. Particularly, those located in community-accessible areas significantly contribute to fostering community involvement and propagating the maker movement. Hence, schools can establish makerspaces through various workshops, while other non-school learning environments like libraries, museums, and open spaces can also host makerspaces (Andrews, 2017). Studies characterize makerspaces as richly stimulating learning environments due to their capacity to facilitate hands-on learning, creative thinking, teamwork, and problem-solving (Bayliss, 2016; Feinstein, DeCillis, & Harris, 2016; Lecorchick, Spires, & Gallo, 2019; Mercan & Gözüm, 2023a).

A significant characteristic of makerspaces as richly stimulating environments is the array of tools and materials they house. Empirical and applied studies reveal that makerspaces can be technologically supported or solely reliant on manual tools, depending on their intended purpose. Technology-supported makerspaces frequently employ 3D printers, computers, and digital programs, while non-tech spaces utilize materials such as wood, fabric, paper, and three-dimensional leftovers. The literature also acknowledges the importance of art-integrated makerspaces, which offer creative platforms for individuals and groups to explore, create, and produce innovative projects (Jordan et al., 2021; Sweeny, 2017).

Schools can incorporate makerspaces in diverse ways, depending on their specific goals, budget constraints, and target age groups (Bird, Arch, & Teach, 2017; Pepper-Kittredge, Bird, & Lindsey, 2018; Sang & Simpson, 2019; Mercan & Gözüm, 2023b). Some schools might house artistic makerspaces, others might offer tech-supported or tech-free makerspaces, and some might establish makerspaces within their libraries (Kemp, 2013). This flexibility extends beyond the configuration of makerspaces; it influences their intended users, with makerspaces catering to different age groups and educational levels. This productive and inventive process, which commences in preschool education and continues into adulthood, necessitates support at all educational stages (Henderson, Vogel, & Campagna, 2017).

Preschool makerspaces serve as vital arenas that inspire learning, exploration, and play. These environments motivate children's learning and offer richly stimulating learning spaces. Children engage in various discoveries and experiments, collaborate with their peers, and act as autonomous learners making their own choices and decisions. This approach facilitates hands-on and experiential learning (Strawhacker & Bers, 2018; Clapp et al., 2020; Marx-Mackerley et al., 2021; Mercan & Gözüm, 2023a).

Makerspaces provide suitable environments for STEAM (Science, Technology, Engineering, Art, and Mathematics) learning. Current research emphasizes the pivotal role of learning environments in the realm of STEAM education (Blackley, Sheffield, & Koul, 2018; Ramey, Stevens, & Uttal, 2018; Nackerud, 2019; Hillyard, 2022; Mercan & Gözüm, 2023b). Makerspaces can cater to individual STEAM disciplines or a combination thereof, such as art and technology.

Theoretical Framework

Makerspaces operate as robustly stimulating environments that bolster and enrich STEAM (Science, Technology, Engineering, Art, and Mathematics) education. These learning settings place a high value on materials that facilitate children's STEAM learning and the social context that fortifies this learning process. In STEAM makerspaces, it is imperative to supply materials that encourage children to learn through active engagement and hands-on experiences (Blackley, Sheffield, & Koul, 2018; Ramey, Stevens, & Uttal, 2018; Nackerud, 2019; Hillyard, 2022).

Materials for STEAM makerspaces can be derived from everyday life, hold relevance for children, be readily accessible, and sourced from their immediate surroundings, such as wood, fabrics, and natural

materials. Research posits that these commonplace materials serve as open-ended resources. With these open-ended materials, children can repurpose a single item for multiple uses. For instance, a twig can be transformed into a toy horse, incorporated into a painting, or used as a make-believe umbrella. This versatility fosters creativity and critical thinking as children manipulate materials during play (Gözüm, 2019). Additionally, STEAM makerspace resources can be constituted of items such as blocks or Lego, which are easily accessible in a school setting and offer open-ended possibilities. These materials enable children to materialize imagined situations or events into tangible products. For instance, a child building with Lego can construct a house, a car, a tower, and so forth. Some schools may even provide technology-supported STEAM makerspaces, equipped with technology materials suitable for children's age, developmental level, interests, and needs, thereby creating environments conducive for exploration through trial and error (Strawhacker & Bers, 2018; Clapp et al., 2020; Marx-Mackerley et al., 2021; Mercan & Gözüm, 2023a; Mercan & Gözüm, 2023b).

STEAM makerspaces foster children's learning processes. In these environments, children congregate with their peers based on their interests and engage in cooperative work, play, experimentation, exploration, and production. Consequently, STEAM makerspaces also augment children's social learning. As children create various projects and interact with materials in these spaces, they not only acquire new knowledge but also become intrinsically motivated to learn. This is primarily because STEAM makerspaces encourage children to learn through doing, fostering their ability to make independent choices and decisions, thus turning them into active participants in their own learning (Burke & Crocker, 2020). In light of this, this study aims to explore teachers' perspectives on the utilization of STEAM makerspaces and observe children's interactions within these spaces.

Method

The methodology for this study encompasses the research model, the study group, data collection instruments, the data collection process, data analysis, and data handling.

Research Model

This research is framed within a phenomenological design, a subset of qualitative research methodologies. This approach seeks to elucidate individuals' experiences regarding a phenomenon and the meanings they attribute to those experiences (Creswell, 2007).

Nominal focus group interviews and observational techniques were employed in the study. The nominal focus group interviews were carried out with preschool teachers who regularly engage with the STEAM makerspace. Following the nominal focus group interview technique, data were analyzed post-interview. The responses provided by the teachers were ranked by frequency, and the teachers' agreement on this ranking was sought during a second group interview. As for the observational technique, children's interactions with the makerspace were scrutinized using a structured observation form. The research process ensured that multiple observations were made by more than one observer to maintain a comprehensive and accurate assessment.

Study Group

The research study group comprised preschool teachers and children from a kindergarten in Gaziantep /Turkey, which is affiliated with the Ministry of National Education and possesses a STEAM Makerspace. Criterion-based sampling was employed in the research, taking into account the following criteria: preschool teachers working in the kindergarten equipped with a STEAM makerspace, regular and frequent use of the STEAM makerspace, and willingness to participate in the study. As for the children involved in the study, those who were enrolled in the kindergarten and consistently used the makerspace were selected.

Details about the study group are presented in Table 1 (for teachers) and Table 2 (for children).

Data Collection Tools

The "Makerspace Teacher Interview Form" and the "Makerspace Child Observation Form", both of which were developed and validated by the researchers, served as data collection instruments for this study.

The Makerspace Teacher Interview Form is divided into three subheadings: Planning, Implementation, and Evaluation, each containing six questions

Table 1: Demographic information of the teachers participating in the study

Session	Teacher	Age	Seniority	Duration of Using the Workshop	
				Year (2019-2023)	Frequency Education process (spring and fall semesters)
Morning	T1	29	8	4	Two days a week, one hour a day
	T2	37	14	4	Two days a week, one hour a day
	T3	40	22	4	Two days a week, one hour a day
	T4	50	30	4	Two days a week, one hour a day
	T5	37	12	4	Two days a week, one hour a day
	T6	30	1	1	Two days a week, one hour a day
Afternoon	T7	39	13	4	Two days a week, one hour a day
	T8	38	12	4	Two days a week, one hour a day
	T9	48	14	4	Two days a week, one hour a day
	T10	47	24	4	Two days a week, one hour a day
	T11	44	24	4	Two days a week, one hour a day
	T12	36	14	4	Two days a week, one hour a day

Table 2: Demographic information of the students participating in the study

School	Age	Number of children	Frequency of workshop use		
A Kindergarten affiliated to Gazian-tep Provincial Directorate of National Education	5-6 years old	25	Semester (Febru-ary-June)	Two days a week	One hour a day

(See Appendix 1). To verify its content validity, the Makerspace Teacher Interview Form was presented to five domain experts. These experts were asked to provide their insights on each question/item by selecting one of three options - appropriate, somewhat appropriate, not appropriate - and by writing comments regarding the relevant item/question. Expert opinions were taken into account, but, based on their consensus, no alterations were made to the form, as they deemed it satisfactory as it stood.

The Makerspace Child Observation Form, devised by the researchers, is a structured observation tool. This form includes demographic data and two subsections related to the activity observed and the functionality of the STEAM makerspace. The demographic information collected includes the child's full name, assigned code, age, gender, the date of observation, duration of observation, and the observer's full name. Each of the subsections on the observed activity and the STEAM makerspace's functionality contains ten open-ended questions (See Appendix 2). To establish its content validity, the Makerspace Child Observation Form was reviewed by five domain experts. They were asked to express their opinions on each question by selecting one of the aforementioned options and writing explanatory comments for each question. After considering the experts' feedback, no changes were made to the form, with the experts deeming it suitable in its current form.

Data Collection Process

The data collection process for this research was meticulously conducted over an extended period from October 2022 to May 2023. During this process,

a methodical "nominal focus group interview" strategy was employed with the teachers, whilst children's activities and interactions within the makerspace environment were thoroughly observed on four separate occasions, each observation session spanning one hour and conducted twice a week.

In utilizing the "nominal focus group interviews" with the teachers, a systematic approach was observed to ensure the collection of in-depth and comprehensive data. The sequential steps executed during this phase are delineated in Figure 1.

The processes related to the observation of children during the data collection process are presented in Figure 2.

Data Analysis

The data gathered in this study were subjected to a rigorous process of descriptive analysis. This process of analysis facilitated the construction of themes, which were informed and guided by the extant literature in the field (Can Gözüm & Güneş, 2018; Kandır, Can Yaşar, Can Gözüm, & Mercan, 2022). These themes provided a comprehensive and structured approach to understanding the collected data.

In the subsequent step, the thematic framework was compartmentalized under four primary categories: Planning, Implementation, Evaluation, and Reflection and Feedback. These categories facilitated an in-depth analysis of the data, providing further insight into the experience and perception of the participants in relation to the use of STEAM makerspaces.

Table 3 elaborates on the themes and sub-themes, offering a structured representation of the data analysis process and its outcomes. This systematic process enabled a nuanced understanding of the data, offering rich insights into the implications of the use of STEAM makerspaces in preschool education.

Establishing Validity and Reliability

In order to ascertain the validity of the research, both the "Makerspace Teacher Interview Form" and the "Makerspace Child Observation Form" were reviewed by five experts within the field. These experts

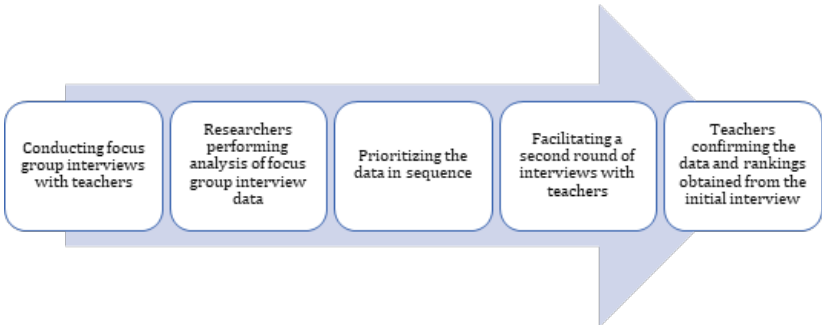

Fig. 1: Nominal focus group interview process steps

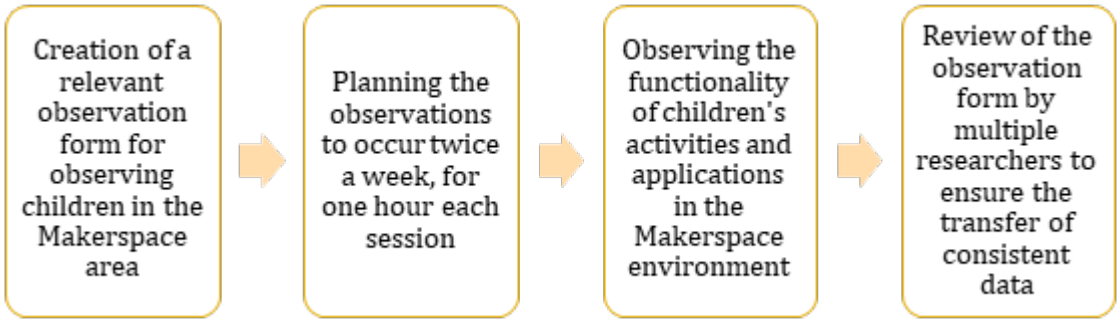

Figure 2: Process steps of child observation process

Table 3: Themes and sub-themes

	Themes			
	Planning	**Application**	**Evaluation**	**Reflection and Feedback**
Sub-themes	1. Planning for the training program 2. Benefits for children 3. Considerations in the planning process 4. Changes in the planning process 5. Implications for STEAM makerspace planning	1. A must-have when implementing a STEAM activity 2. STEAM activity outcomes 3. STEAM makerspace functionality 4. No STEAM makerspace functionality 5. STEAM makerspace effects on child development-general 6. STEAM makerspace effects on child development - special 7. STEAM makerspace children's participation in the process 8. STEAM Makerspace material diversity meets the need 9. STEAM makerspace material use 10. Challenges encountered in STEAM Makerspace applications	1. Assessing development 2. Form of evaluation 3. STEAM Makerspace differs from other learning environments 4. Opinions on STEAM makerspace update 5. The effect of STEAM makerspace on pedagogical content knowledge/ professional experience	1. Purpose of the STEAM activity 2. Children's achievements in STEAM activity 3. Materials used in STEAM activity 4. Methods used in STEAM activity 5. Strategies used by teachers when assessing children 6. Teacher role in STEAM implementation 7. The role of the child in STEAM 8. What children learn in STEAM 9. Children's feelings in STEAM 10. The suitability of the STEAM maker environment for the purpose 11. Functionality of the materials used in STEAM makerspace 12. STEAM makerspace functionalization of the planned method 13. STEAM makerspace arrangement according to the teacher's educational environment 14. Relevance to the evaluation strategy 15. STEAM makerspace facilitates teacher guidance 16. STEAM makerspace facilitates active participation of the child 17. STEAM makerspace facilitates children's learning 18. The impact of STEAM makerspace on how children feel

were requested to evaluate each item/question in the relevant forms using a scale of 'appropriate', 'partially appropriate', or 'not appropriate', and to provide further explanations where necessary. The consensus of the experts deemed every question/item across both forms as 'appropriate', consequently, no alterations were implemented to the forms in the data collection process.

The interview aspect of the research employed the "Nominal Focus Group Interview Technique". This was to ensure that teachers were able to fully express their views, prioritize these views, and endorse these priorities during the data analysis process.

The observation aspect of the research required meticulous attention to ensure reliability. Observations made using the "Makerspace Child Observation Form" were undertaken across multiple weeks and during various makerspace uses. This was to discern if observed behaviors were unique to certain activities or a consistent pattern across all. Furthermore, the Makerspace Child Observation Form was completed by more than one researcher to encourage inter-observer reliability. Data that were agreed upon by both researchers were then included in the study, ensuring a consistent and reliable evaluation of observed behaviors.

Procedure

STEAM Makerspace (Gaziantep/Turkey)

STEAM Makerspace was prepared in a kindergarten affiliated to the Ministry of National Education in Gaziantep, Turkey within the scope of Mercan's (2019) doctoral dissertation titled "The Effect of Early STEAM Future Readiness Program on Children's Visual Spatial Reasoning Skills" to support children's STEAM learning (See Figure 1).

Fig. 1: STEAM makerspace

STEAM Makerspace philosophy

STEAM Makerspace is deeply rooted in the belief in the significance of early childhood STEAM education, professing the notion that the introduction of STEAM learning should be initiated from an early age. The Makerspace is a stimulus-rich environment that has been specifically designed to promote children's learning in the areas of STEAM. Within this setting, children have the opportunity to collaborate with their peers and engage in various projects.

This Makerspace, established within the school, is designed to integrate seamlessly with the Turkish Ministry of National Education preschool education program (MoNE, 2013), with an overarching aim to bolster children's holistic development. It further emphasizes the enhancement of collaborative efforts, creativity, problem-solving abilities, and most notably, design thinking. The significance of the design process warrants attention here. The process aligns with the Makerspace's philosophy of "imagine, plan, create, develop, reflect." This very process enables children to transform their imaginations into tangible designs, to refine these designs, and to share them with peers or adults (DeJarnette, 2018; Mercan, 2019; Mercan & Kandır, 2022; Vale et al., 2022).

Within the STEAM Makerspace, children are considered autonomous entities who can make decisions, devise designs, execute projects collaboratively with their peers, and learn through direct interaction with a variety of materials. By engaging in the design process, children develop their abilities to make independent choices, think critically, solve problems, and be creative. This process further supports the development of their fine motor skills and cognitive abilities.

The STEAM Makerspace, therefore, houses learning spaces and materials pertinent to STEAM disciplines, while also cultivating children to become solution-oriented, multidimensional thinkers, capable of addressing challenges they may encounter in their everyday lives (Mercan & Kandır, 2022).

STEAM Makerspace Learning Spaces and Materials

STEAM Makerspace is a learning environment meticulously tailored to children's developmental stages, interests, and needs. This area is meticulously designed, featuring child-friendly, open, transparent, and easily accessible spaces, allowing children to comfortably reach materials. All areas are strategically placed to enable collaborative work, while also avoiding congestion within the learning environment.

In a bid to optimize space and ensure children's ease of movement, the walls of the Makerspace are utilized effectively, adorned with transparent boxes containing diverse materials. These boxes hold an array of items, from everyday materials that children can interact with, to technologically advanced materials and those specific to STEAM disciplines (Mercan, 2019) (refer to Figure 2).

Fig. 2: STEAM Makerspace-Engineering Space

The Makerspace has been designed with dedicated spaces for each of the STEAM disciplines, intending to establish a solid foundation for STEAM learning. Thus, it encompasses areas for science, technology, engineering, art, and mathematics (Gözüm, 2022). The arts area further diversifies into sub-sections for dance and music, drama, and visual arts.

Recognizing the importance of children experiencing both natural and social sciences, the science area is equipped with materials that promote these fields. This includes items like magnetic Lego sets, science books, and experiment tools. The technology area boasts equipment such as keyboards, mice, cables, etc., allowing children to tinker with and gain hands-on experience with technological devices. The engineering area is stocked with Lego sets, blocks, bricks, connectors, and cables, encouraging children to design and create in line with the "imagine, plan, create, develop, reflect" philosophy. The mathematics area features items like unit cubes, measuring cups, numbers, etc., promoting an understanding and experience of mathematics in everyday life.

The arts area is divided into dance and music, drama, and visual arts. The dance and music section includes bells, rhythm sticks, ribbons, etc., facilitating rhythm creation, music-making, and dancing. The drama section offers costumes, hats, accessories, etc., promoting role-playing and dramatic games. The visual arts section provides materials such as pencils, paints, brushes, play dough, etc., encouraging drawing and artistic creations. This area also includes design walls that encourage children to create artistic designs.

Findings

The findings were analyzed under four main themes: planning, implementation, evaluation and reflection/ feedback.

Planning

1. What do you think about STEAM makerspace?
The sub-themes belonging to the theme of planning are discussed under two headings: planning for the education program and benefits for children.

In Table 4, under the theme "What do you think about STEAM makerspace?", firstly the teachers' opinions were taken and then data were obtained from the transcribed text. For the nominal group evaluation, the participants first wrote their individual answers to the questions asked to them, then discussed the items as a group and determined the ranking order that they all agreed on. Table 4 shows the ranking order for the sub-themes and items identified in the nominal group interview.

Table 4: Teachers' opinions about STEAM makerspace

Subtheme1	Subtheme 2
Planning for the training program	**Benefits for children**
1. STEAM maker should be included when planning education programs, 2. Their achievements should be appropriate for the new generation, 3. Integration of the classroom with Stem Maker is necessary 4. It should be included in the classroom, not as a workshop	STEAM makerspaces develop children's imagination, this should be taken into account in planning

According to Table 4, the most frequently expressed situation in the planning of the education program is that "STEAM maker should be included when planning the programs". In this context, the statement of one of the teachers is given below:

T4: "STEAM maker areas should be included when planning education programs, children should be in environments with rich stimuli"

According to Table 4, the most frequently mentioned situation regarding the benefits of STEAM makerspace for children is that "STEAM makerspace develops children's imagination". Teachers stated that this situation should be taken into consideration in educational planning;

T6: "STEAM makerspace allows children to use their imagination because it contains a wide variety of materials"

2. *Before implementing STEAM activities, do you plan how you will do STEAM makerspace activities? If you plan, what do you consider (frequency, getting children's opinions, type of activity, etc.)?*

Table 5. Considerations in the planning process

Subtheme 1
Considerations in the planning process
1. Preparation process, 2. Material-oriented plan (material control, material-appropriate design) 3. Type of group (small group activity, etc.), 4. Type of activity (such as integrated activity)

Table 5 presents the items listed by the teachers in the nominal focus group interview under the theme of "Considerations in the planning process".

According to Table 5, teachers emphasized the "preliminary preparation process" the most in the theme of what is taken into account in the planning process. Accordingly, teachers' statements are as follows:

T8: "In the planning process, the preliminary preparation process is very necessary, even indispensable. If the preparation process is effective, planning and even implementation becomes more enjoyable".

3. *How did you plan STEAM activities before the STEAM makerspace / Has there been any difference in planning your STEM activities after the STEAM makerspace?*

The sub-themes related to how teachers planned STEAM activities before STEAM makerspace were expressed under two headings: there are changes in the planning process and there are no changes in the planning process. In this context, the responses of the teachers in the nominal group interview and their rankings are presented in Table 6.

In Table 6, regarding the sub-theme "There are changes in the planning process", the teachers most frequently and primarily answered "There is a difference in materials, there is no difference in other planning". According to this, teachers' opinions:

T1: "STEAM makerspace makes a difference with the material difference in the planning process. Other planning processes are similar to the planning processes in the program."

Table 6: How STEAM activities were planned before the STEAM makerspace

Subtheme1	Subtheme 2
There are changes in the planning process	No change in the planning process
1. Differences in material, no differences in other planning 2. Change in emphasizing creativity 3. Giving children freedom/opportunity 4. Process in which the teacher is passive and the child is more active	There was no change in the planning, we were preparing a plan for STEAM, but the title was not STEAM.

In Table 6, regarding the sub-theme of no change in the planning process, the teachers most frequently and primarily answered "There was no change in planning, we were preparing a plan in accordance with STEAM, but the title was not STEAM".

T7: "I was doing the same planning before STEAM makerspace, only I was not using STEAM concepts."

4. What impact do you think STEAM makerspace has on planning your STEAM activities (facilitating or complicating)?

When the effects of STEAM makerspace on planning STEAM activities were considered, all teachers stated that STEAM makerspace had an effect. In this context, the ranking of the teachers' answers in the nominal focus group interview is given in Table 7.

Table 7. The effects of STEAM makerspace on planning STEAM activities

Subtheme1	
STEAM Makerspace has impacts	
1.	Motivating environment,
2.	Rich in materials,
3.	Comfortable environment,
4.	Motivating the child and the teacher,
5.	Access to the material,
6.	Facilitating role.

According to Table 7, the most frequently expressed by the teachers is that the effect of STEAM makerspace on planning STEAM activities is "motivating environment". Accordingly, teachers expressed the following statements:

T9: "STEAM makerspace provides a motivating environment for us and the children while planning STEAM activities. Our interest in STEAM activities increases".

Application

The practices in STEAM Makerspace constitute the second main theme of this research.

1. What is the must-have for implementing STEAM makerspace STEAM activity?

The rankings of the answers related to the sub-theme of STEAM makerspace STEAM activity implementation and STEAM activity achievements are presented in Table 8.

Table 8: Essentials when implementing a STEAM activity

Sub-theme 1:	Sub-theme 2:
A must-have when implementing a STEAM activity	STEAM activity outcomes
1. Material 2. Small group activity	1. Conversation with the child, 2. Question and Answer, 3. Preliminary study, 4. Imagination, 5. A journey from concrete to abstract, from abstract to concrete, 6. Material

According to Table 8, STEAM makerspace is the "material" that is indispensable when implementing STEAM activities. Accordingly, while the most common answer given by the teachers in the nominal focus group interview was the material, the most common answer presented in the STEAM activity outcomes was the conversation with the child. In this context, teachers' responses are as follows:

T3: "STEAM makerspace is the most contributing materials when implementing STEAM activities. Having various materials makes the activity enjoyable and effective".

T5: "There are many gains in STEAM activity applications, the most important one is that it provides the opportunity to chat with children".

2. *What do you think about STEAM makerspace functionality when implementing your STEAM plans?*

Table 9 shows the responses and frequencies of teachers who provided positive and negative opinions about STEAM makerspace functionality while implementing STEAM plans.

According to Table 9, the teachers who expressed the functionality of STEAM makerspace positively gave the answer "STEAM makerspace is a functional area because it addresses all areas of development", while the teachers who expressed negatively gave the answer "Having a separate workshop from the classroom reduces its functionality, it is not efficient for the whole school to use a single area". According to this, teachers;

T2: "STEAM makerspace is very functional because it offers experiences that support all developmental areas of children".

T11: "STEAM makerspace is not functional because it is in a separate area from the classroom, which wastes time".

3. *What do you think about STEAM makerspace supporting children's development while implementing your STEAM plans?*

The responses of the teachers who expressed the effects of STEAM makerspace on child development in two themes, general and specific, and the order of the responses are presented in Table 10.

According to Table 10, all of the teachers who expressed the effects of STEAM makerspace on child development in general context answered "addressing all developmental areas", while STEAM makerspace "supports self-confidence" was the most common answer for its effects on child development:

Table 9. STEAM makerspace functionality when implementing STEAM plans

Subtheme 1:	**Subtheme 2:**
STEAM Makerspace Functionality (Positive)	STEAM Makerspace Functionality (Negative)
1. The functional space addresses all areas of development, 2. Diversity in terms of space, 3. Having a separate workshop increases its functionality, 4. A change of environment motivates both the child and the teacher, 5. It is more functional to have a workshop in a different area instead of squeezing all areas into the classroom. 6. Diversity in materials, 7. A stimulus-rich environment, 8. Functional, suitable for research and study.	1. Having a separate workshop from the classroom reduces its functionality, it is not efficient for the whole school to use a single space (in terms of time, frequency of use), 2. The material layout is not functional, 3. Space is tight, time is limited, students are many.

Table 10: Effects of STEAM makerspace on child development

Sub-theme 1:	**Sub-theme 2:**
STEAM Makerspace effects on child development (General)	STEAM Makerspace effects on child development (Specific)
1. It addresses all areas of development.	1. It supports self-confidence, 2. It makes a difference in the way you think, 3. Creative products emerge.

T4: "STEAM makerspace supports all developmental areas of children such as physical, social, emotional, cognitive, etc.".

T5: "STEAM makerspace children participate actively, this learning environment supports self-confidence in children"

4. When implementing your STEAM plans, does the STEAM makerspace enable children to be active in the activity process?

All teachers expressed positive opinions about STEAM Makerspace children's participation in the process. Accordingly, teachers state that STEAM Makerspace enables children to actively participate in the process. Teachers' responses and their rankings in this context are presented in Table 11.

Table 11. STEAM makerspace children's participation in the process

Sub-theme 1:
STEAM Makerspace children's participation in the process (positive)
STEAM Makerspace ensures that children's participation in the process is active, 1. Less teacher intervention, 2. The child's production alone is increasing, 3. The material is accessible, 4. The atmosphere is cozy, 5. An area where dreams come true, 6. It's interesting, 7. The workshop is a reward for children, 8. The presence of the workshop is a reason for children to be active.

According to Table 11, the most common answer given by the teachers regarding STEAM makerspace, where children actively participate in the process, is "teacher intervention decreases". According to this;

T7: "In STEAM makerspace, children actively participate in the whole process, and teacher intervention is reduced in this environment"

5. Do the materials in the STEAM makerspace meet your needs while implementing your STEAM plans?

Positive and negative opinions about STEAM Makerspace material diversity meeting the needs are presented in Table 12.

According to Table 12, while the teachers mostly answered "it was more adequate when it was first established" about the STEAM makerspace material diversity meeting the needs, they answered "the space of the materials is no longer adequate" about not meeting the needs. According to this;

T4: "When STEAM makerspace was first established, it had richer materials, it decreased over time, the materials should be updated"

T10: "A larger space should be provided for leftover materials in STEAM makerspace art area"

6. When implementing your STEAM plans, are the materials available in STEAM makerspace functional to use during implementation?

Teachers presented their positive and negative opinions about the use of STEAM Makerspace materials. Accordingly, the responses and their frequencies are presented in Table 13.

According to Table 13, all of the teachers who characterized the use of STEAM makerspace materials positively answered "functional in terms of material diversity". The most common statement of the teachers who characterized STEAM makerspace material use negatively was "material location is not functional". Accordingly, the statements taken from the teachers' answers are as follows:

T3: "STEAM makerspace is very diverse in terms of materials, so it is a stimulus-rich environment"

Table 12: STEAM Makerspace material diversity meets the need

1. Sub-theme 1:	2. Subtheme 2:
STEAM Makerspace material diversity meets the need	STEAM Makerspace material diversity does not meet the need
1. It was more adequate when it was first established, 2. Materials should be constantly updated	1. Space for materials is no longer enough 2. Not proficient in mathematics and music

Table 13: STEAM makerspace material use

Sub-theme 1:	Subtheme 2:
STEAM Makerspace material use (Positive)	STEAM Makerspace material use (Negative)
1. Functional in terms of material diversity	1. The location of the materials is not functional, 2. It is not in a position suitable for the child's development,

T9: "STEAM makerspace materials could be more functional in terms of location"

7. *What are the challenges and difficulties you face in STEAM makerspace while implementing your STEAM plans? What are your suggestions for solutions to the challenges and difficulties?*

The responses and rankings of the teachers in the nominal group interview regarding the difficulties encountered in STEAM Makerspace applications are given in Table 14.

Table 14. Challenges encountered in STEAM Makerspace applications

Sub-theme 1:
STEAM Makerspace challenges
1. High number of children 2. Small surface area, 3. Renovation, arrangement, consolidation works should be carried out / deficiencies identified and not followed up

According to Table 14, the main difficulty encountered in STEAM makerspace applications is the high number of children. According to this, teachers:

T6: "Children enjoy STEAM makerspace environment very much, but the high number of them makes it difficult to use"

In their opinions on STEAM Makerspace applications, teachers stated that the STEAM Makerspace area being a separate area in the classroom, offering diversity in materials and being a stimulus-rich environment motivated children and teachers. However, there were also teachers who stated that using the workshop environment together was difficult in terms of time management and space. Teachers who stated that STEAM Makerspace applications support all developmental areas of children find makerspace applications functional, especially in developing thinking skills, revealing imagination and creativity, and supporting children's self-confidence. The teachers stated that since STEAM Makerspace is a comfortable and accessible environment for children, it increases children's active participation, is interesting and children express themselves more freely, and that the presence of the workshop is a reason for children to be active and a reward for children. Although teachers find STEAM Makerspace functional and effective, they also state that the variety of materials decreases over time and needs to be updated from time to time.

Evaluation

Evaluation constitutes the third main theme of this research.

1. *Can STEAM makerspace be a tool to assess children's development? What do you think about this topic?*

According to all teachers who participated in the study, STEAM makerspace can be a tool for assessing children's development. The sub-themes related to

Table 15: Using STEAM makerspace as a tool to assess children's development

Subtheme 1:	Subtheme 2:
Assessing development:	Type of evaluation:
1. A suitable environment to assess all areas of development, 2. Assessing cognitive development 3. Assessing creativity	Can be evaluated according to time

assessing development and the way of assessment are presented in Table 15.

According to Table 15, STEAM makerspace being "a suitable environment for evaluating all developmental areas" is the most frequently expressed answer. The type of evaluation is "based on time" is the response of all teachers. According to this;

T2: "STEAM makerspace can be a suitable tool for assessing development because it is a suitable environment for assessing all areas of development.

T11: "STEAM makerspace can be based on time in evaluating development".

2. *When you evaluate the activities you do in STEAM makerspace, what is the difference that distinguishes STEAM makerspace from other educational environments?*

Teachers' responses and rankings regarding the difference of STEAM Makerspace from other learning environments are presented in Table 16.

Table 16. STEAM Makerspace differs from other learning environments

Sub-theme 1:
STEAM Makerspace is different from other learning environments:
1. An environment where the child is more active and more willing,
2. Appeal to all areas of development,
3. Don't have many areas in the same environment,
4. Hosting science and engineering fields
5. Excess and diversity of materials
6. Easy access to material
7. Feeling belonging to the environment

According to Table 16, the last and first answer given by the teachers regarding the difference of STEAM Makerspace from other learning environments is that it is "an environment where the child is more active and more willing". According to this;

T12: "STEAM makerspace environment is different from other learning environments, children are more active and enthusiastic here"

3. *How should the STEAM makerspace be revised based on the results that emerged during the implementation, what should be added to the workshop - what are your suggestions for improvement?*

Teachers' responses and their rankings regarding the STEAM Makerspace update are presented in Table 17.

Table 17. Opinions on updating STEAM Makerspace

Sub-theme 1:
Regarding STEAM Makerspace update:
1. Balancing the number of children
2. Recruitment of 1 extra teacher
3. Supporting a robust structure,
4. Continuous monitoring,
5. Organization in accordance with the child's development (cupboard, shelves, boxes and their position)
6. Adding ingredients,
7. Drama field should be updated
8. There must be a sound system.

According to Table 17, balancing the number of children was the most common response in teachers' views on updating STEAM makerspace. In this context, teachers;

T11: "The best way to use and update the STEAM makerspace more effectively is to balance the number of children"

4. *As a result of your evaluation of the STEAM makerspace, what do you think about reorganizing the STEAM makerspace according to your needs? (Is there an area that should be added to the workshop? If yes, which one and why should it be added?*

Teachers' responses and rankings regarding the effect of STEAM makerspace on pedagogical content knowledge/professional experience are presented in Table 18.

According to Table 18, the most common and prioritized answer regarding professional experience was "teachers should be given trainings on its use". According to this

T12: "Teacher trainings on the use of STEAM makerspace are important and necessary. Thus, the space can be used more effectively".

In terms of STEAM makerspace child-program and practice-oriented evaluation, the findings show that

Table 18. *The effect of STEAM makerspace on pedagogical content knowledge/professional experience*

Sub-theme 1:
Impact on pedagogical content knowledge/professional experience
1. Teachers should be trained on its use. 2. Adopt a way of teaching without limiting the child, 3. The place where teachers realize their dreams, 4. Contribution to planning.

this space is an appropriate learning environment to assess the whole development of the child. STEAM makerspace supports children's active participation in the process due to the variety of spaces and materials it contains. Teachers do not feel that STEAM Makerspace needs an additional area, but they need updates such as increasing the variety of materials, enriching materials in certain areas, and balancing the number of children in order to use the space effectively.

Reflection and Feedback

Data on children's use of Makerspace were presented under the theme of reflection and feedback. The sub-themes addressed in this context are the observation of the STEAM Makerspace activity and the observation of the STEAM Makerspace function.

Observation of the activity implemented in STEAM Makerspace

1. What is the purpose of the STEAM activity?
Observers' notes on the purpose of the STEAM activity are presented in Table 19.

Table 19. Purpose of STEAM activity

Subtheme 1: STEAM Maker Space Observation of the Implemented Activity
1. Supporting children's skills based on research, inquiry and discovery 2. Providing an activity environment where they can realize life-based activities and spend free time

According to Table 19, the most frequently observed aim of the observers was for children to develop skills based on research, inquiry and discovery.

2. Which outcomes does STEAM activity support for children?
The observation notes regarding which achievements of the children were supported in the STEAM activity are presented in Table 20.

Table 20. Children's achievements in STEAM activity

SUBTHEME 1: STEAM activity children's achievements
1. Cognitive development; 2. Do not pay attention 3. Forecasting 4. Generating solutions to problem situations 5. Social and emotional development; 6. Expressing oneself in creative ways 7. Self-motivation to accomplish a job or task. 8. Motor development; 9. Supports movements that require the use of small muscles.

According to Table 20, children acquired cognitive, social, emotional and motor development outcomes in STEAM makerspace.

3. What materials were used for the STEAM activity?
Children used various materials related to STEAM disciplines in STEAM activities. This situation is presented in Table 21.

Table 21. Materials used in STEAM activities

Subtheme 1: Materials used in STEAM activity
1. Lego materials in the field of engineering, 2. Journals and books in the field of science, 3. Waste technological devices in the technology corner, 4. Waste materials in the field of mathematics (bottle caps, beads, etc.), legos, measuring cups, etc. 5. Hats and bags in the drama area were used by the children.

According to Table 21, children use various materials from science, engineering, technology, art and mathematics disciplines in STEAM activities.

4. What are the methods used by the teacher in STEAM activities?

Observation notes regarding the methods used by teachers in STEAM activities are presented in Table 22.

Table 22: Methods used in STEAM activities

Subtheme 1: Methods used in STEAM activity
1. Discussion 2. Brainstorming 3. Case study 4. Problem solving

According to Table 22, the methods used in STEAM activities are discussion, brainstorming, case study and problem solving.

5. What strategies did the teacher use to assess the children?

The strategies used by teachers when evaluating children are presented in Table 23.

Table 23. Strategies used by teachers when evaluating children

Subtheme 1: Strategies used by teachers when assessing children
1. Children select and use materials carefully while working and put them back in their places after use, 2. Working collaboratively with peers and willingness to share materials, 3. Systematic progress in their work, 4. Planning in advance and selecting materials in line with their planning 5. Whether they were able to achieve the outcome or not was taken into account, as was their willingness to strive for it.s

According to Table 23, the teacher used many strategies to evaluate children's use of STEAM Makerspace, such as carefully selecting materials, leaving materials in their places, and collaborating with peers.

6. What is the role of the teacher in STEAM implementation?

Observation notes and reflections on the teacher role in STEAM practices are presented in Table 24.

According to Table 24, the teacher is a guide and supports children with scaffolding. Here the concept of scaffolding in Vygotsky's sociocultural learning theory emerges. The teacher is the person who supports children to demonstrate certain skills independently.

Table 24. Teacher role in STEAM implementation

Subtheme 1: Teacher role in STEAM implementation
The teacher acts as a guide. She supports the children with scaffolding.

7. What is the role of the child in STEAM?

Observation notes and reflections on the role of children in STEAM practices are presented in Table 25.

Table 25: Child role in STEAM application

Subtheme 1: The role of the child in STEAM
The child is actively engaged, at the center of learning

According to Table 25, the child is at the center of learning and is active. This observation note is in line with the views of the teachers who shared their opinions in the nominal focus group discussion about the STEAM makerspace. Teachers emphasize the active participation of children just like the observation notes and reflections.

8. What did the children learn during the STEAM implementation process?

Observation notes on what children learned in STEAM are presented in Table 26.

Table 26: What children learned in STEAM application

Subtheme 1: What children learn in STEAM
1. Children made patterns with the materials. 2. Someone tried to build a machine. 3. They made measurements by filling the measuring cups with Legos. 4. They also made a cake with Legos. 5. They learned to research and question 6. They experienced problem solving 7. They experienced making a plan

According to Table 26, children acquired thinking skills such as research, questioning, problem solving and planning, as well as mathematical skills such as measurement, patterning, and finding the whole from parts in STEAM practices.

9. *How did the children feel during the STEAM implementation process?*

Reflections on how children felt during the STEAM implementation process are shown in Table 27.

Table 27: Children's feelings during STEAM implementation

Subtheme 1: Children's feelings in STEAM
When even the smallest efforts of children were reinforced, they were happy and confident. Accordingly, they started to work and research more.

According to Table 27, STEAM practices are effective in terms of making children happy, supporting their self-confidence and motivating them to work or research.

Observation of STEAM Makerspace function

1. *Is the STEAM maker environment fit for purpose?*

Observation notes on the suitability of the STEAM maker environment for the purpose are shown in Table 28.

Table 28. Fitness for purpose of STEAM maker environment

Subtheme 1: The suitability of the STEAM maker environment for the purpose
It is fit for purpose in terms of material and accessibility.

According to Table 28, the STEAM maker environment is fit for purpose in terms of materials and accessibility. This observation note is similar to the findings of the nominal group interview. In the nominal group interview, teachers stated that STEAM makerspace was effective in terms of materials and accessibility.

2. *Does the STEAM makerspace make the materials used functional?*

Observation notes on the functionality of the materials used in STEAM makerspace are shown in table 29.

Table 29: Functionality of the materials used in STEAM makerspace

Subtheme 1: Functionality of the materials used in STEAM makerspace
1. The number of students in the class made it necessary to share desks. 2. Different areas were also used in case of need

According to Table 29, the number of students in the classroom necessitated the sharing of tables and different areas were used when needed. This situation is consistent with the views of the teachers regarding the number of students in the nominal focus group interview. Accordingly, the distribution of the number of students in the STEAM makerspace is important for the functional use of the space.

3. *Does the STEAM makerspace make the planned method functional?*

The observation findings regarding the functionality of the STEAM makerspace planned method are presented in Table 30.

Table 30: STEAM makerspace functionalization of the planned method

Subtheme 1: STEAM makerspace functionalization of the planned method
1. Steam makerspace children's conversations with both the teacher and their friends in accordance with the discussion and problem solving method show that the environment is functional in this sense. 2. With the guidance of the teacher or the influence of peer learning, children were able to develop new ideas.

According to Table 30, children speak in accordance with the STEAM makerspace discussion and problem solving method. This situation is also improved with teacher guidance.

4. *Is it appropriate to organize STEAM makerspace according to the teacher's educational environment?*

The observation notes regarding the appropriateness of the STEAM makerspace teacher's arrangement according to the educational environment are presented in Table 31.

Table 31: STEAM makerspace teacher's organization according to the educational environment

Subtheme 1: STEAM makerspace arrangement according to the teacher's educational environment
Materials need to be updated according to need.

According to Table 31, updating the materials according to the needs is important for the teacher to organize the STEAM makerspace as an educational environment. A similar finding was also revealed in the nominal focus group interview. Both observation and interview notes emphasize the necessity of updating the makerspace from time to time according to the needs. As stated in the literature, STEAM makerspace is a dynamic learning environment that can be updated in accordance with the purpose and the conditions of the age.

5. *Is STEAM makerspace suitable for the teacher's application of the assessment strategy?*

The reflections on the appropriateness of the STEAM makerspace teacher's application of the evaluation strategy are presented in Table 32.

Table 32: Compliance with the evaluation strategy

Subtheme 1: Relevance to the evaluation strategy
STEAM makerspace suits the teacher's application of the assessment strategy.

6. *Does STEAM makerspace facilitate teacher guidance?*

The responses and feedbacks about whether STEAM makerspace facilitates teacher guidance are presented in Table 33.

According to Table 33, STEAM makerspace supports the teacher's guidance because the diversity in the environment keeps children's attention alive.

Table 33: STEAM makerspace facilitates teacher guidance

Subtheme 1: STEAM makerspace facilitates teacher guidance
The diversity of the environment kept children's attention.

7. *Does STEAM makerspace facilitate active participation of the child?*

Reflections on the feature of STEAM makerspace facilitating the active participation of the child are presented in Table 34.

Table 34: STEAM makerspace facilitates active participation of the child

Subtheme 1: STEAM makerspace facilitates active participation of the child
STEAM makerspace materials ensured children's participation during this time. Children worked actively for 30 minutes.

According to Table 34, STEAM Makerspace materials enable children to participate in the process. Similarly, teachers also stated that STEAM makerspace materials enable children's active participation.

8. *Does STEAM makerspace facilitate children's learning?*

Findings regarding the facilitating feature of STEAM makerspace in children's learning are presented in Table 35.

Table 35. STEAM makerspace facilitates children's learning

Subtheme 1: STEAM makerspace facilitates children's learning
1. STEA STEAM makerspace has more materials than learning environments in classrooms, 2. Being independent from the classroom environment 3. As a learning environment, the fact that it is a place that gives children freedom was observed as a facilitating effect.

9. *Does STEAM makerspace have an impact on how children feel?*

Findings on the impact of STEAM makerspace on how children feel are given in Table 36.

Table 36: The effect of STEAM makerspace on how children feel

Subtheme 1: The impact of STEAM makerspace on how children feel
Throughout the process, reinforcement, support and conversations about the products showed that the children had fun and enjoyed themselves

STEAM makerspace is a learning environment that allows children to experience, explore and solve problems. It can be said that the diversity of materials in this environment, children's accessibility to materials and the fact that there is a learning environment independent from the classroom are effective in children's active participation and research. Makerspace also allows children to gain different experiences and work in cooperation with their peers with the alternative and libertarian learning environment it offers. The learning environment is extremely important for children's learning. The findings of the study also emphasize the importance of using the space effectively. The organization of the space according to the number of children and the effective use of the floor, table or walls in the space are also valuable in this context. However, observation results also emphasize the importance of teacher guidance. It can be said that supporting children with the scaffolding method and using methods and techniques such as discussion, case studies, brainstorming and problem solving support children's learning processes.

Discussion and Conclusion

The present research explored the perspectives of teachers and students concerning the planning, implementation, and evaluation of STEAM Makerspaces, including reflective feedback. It was found that:

- STEAM Makerspaces provide a richly stimulating learning environment.
- Such spaces foster children's creativity and imagination through diverse material resources.
- These are welcoming, unrestricted spaces where children feel a sense of belonging.
- STEAM Makerspaces positively contribute to overall developmental areas, with particular emphasis on cognitive development, creativity, imagination, and self-confidence.
- Evidence suggested that a STEAM Makerspace learning environment encourages active child participation.

The research outcomes align with existing national and international literature. Knobel and Lankshear (2010) argue that Makerspaces signify the shift towards a "Do It Yourself" culture, where individuals become more proactive and self-reliant, facilitated by the evolution of digital tools and applications. Similarly, teachers in our study noted that children who consistently engaged with makerspaces produced original creations within an unrestricted and comfortable environment, showing active involvement and enhanced creativity. Makerspaces endorse a learning-by-doing model where individuals can independently or collaboratively work on significant creative design projects (Makey, 2020).

In makerspace pedagogy, children are placed at the center of learning, with their interests directing the learning activities through play, construction, design, and exploration (learning by doing) (Scaradozzi et al., 2021). This aligns with the themes emerging from our research findings. Teachers stated that children enjoyed being in the makerspace during the planning, implementation, and evaluation phases. They observed the space to be motivational and appealing to children and noted how the children acted more freely, actively participating and remaining at the learning center. Feinstein, DeCillis, and Harris (2016) also noted that makerspace applications provide a learning environment distinct from traditional classrooms, reinforcing learning by doing. Our study confirms these observations, presenting the makerspace learning environment as a more active, engaging alternative to traditional classrooms. The area caters to all developmental aspects of children and encourages learning by doing due to the diverse learning zones, an abundance of materials, and easy accessibility.

The Maker movement can impart learning skills like creative thinking, critical thinking, collaboration, and communication, along with 21st-century

competencies such as technology literacy, flexibility, innovation, social skills, productivity, and problem-solving (Feinstein, DeCillis, Harris, 2016; Papadakis, Kalogiannakis, & Gozüm, 2022). Our study findings corroborate this. Teachers observed that the Maker movement diversified children's thinking abilities, bolstered cognitive development, and specifically nurtured imagination and creativity at all stages. Creativity is defined as the capacity to produce multiple solutions to a problem through divergent thinking, as opposed to a single solution via convergent thinking (Daly et al., 2014). Maker pedagogy can enable students to investigate a problem as a team, exchange ideas, and construct and reconstruct their thoughts. Creativity is an essential tool that aids students in actualizing their innovative ideas and cultivating their creative competence (Papadakis, 2021; Xia et al., 2021; Gözüm, Papadakis, & Kalogiannakis, 2022).

Makerspaces serve as enriched learning environments for children, offering a variety of learning materials and allowing for hands-on experimentation to create their imagined designs. It supports STEAM experiences, encourages cognitive skills such as problem-solving and planning, and fosters collaborative work among peers. Even though Makerspaces are often tied to STEAM experiences, their significance extends to all early childhood education methodologies. Several early childhood education approaches like Waldorf, Reggio Emilia, and Montessori emphasize the importance of learning spaces. For instance, Reggio Emilia describes the environment as the third teacher (Strong-Wilson & Ellis, 2007; Robson, 2016; Hall, 2017; Miller, 2019). Waldorf promotes the use of natural learning spaces (Drąsutė & Umbrasaitė, 2015; Mezentseva, 2019), Reggio Emilia offers children various indoor and outdoor learning spaces and "piazza" spaces for project-based work and collaboration (You, 2014; McNally & Slutsky, 2017). In Montessori, there are multiple learning centers (like mathematics, senses, daily life) to facilitate children's learning. Makerspaces share similarities with the Reggio Emilia Approach, emphasizing the significance of the environment. Both makerspace and piazza areas allow for project-based work and collaboration. However, makerspaces might include technology-based materials based on the purpose and can be developed in various locations (libraries, museums, workshops, etc.) in association with the community (Keune & Peppler, 2019; Mersand, 2021). The learning spaces in the Montessori Education Approach also share similarities with makerspaces to an extent. Both provide a purposeful, stimulating environment with diverse materials. However, while the Montessori approach includes learning areas aligned with its educational philosophy, makerspaces contain materials suited to contemporary needs. As per the literature, makerspace areas can be found both inside and outside the school. The current study's makerspace is located in a preschool education institution. However, future studies should look at integrating makerspaces with nature and ensuring their frequent inclusion not only indoors but also in open spaces.

In conclusion, our research presents findings that substantiate the existing literature. The study demonstrates that makerspaces, as learning environments, possess richly stimulating and encouraging qualities, allowing children to develop a "do-it-yourself" culture. Such spaces promote active participation and learning by doing and experiencing, thereby fostering all aspects of children's development, particularly cognitive skills such as imagination and creativity. As a result of our research, the following recommendations are offered:

STEAM Makerspaces should be included as learning spaces in the early years. These spaces support learning by doing and experiencing with the rich stimulating environment they provide. STEAM Makerspaces also support collaboration and teamwork. For this reason, it is necessary to increase the number of STEAM Makerspaces suitable for early childhood both in and out of school.

STEAM Makerspace learning spaces should be designed to be integrated with education programs. Thus, it is possible for all children to benefit from these spaces and to ensure equal opportunity in education (Papadakis, Kalogiannakis, & Gozüm, 2022).

The STEAM Makerspace can be designed either with digital content or manually, or a combination of both. This should be based on social needs and support children.

STEAM Makerspaces should not only be confined to the walls, but should also be offered in open spaces and nature.

STEAM Makerspace, teachers and parents should be involved and support should be provided to increase the cooperation between society and education (Mercan, Papadakis, Gözüm, & Kalogiannakis, 2022; Papadakis, Gözüm, Kalogiannakis, & Kandır, 2022)

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Appendix 1:

STEAM Makerspace Teacher Interview Form

Opinions of Teachers Using STEAM Makerspace About STEAM Makerspace

- Do you use STEAM Makerspace?
- How often do you use STEAM Makerspace?
- What kind of activities do you use STEAM Makerspace for (free time, integrated activity...)?
- Is STEAM Makerspace used in family involvement activities?

PLANNING-HOW TO PLAN

1. *What do you think about* STEAM Makerspace*?*
2. *Before implementing STEAM activities, do you plan how you will do the activity in* STEAM Makerspace *environment --- If you are planning, what do you take into consideration (frequency, getting children's opinion, type of activity, etc.)?*
3. How would you plan STEAM activities before the STEM maker space?
4. Has there been any difference in planning your STEM activities after STEAM Makerspace was built?
5. What impact do you think STEAM Makerspace has on planning your STEAM activities (facilitating or complicating)?
6. STEAM Makerspace What is a must in your STEAM activity implementation plan?

IMPLEMENTATION-HOW IT IS IMPLEMENTED

1. What do you think about STEAM Makerspace functionality when implementing your STEAM plans?
2. What do you think about STEAM Makerspace supporting children's development while implementing your STEAM plans?
3. When implementing your STEAM plans, does STEAM Makerspace enable children to be active in the activity process?
4. *Do the materials* in the STEAM Makerspace *meet your needs* when implementing your STEAM plans*?*
5. *Is it functional to use the materials* available in STEAM Makerspace during the implementation of your STEAM plans*?*
6. *What are the challenges and difficulties you face in* STEAM Makerspace while implementing your STEAM plans*? What are your solutions to the challenges and difficulties?*

EVALUATION- CHILD-PROGRAM-IMPLEMENTATION ORIENTED EVALUATION

1. Can STEAM Makerspace be a tool to assess children's development? What do you think about this topic?
2. When you evaluate the activities you do in STEAM Makerspace, what is the difference that distinguishes the STEM maker space from other educational environments?
3. What are your thoughts on the impact of STEAM Makerspace activities on children's development?
4. How should the workshop be revised based on the results of the implementation, what should be added to STEAM Makerspace - what are your suggestions for improvement?
5. As a result of your evaluation of STEAM Makerspace, what do you think about reorganizing STEAM Makerspace according to your needs (*Is there an area that should be added to the workshop? If yes, which one and why should it be added?*
6. What do you think about the impact of STEAM Makerspace on your pedagogical content knowledge and professional experience?

Appendix 2:

STEAM Makerspace Child Observation Form

Name Surname		Date	
Project Name		Observation Start Time	
Observation Location		Observation End Time	
Observed Teacher Code		Person Observing	
Observation of the Activity Implemented in STEAM Makerspace		Observation of STEAM Makerspace Function	
What is the purpose of the STEAM activity?		Is STEAM Makerspace fit for purpose?	
Which outcomes does STEAM activity support for children?		Is STEAM Makerspace suitable for supporting learning outcomes?	
Which materials were used for the STEAM activity?		Does STEAM Makerspace make the materials used functional?	
What is the method used by the teacher in STEAM activities with children?		Does STEAM Makerspace make the planned method functional?	
Did the teacher organize the educational environment while doing STEAM activities with the children?		Is it appropriate to organize STEAM Makerspace according to the teacher's educational environment?	
What strategies did the teacher use to assess the children?		Is STEAM Makerspace suitable for the teacher's assessment strategy?	
What is the role of the teacher in STEAM implementation?		Does STEAM Makerspace facilitate teacher guidance?	
What is the role of the child in STEAM?		Does STEAM Makerspace facilitate the active participation of the child?	
What did the children learn during the STEAAM implementation process?		Does STEAM Makerspace facilitate children's learning?	
How did the children feel during the STEM implementation process?		Does STEAM Makerspace have an impact on how children feel?	