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STEAM in Early Childhood: An Analysis Towards Teachers' and Children's Perspectives

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Abstract
This research examines teachers' and children's perspectives regarding STEAM (science, technology, engineering, art and math) in early childhood education. The participants of the study consisted of 35 teachers and 73 children selected from the children in the preschool classrooms where the teachers worked. Semi-structured interview forms prepared in line with the relevant literature and expert opinions were used as data collection tools in the research. The data obtained was analyzed using the content analysis technique. The themes obtained from the analysis of teachers' perspectives and teachers' knowledge about STEAM, materials used, activity types, activity resources, teacher competence, and solutions. The themes regarding the perspectives of children participants were determined as the topics children are curious about and the activities they enjoy about STEAM. Results showed that teachers did not have sufficient knowledge about STEAM, gave little place to STEAM activities in their classrooms, and had problems finding resources while preparing these activities and in the activity planning process. They also stated that teachers felt inadequate in implementing STEAM activities. According to the other results obtained from the research, the subjects that the children were most curious about in STEAM were science and engineering-related subjects, and the activities they enjoyed participating in the most were experiments, art, and games. The results were discussed per the relevant literature, and suggestions for STEAM applications in early childhood education were presented.

Keywords Early childhood · STEAM · STEM · Teacher · Child

Introduction

STEAM is a general term used for the core disciplinary groups of Science, Technology, Engineering, the Arts, and Mathematics, generally referring to an integrated approach to teaching and learning (Wan et al., 2021; Zendler, 2018). STEAM education is a teaching approach that combines the curriculum of science and mathematics disciplines by bringing together scientific inquiry, technology and engineering design, mathematics analysis, and multidisciplinary concepts and skills of the 21st century (Alghamdi, 2023; Johnson, 2013). Integrated STEAM education is important because it gives a practical opportunity to develop these abilities, knowledge, and attitudes to face current and future difficulties (Silva-Hormazábal & Alsina, 2023).

It is critical for a country's economy that schools educate children who can achieve success in STEAM-related subjects. Schools should simplify STEAM curricula and optimize teaching methodologies to effectively maximize students' STEAM potential (Margot & Kettler, 2019). Over the past few years, government policies have been needed worldwide to promote STEAM education. For example, the U.S. Department of Education (2018) allocated $279 million in STEAM discretionary grant resources for excellence in quality STEAM and computer science education in 2018. Many states have regulations to promote STEAM education in schools and STEAM professional

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development for educators (Johnson, 2012). In Australia, the government allocated more than $64 million to enhance students' STEAM studies by focusing on digital technologies (Department of Education, 2018). The Chief Executive's Policy Addresses indicated the official decision to strengthen STEAM education in Hong Kong in both 2015 and 2016 (So et al., 2018). Current initiatives in the United States, like the Next Generation Science Standards and the Common Core State Standards for Mathematics, emphasise an integrated STEAM approach (Belbase et al., 2022). Similarly, the Department of Education of Western Australia in 2019 defined STEAM as a pedagogical method that facilitates creativity, inquiry, conversation, cooperation, and critical thinking (Belbase et al., 2022). STEAM offers a method for achieving STEAM by integrating the principles of each discipline with art as interdisciplinary learning to critical areas of math, science, and art as a whole through new technology and design thinking with an investigative process (Belbase et al., 2022). In short, STEAM education is considered one of the priorities in the education policies of many countries. All these developments reveal the importance of providing individuals with skills in these four disciplines through STEAM education from an early age. However, although it is included in government policies, there may be difficulties in integrating this approach into early childhood classrooms and implementing it effectively at this stage. Therefore, the current study focused on teachers, who are the implementers of education policies, and children affected by these policies.

Theoretical Background

Bronfenbrenner's bioecological systems model explains the developmental process in terms of the child's interaction with the factors in his/her environment (Bronfenbrenner & Morris, 2006). In this model, development is defined by the interactions between the individual's multi-level and multi-dimensional environmental structures (Yang et al., 2023). Various environmental variables shape the individual's experiences, attitudes, and learning process. Accordingly, environmental systems and the factors in these systems interact gradually (Yang et al., 2023). The individual is in the centre of the circle, while other circles extend out from them to reflect the degrees of influence contributing to individual learning at each level (Garbarino, 2017; Guy-Evans, 2020). Bronfenbrenner classified the individual's environment into five ecological systems: microsystem, mesosystem, exosystem, macrosystem, and chronosystem (Yang et al., 2023). The first layer is the microsystem, in which interactions between the individual and the environment are bidirectional, each influencing and changing the view of the other (Jordan, 2004; Guy-Evans, 2020). The mesosystem refers to the interactions between microsystems, such as academics and their peers in a higher education setting (Jordan, 2004; Guy-Evans, 2020). The exosystem refers to the environment that does not directly contain the individual but has a substantial impact, such as judgments made by school presidents and deans (Guy-Evans, 2020). The macrosystem is the influencing culture in which an individual is enmeshed, and it shapes belief, i.e., the STEAM culture (Guy-Evans, 2020). Finally, the chronosystem and events that impact individuals and occur over time, such as a life-changing event like COVID-19 or shifting jobs (Guy-Evans, 2020). The first layer, the microsystem contains the most influential factors on child development (Bronfenbrenner, 1995; Bronfenbrenner & Morris, 2006). The microsystem includes individual characteristics of the developing child and environmental parameters such as family, home, peers and school-related factors (Bronfenbrenner & Morris, 2006; Yang et al., 2023). In the current study, the theoretical background is based on the bioecological systems model. We designed the research by including children and teachers as one of the environmental factors in their microsystem.

The Bioecological Systems Model has moved learning perspectives from being an individual characteristic to the interaction between the characteristics of the individual and the variables that affect learning (Ross et al., 2022). The model states that an individual's learning is a reciprocal interaction between environmental quality and the individual; the individual is affected by the environment and the environment affects the individual (Ungar, 2012). In addition, all layers in the system affect each other and changes in any of these layers should not be evaluated separately from the others. The influence of multiple interactions between complex and intertwined systems becomes important in the development of the child. Bronfenbrenner's model has been used to examine and understand the effects and experiences of teachers who implement education-focused STEAM at various career stages (Ross et al., 2022). The current study, based on to this model to evaluate STEAM applications in early childhood education from a more comprehensive perspective. In line with this theory, we focused on the factors in the microsystem, which is the first layer mentioned in the theory. We aimed to analyse the views of the child and the teacher, who is in direct interaction in the microsystem, and to analyse their views on STEAM in depth.

Teachers' Perspectives on STEAM Education

In recent years, schools have been incorporating STEAM subjects and teaching methods into their daily learning to meet the demand for more science, technology, engineering, and mathematics-educated employees (Margot & Kettler,

2019). Similarly, in the STEAM approach applied in early childhood education, educators and other environmental factors collaborate to reach children's existing potential (Margot & Kettler, 2019). According to Bagiati and Evangelou (2015), teachers are the most important contributors to children's STEAM-related learning.

Although STEAM is a generally accepted term in the education community, teachers' perspectives on the subject may differ (Wan et al., 2021). According to Haney et al. (2002), teachers are the most important factor in encouraging children's STEAM education and interest because teachers' views and perspectives are the factors that put educational theories into practice and shape classroom behaviours. In this respect, the perspective of teachers is included in the current study. Simoncini and Lasen (2018) used a written survey to assess the attitudes toward STEAM among 117 Australian teachers. STEAM was classified as a separate subject by 62% of respondents. Some participants, for example, defined STEAM simply by naming the disciplines represented by the acronym, whilst others expanded by stating the disciplines and offering instances of associated activities. Simultaneously, only 6.79% of respondents depicted STEAM as an integrated approach to education. STEAM was viewed as "hands-on" and/or "play-based" by 45% of participants. 35% stressed STEAM as a means of building mental habits. Park et al. (2017) used open-ended inquiries to assess the views of STEAM values among 830 American kindergartens to third-grade educators. Regarding their perspectives on the appropriateness and importance of STEAM, 24% of those who responded said STEM plays an important role in the development of principles, understanding, and capabilities.

Years of teaching experience are connected to teachers' assessments of the integration of STEAM subjects or education, and instructors' value or interest in STEAM may mitigate the connection (Margot & Kettler, 2019). According to Margot and Kettler (2019), years of experience, for instance, appear to have some impact on a teacher's perspective. According to Park et al. (2016), when compared with new teachers (between 1 and 5 years of experience), more experienced teachers (>15 years) had a more favourable perspective of the value of STEAM learning. Nadelson et al. (2013) found that as teachers' ages increased, so did their positive perceptions of engineering activities in the educational environment. Female teachers have been demonstrated to consider technology less significant in STEAM fields than male colleagues (Smith et al., 2015), and they have a more negative perception of STEAM education in general than male teachers (Park et al., 2016).

STEAM in Early Childhood

In early childhood education, the inclusion of the 'arts' in STEM (resulting in the acronym STEAM) allows children to articulate STEM ideas in innovative and inventive ways (Radziwill et al., 2015). The STEAM approach, which includes art in the field of STEAM education, integrates science, technology, engineering, and mathematics with art. This approach aims for children to acquire soft skills along with positive sciences (Gonzales & Kuenzi, 2012). According to educators, this type of learning increases children's interest in learning, develops observation, research and questioning skills, and children become capable of critical thinking as they expand their knowledge (Ata Akturk et al., 2017; Tippett & Milford, 2017). Conradty and Bogner (2020) conducted a study that demonstrated the effectiveness of STEAM course instruction in improving students' creativity and self-efficacy levels. STEAM may be a good technique for increasing both school motivation and willingness to perform (Conradty & Bogner, 2020). According to the Department of Education of Western Australia (2019), STEAM education helps students acquire vital abilities such as problem-solving, creativity, critical analysis, teamwork, independent thinking, initiative, communication, and digital literacy. These competencies are required for pupils to succeed in their future occupations (Belbase et al., 2022). STEAM education may combine information from numerous fields and technologies at the same time, and it has the potential to significantly improve children's learning. Preschool children's engagement with STEAM activities can boost their creativity, emotion, collaborative inquiry, and literacy abilities (Kewalramani et al., 2021). STEAM learning allows children to employ their creativity and critical thinking skills (Costantino, 2018). STEAM method is expected to extend beyond cognitive and critical thinking abilities, helping children to engage their senses and emotions, as well as learn via doing/making (Costantino, 2018). Participating in STEAM activities enables preschool children to express and manage their emotions, therefore developing emotional intelligence as they navigate collaborative projects and problem-solving settings (Bailey, 2015). The hands-on nature of STEAM activities allows children to explore their emotions and build empathy as they collaborate with others and share their ideas and experiences (Belbase et al., 2022). STEAM involvement teaches children to integrate their emotional experiences with their creative outputs, which improves their capacity to successfully convey thoughts and ideas (Bailey, 2015).

Although STEAM education provides students with the necessary technical and practical abilities for success, these disciplinary skills are insufficient to adapt to a rapidly changing environment (Silva-Hormazábal & Alsina, 2023).

STEAM education provides students with important technological skills, it does not adequately prepare them for the dynamic character of modern society (Smith et al., 2022). Critical thinking, cooperation, and creativity are all skills that students must have in order to adapt effectively (Smith et al., 2022). As Silva-Hormazábal and Alsina (2023) point out, using multidisciplinary techniques improves adaptation by allowing students to draw insights from a variety of fields. Furthermore, developing emotional intelligence and ethical reasoning is critical; students must traverse complicated social challenges and collaborate in diverse teams (Silva-Hormazábal & Alsina, 2023). According to research, including real-world problem-solving experiences in the STEAM framework can also promote resilience and inventiveness, helping children to flourish in the face of change (Smith et al., 2022). As a result, a comprehensive approach to STEAM education that incorporates these abilities is critical for developing flexible and future-ready students (Silva-Hormazábal & Alsina, 2023). While STEAM education provides students with important technical and practical abilities, it is critical to remember that adaptation in a fast-changing world necessitates a wide range of talents (Smith et al., 2022). According to Silva-Hormazábal and Alsina (2023), soft skills such as critical thinking, creativity, and teamwork are essential for overcoming difficult situations. Furthermore, cultivating a growth mindset and resilience allows students to effectively deal with change and ambiguity (Silva-Hormazábal & Alsina, 2023). Also, interdisciplinary approaches that combine social sciences and humanities might help students better comprehend and respond to societal concerns, developing more holistic problem-solving abilities (Smith et al., 2022). As a result, a well-rounded education that incorporates STEAM and these extra abilities is critical for educating kids to flourish in an ever-changing environment (Smith et al., 2022).

STEAM emphasises the intertwined nature of different disciplines and demonstrates their value for children's long-term academic performance and social development (Herro, 2016; Han et al., 2016). In addition, the STEAM approach is also a supportive element for teachers in early childhood education. According to research, integration with other disciplines, such as art, can help teachers to encourage creativity in young children (Yakman, 2008) and provide a space to personalise the learning process. This situation affects the motivation of teachers and children towards STEAM education (Land, 2013; Wynn & Harris, 2012). Sullivan et al. (2013) suggested that STEAM practices can complement STEAM education of early-age children with the addition of additional art subjects. Here, the 'A' in STEAM stands for visual arts and crafts, liberal arts, language arts, social studies, music, and culture. In conclusion, it can be said that the inclusion of STEAM in curricula and practices in early childhood education is a globally recognised and accepted practice for children's development and learning.

STEAM education is an approach to learning discipline-based subjects beyond the surface level (Vasquez et al., 2013). This approach is essential for teachers to support 21st-century skills for children to navigate a new and rapidly changing world (Bybee, 2013). 21st-century skills include the capacity to produce knowledge, communicate, collaborate to solve real-world problems, and use information and communication technologies (ICT) safely and appropriately. These skills develop in early childhood, so STEAM education creates a natural connection between these skills and early childhood education. Because STEAM includes applications that require children to solve problems using real-world scenarios (Quigley et al., 2017), these applications provide powerful and authentic learning experiences while also engaging children in the challenging STEAM subjects needed for the future workforce (Jamil et al., 2018). Considering the different implementations among countries, STEAM, as a still developing paradigm in early childhood education, enables children to learn to build new things, observe and combine existing things in new ways, and think freely and unconventionally (Jamil et al., 2018).

Many learning objectives have been proposed within the scope of STEAM education; these include understanding basic STEAM concepts, understanding STEM discipline characteristics, skills to address STEM-related questions and problems, 21st-century skills (such as creativity, critical thinking, communication, and collaboration), and positive attitudes toward STEAM (such as interest, participation, and self-efficacy) (Bybee, 2013). Studies have been conducted to investigate the beneficial effects of STEAM education at various levels, such as the impact of STEAM education on high school students' grades and career choices and the disposition of elementary and middle school students toward STEAM (Han, 2017). However, studies that address STEAM education from different perspectives in early childhood education are limited. Therefore, the current research aimed to understand the perspectives of teachers and children towards the STEAM approach in early childhood education.

The Current Study

Uncovering the problems in integrating different disciplines in STEAM into the early childhood education environment requires an in-depth evaluation of the participants' perspectives on the STEAM approach. In the current study, we aimed to develop a broader perspective by looking at this issue not only from the perspective of teachers but also from the perspective of children, and therefore we applied qualitative methods (Creswell, 2013). In this context, the

research question was defined as follows: What perspectives do teachers and children have on the use of the STEAM approach in early childhood education?

Methods

This research was designed as a qualitative study to examine in detail the perspectives of teachers and children attending preschool education institutions about STEAM education. Qualitative research follows a process in which data on the research subject is collected using qualitative data collection methods and then presented realistically and holistically (Creswell, 2014). Analysing teachers' and children's views on STEAM activities requires uncovering the complex situations that constitute these views. Considering that analysing these complex situations requires an in-depth study, qualitative methods were used in the current research (Creswell, 2014).

Participants

The criterion for determining the participants in this study is that the participants must be active teachers with the necessary diplomas to work in preschool education institutions. The criterion determined for children participants was that they were 36-72-month-old children attending a preschool education institution. Within the scope of the research, 35 teachers and 73 children who met these criteria participated in the study voluntarily.

As shown in Tables 1, 97.1% were female, 80% of the teachers included in the study had bachelor degrees, 14,3% had master's degrees and 5,7% had associate degrees. 74.3% of teachers had graduated from the Department of Preschool Education and 25,7% graduated from the *Department of Child Development and Education*. Additionally, 60% worked in independent kindergartens run by the Ministry of National Education, 31.4% worked in kindergartens in MEB Primary School and 8,6% worked in private kindergartens.

A total of 73 children aged 36 to 72 months who were randomly chosen from their classrooms and 35 teachers who worked in public, private, and kindergartens connected to the Ministry of National Education (MEB) in the province of Istanbul were researched. Girls made up 52.1% ($n=38$) of the preschoolers in the study, while boys made up 47.9% ($n=35$). The general traits of teachers are shown in Table 1.

Data Collection Tools and Process

In the current research, semi-structured interview forms were prepared based on the previous research on STEAM. In addition, we received the opinions of field experts working in early childhood education programs at a university. Eight interview questions were developed to obtain information about teachers' knowledge of STEAM education, the activities they include in STEAM education, how competent they consider themselves in STEAM, and the problems and challenges they encounter during STEAM activities. Five interview questions prepared for children were designed to determine the topics they are most curious about and the activities they enjoy most about STEAM.

The research data collection process started after permission was received from the university ethics committee and the Directorate of National Education. The researchers contacted the school administrations and, after obtaining permission from the school principals identified teachers and children in their classrooms who wanted to participate voluntarily. All teachers and the children's parents/guardians were informed about the research and, teachers and the child's parent/guardian filled out a consent form. The researchers provided sufficient information to the participants that they would not share the data obtained with anyone else and could withdraw from participating at any time. Afterwards, the teacher interview forms were delivered to the teachers in a sealed envelope and received in a closed envelope after completing the filling process. One-on-one interviews were conducted with the child participants. The researchers requested a quiet area separate from the classroom to conduct the interviews. The children with consent, were previously informed by the researchers and the teacher about the research process and were taken to the interview individually. Two researchers conducted each interview to record the children's answers entirely. One researcher asked

Table 1 Education level of the teacher participants (%)

	N	Percent
Female	34	97,1%
Male	1	2,9%
MEB* Independent Kindergartens	21	60%
Kindergarten in MEB Primary School	11	31,4%
Private Kindergartens	3	8,6%
Department of Preschool Education	26	74,3%
Department of Child Development and Education	9	25,7%
Bachelor Degree	28	80%
Masters Degree	5	14,3%
Associate Degree	2	5,7%

*MEB: Republic of Türkiye Ministry of National Education

the interview questions to record the children's statements, while the other recorded the children's responses in writing.

Data Analyses

The data collected through written records were examined by content analysis with the open coding system in qualitative research methods. Content analysis is the systematic transformation of collected data into meaningful themes with the help of coding (Cavanagh, 1997). All data were transcribed simultaneously by three researchers, and then the data were organised by replacing participants' names with participant IDs to ensure confidentiality. We created a verbatim transcript of each participant's responses by reading and annotating all transcripts line by line to generate initial codes. These initial codes were organised into meaningful themes. In describing the phenomenon and analysing the data, we used the process of bracketing (epoche), setting aside our perceptions and opinions (Creswell, 2013). We considered that each coded data reflected the participants' perspectives on the STEAM approach. To ensure the reliability of the codes, the researchers conducted the open coding process together. In addition, the newly created meaningful themes were controlled for the research aim. The reliability of the data was ensured using the strategy of spending sufficient time in the context of the setting and participants to understand the phenomena of interest, which is a strategy for building credibility/trust in qualitative data (Krefting, 1991; Lincoln & Guba, 1985). The researchers applied this strategy by giving the participants enough time to answer the semi-structured interview questions and ensured the reliability of the research.

Results

According to the findings of this study, six major themes emerged from the examination of data collected from teachers. Table 2 shows these themes and their explanations.

Theme 1: What Is the Teacher's Knowledge of STEAM?

This theme demonstrates teachers' current understanding of STEAM methodology. The majority of teachers ($n=23$, 65.7%) in the present study stated that they knew the STEAM approach. Although, some teachers ($n=7$, 20%) claimed that they were unfamiliar with the STEAM approach. Examples of a teacher's perspectives on STEAM as follows: "It is a collaborative approach that promotes problem-solving and learning opportunities." "It is an approach that aims to help children solve the problems they encounter in their daily lives by making use of subjects in the fields of science, technology, engineering, and mathematics." "It is an education system that increases children's ability to think differently and search for new solutions to problems." "It is an interdisciplinary education model that supports the development of children in many areas and facilitates the upbringing of children who are inquisitive, curious and creative."

Theme 2: Materials Used in the Teacher's STEAM Activity

This theme depicts the resources used by teachers in STEAM activities. In the current study, the majority of teachers ($n=25$, 71.4%) said that they employed science resources in STEAM activities. Some of the teachers in the current study ($n=16$, 45.7%) used mathematics materials in STEAM activities. In contrast, some ($n=11$, 31.4%)

Table 2 The themes and explanations of the teachers

Theme 1: What is the teacher's knowledge of STEAM?	It demonstrates teachers' understanding of the STEAM methodology.
Theme 2: Materials used in the teacher's STEAM activity	Identifies the resources used by teachers during STEAM activities.
Theme 3: The type of activity used by the teacher and Practice areas for teachers	It specifies the types of activities teachers use when teaching STEAM ideas and abilities and indicates which STEAM fields the teachers use activities in.
Theme 4: Resources for STEAM activities for teachers	Indicates the resources that teachers use while planning STEAM activities.
Theme 5: Teachers' confidence in their ability to participate in STEAM activities	It indicates whether the teachers feel adequate at the point of applying STEAM activities.
Theme 6: How to Solve STEAM-Related Issues?	It presents teachers' perspectives on how to handle challenges encountered when planning STEAM activities.

used engineering materials for the related question and, some of them (n=7, 20%) used computer and projection technology materials for the related question. Furthermore, the least (n=6, 17.1%) common materials used by teachers are art materials. Examples of a teacher's perspectives on this theme as follows: "As a preschool teacher, I prefer to use scales, rulers, compasses, and number puzzles as math materials in STEAM activities." "I prefer to use computer and projection in my classroom." "I prefer to use raft materials, play dough, wood materials, metal, batteries, simple and waste materials." "I prefer to use world model, magnifying glass, human body puzzle, scale, meter, plants, weather graph, number puzzles, construction materials".

Theme 3: The Type of Activity Used by the Teacher and their Practice Areas

This theme illustrates the different sorts of activities that teachers utilize when teaching STEAM concepts and abilities. This theme also represents teachers' knowledge of the places where STEAM activities are practiced. The majority of teachers (n=26, 74.2%) reported that while they used STEAM activities in the field of mathematics, they also used STEAM activities in the field of science (n=25, 71.4%). Also, teachers claimed that in the current study (n=22, 62.8%) used scientific activities, (n=13, 37.1%) math activities, (n=6, 17.1%) game activities, (n=4, 11.4%) art activities, and (n=4, 11.4%) claimed that they used music activities, respectively. Despite this, teachers reported using drama exercises in the classroom (n=3, 8.6%). Examples of a teacher's perspectives on this theme are as follows: "I include coding in math exercises." "I make an effort to involve children when I undertake age-appropriate science activities." "I prefer to plan construction activities using leftover materials to make miniatures of technological products." "I use integrated activities, science, mathematics, music, drama, language, and play activities." "I usually give coding activities as weekend homework and support them with experiments. ".

Theme 4: Resources for STEAM Activities for Teachers

This theme highlights the materials that teachers use when planning STEAM activities. The majority (n=23, 65.7%) of teachers in this study reported using the Internet. Some teachers (n=7, 20%) claimed that they gained knowledge via books or articles. Some teachers (n=6, 17.1%) said they received no benefit from any source, while the fewest (n=4, 11.4%) said they received an advantage from social media. Examples of a teacher's perspectives on this theme as follows: "Publications and academic works that create preschool activities are helpful to me." "I benefit from the comments of more experienced teachers." " While preparing stem activities, I get support from the internet and stem-related sites." " I look at sample studies that I can do from the internet."

Theme 5: Teachers' Self-Confidence in their Ability To Participate in STEAM Activities

This theme reveals whether or not teachers believe they are proficient in STEAM activities. The majority of the teachers (n=22, 62.9%) reported feeling inadequate when applying STEAM activities to the associated subject. While some teachers in the current study (n=7, 20%) reported feeling competent while implementing STEAM activities, others (n=6, 17.1%) reported feeling just moderately competent. Examples of a teacher's perspectives on this theme as follows: "I don't feel confident. I didn't go through any STEAM-specific training." " I'm attempting to put everything I've learned into practice. " "I feel confident. I plan activities that are appropriate for children's ages and developmental stages." " I need more information to be able to teach and apply this system." "I am trying to follow the subject by researching and training in my own way. If education is a process, I think I should continue on my way without ever saying yes I am enough. Otherwise, I will stop researching.‘’.

Theme 6: How To Solve STEAM-Related Issues?

This theme reflects teachers' perspectives on how to handle challenges encountered when planning STEAM activities. In the current research, the majority of the teachers (n=18, 51.4%) in the current study felt that the difficulties may be remedied in different ways. Some teachers (n=12, 34.3%) stated that difficulties may be solved by offering training. Some of the teachers (n=8, 22.9%) suggested offering material assistance, while others (n=5, 14.3%) suggested donating resources. Examples of a teacher's perspectives on this theme as follows: "I can receive STEAM training and add more activities." "I can deepen my understanding by taking part in a STEAM model training." ‘’I have difficulty in finding activities. I have difficulty in designing materials. There may be a sample site or platform for this. Like a monthly stem magazine. Or a stem website. Or a book for teacher and child. Maybe the Ministry of Education can provide training. Like in-service training like seminars. " "It could be a stem set containing materials or giving examples." "I usually design my environment and activities with what I have. My parents are always supportive. My school administration is very forward-thinking in this regard. I am lucky.‘’.

Table 3 The themes and explanations of children

Theme 1: What the child is curious about related to STEAM	
a.Science-related topics (plants, animals, space)	It represents the kinds of questions that preschool children have about plants, animals, and space.
b.Construction related topics	Describes what preschool children construct with blocks.
Theme 2: The type of activity that the child enjoys	Indicates the types of activities that preschool children enjoy doing.

According to the findings obtained from the perspectives of children participants in the current study, two major themes emerged. Table 3 shows these themes and their explanations.

Theme 1: What the Child Is Curious about Related to STEAM

This theme highlights the things preschool children are curious about in STEAM methodology. It reflects children's interests on the questions they have about plants, animals, space and construction.

Theme 1.a: Science-Related Topics (Plants, Animals, Space)

This sub-theme represents the kinds of questions that preschool children have about plants, animals, and space. In the current study, most children (n = 20, 27.4%) expressed their curiosity about plant growth. The answers to this question are presented in brackets (e.g., "How do plants grow? "How do trees grow thick without falling?" "How do plants grow with water?" "Why can't plants walk? Are they alive?). Most of the children (n = 17, 23.3%) were intrigued by flowers (e.g., "Where does the smell of flowers come from?" "Do the leaves get cold when they fall?"). Some (n = 9, 12.3%) questioned plant leaves (e.g., ''Why are pine tree leaves pointed? How do flowers shed their petals?" Why aren't the leaves green in the fall? What do the street cleaners do when they pick up the leaves?)''), and some (n = 5, 6.9%) wondered about plant nutrition (e.g., ''How do plants drink water?''). The fruits of plants are the least exciting (n = 3, 4.1%) question children have.

The majority of children (n = 33, 45.2%) in the current study expressed their interest in animal traits (e.g., "How do dogs sense smells? Why do fish have gills? Why do wolves howl at a full moon?" ''How do cows make milk?'' ''Why do kittens meow so much?''). Children in the study (n = 14, 19.2%) were curious about the type of animals (e.g., "How many types of dinosaurs are there? I'm curious about roosters and hens."), (n = 13, 17.8%) were curious about the look of animals (e.g., "Why do cats have small ears and dogs have big ears? How are lions' manes formed?" "How big does a giraffe grow, and how big is its mouth?), and (n = 10, 13.7%) were curious about animal feeding (e.g., ''What do elephants eat?" '' Why do rabbits eat so many carrots?" "How does the panda chew bamboo?" "What is the peacock's food?).

The majority of children (n = 27, 37%) in the current study expressed their interest in stars and their features (e.g., ''How do the stars shine? How many kinds of stars are there? Doesn't their light ever end?'' ''How many kinds of stars are there? Does their light never end? Do stars die?). Children (n = 26, 35.6%) were curious about the planets (e.g., "Why is Neptune big, ringless, and what colour is it? Is there water on Mars?" "What are the colors and temperatures of the planets?" "Why is Jupiter the biggest planet and why is Mercury so hot?), (n = 18, 24.7%) were curious about space (e.g., ''Is there air in space? Can we jump in space?" ''How can I see space?'' ''Why is space dark?'' ''How is garbage thrown into space?''), (n = 11, 15.1%) were curious about the spaceship (e.g., "How do you go into space with a rocket? I'm curious about the space buggy and the interior of the car"), (n = 10, 13.7%) were curious about the moon (e.g., "Why is the moon white? Why do we see the moon at night?"), (n = 8, 11%) were curious about the sun (e.g., "How old is the sun? How does the sun shine? Does it go into space when the sun disappears?"). The question that children wonder least (n = 7, 9.6%) is about the astronaut (e.g., "Why do astronauts wear different clothes when they go to space? How do astronauts jump in space?").

Theme 1.b: Construction-Related Topics

This sub-theme describes what preschool children construct and enjoy building with blocks. Most children (n = 44, 60.3%) in this study said they enjoy constructing dwelling areas out of blocks. Some of the children (n = 21, 28.8%) indicated that they created towers with blocks, automobiles with blocks, and products with blocks.

Theme 2: The Type of Activity that the Child Enjoys

This theme indicates the types of activities that preschool children enjoy doing. Some children (n = 11, 15.1%) in the current study said they enjoyed balloon experiments. Also, some of the children (n = 11, 15.1%) reported that they enjoyed colour experiments, water experiments (n = 10, 13.7%), slime experiments (n = 9, 12.3%), and food experiments (n = 3, 4.1%).

The majority of children ($n=52$, 71.2%) in the current study said they enjoyed doing arts and crafts. Most of the children enjoyed ($n=33$, 45.2%) the play activity, ($n=15$, 20.6%) the Turkish-language activity, ($n=13$, 17.8%) the math activity, ($n=7$, 9.59%) the music activity, ($n=7$, 9.6%) the scientific activity, and ($n=4$, 5.5%) the drama activity, respectively.

In the classroom, teachers mostly do apply math and scientific activities. However, the children prefer playing, making art, and other creative pursuits. Children ($n=52$, 71.2%) mentioned that they enjoy engaging in art activities the most. Children are more exposed to art activities as a result, and they enjoy them. Children's interest in STEAM subjects may rise if teachers do experiments relating to it. STEAM is more than just science, technology, engineering, and math. It ought to be applied to and integrated into the creation of art because children enjoy arts and crafts. However, using it in conjunction with STEAM rather than just using it for an art exercise may increase children's interest more.

It can also be said that children are quite interested in learning about scientific topics. Children are interested in a wide range of topics, from their immediate environment to animals, plants, and outer space. For this reason, giving more space to STEAM activities can satisfy children's curiosity. In the current research, according to the results in theme 3, teachers mostly prefer math and science activities in the classroom. However, greater time should be allotted for engineering and technology. Activities that combine play and artistic endeavours might be used for this.

Discussion and Conclusion

This study aimed to research the perspectives of teachers and children towards the STEAM approach in early childhood education. We gathered data on the perspective of the teachers' perspective about the knowledge of STEAM, the materials used in the STEAM activity, the type of activities, resources for STEAM activities, self-confidence in their ability to design and implement STEAM activities, and how to handle challenges when planning STEAM-related activities.

The result of this study showed that teachers need help regarding STEAM and STEAM-based course activities. In addition, the majority of the teachers claimed to be familiar with the STEAM approach. However, they admitted to being unqualified to apply STEAM activities in the classroom. Although STEAM is increasingly common in the educational community, teachers' interpretations could differ (Alghamdi, 2023. For instance, Simoncini and Lasen (2018) used a survey to look at the perspectives of 117 Australian teachers. STEAM was identified as a distinct field in 62% of the replies. Sixty per cent of the 117 teachers mentioned the importance of fostering students' skills in observation, experimentation, and inquiring, 39% discussed laying the groundwork for young children's later academic achievement, 13% talked about preparing students for future professional opportunities and issues facing society, and 12% connected STEAM to creating engaging and fun learning environments. Alghamdi (2023) found that teachers lacked appropriate knowledge and comprehension of STEAM instruction. Only one-quarter of the teachers said they fully knew how to include various STEAM activities into their curriculum and had a solid understanding of basic tactics for incorporating STEAM topics.

The current study found that teachers do not respond positively to planning and implementing STEAM activities in their classrooms. Teachers often lack self-confidence and their unfamiliarity with STEAM may cause them to not prefer applying this approach in daily programmes. Additionally, most of the teachers struggle to access STEAM resources. This problem may cause them not to organize and carry out STEAM-related activities in their classrooms. Similarly to this result, Park et al. (2017) examined 830 American teachers from preschool to third grade, 30% of the teachers expressed their concerns about the suitability of the STEAM curriculum for pre-schoolers. The use of STEAM in preschool classrooms because the concept of incorporating STEAM education into the setting classroom is still relatively new in educational implementations (Park et al., 2017). Because there may be difficulties in integrating this approach into early childhood settings and developing activities effectively at the early childhood level. In recent years, STEAM has received more attention in educational research (Takeuchi et al., 2020). Since 2007, there has been a notable increase in the number of peer-reviewed English publications on STEAM education (Takeuchi et al., 2020). However, in some non-western countries, STEAM research and practices slowly increasing exponentially (Gulhan, 2022). As an example, Cavas et al. (2020) found that no strategic action plan has been prepared by the Ministry of National Education for STEAM education in Turkey since 2015. Accordingly, integrating STEAM into education policies, including it in educational objectives and making it widespread in schools could be still a new issue, especially in early childhood education.

As another finding of the current study, teachers spent little time on STEAM implementation. We may interpret that obstacles and challenges will arise during STEAM activities (Wan et al., 2021). As Park et al. (2017) mentioned, one reason could be that school administrators prioritized students' reading, writing, and comprehension skills over STEAM skill development. The school leaders might provide these topics to teachers as professional development opportunities

rather than STEAM. Similarly, Alghamdi (2023) found that teachers were quite familiar with the term STEAM but had little awareness of the integration process, as well as the basic methods and abilities required for implementation. A significant majority of the teachers felt that they required more professional development and training to properly incorporate STEAM subjects into their courses.

In the current study, we found that teachers hardly spend time on engineering and technology in the context of the STEAM approach. Instead, they included activities, particularly in science and math. One reason could be that teachers carry out these activities merely to adhere to the daily programme. However, if teachers used STEAM activities more frequently, they could positively affect motivation towards the learning process. STEAM may be a good technique for increasing both school motivation and willingness to perform (Conradty & Bogner, 2020). According to the Bioecological Systems Theory, teachers within the microsystem are among the elements that most affect children's development and learning (Bronfenbrenner & Morris, 2006). According to DeJarnette's (2018) observations, students were too eager to participate in the STEAM learning centre after participating in the hands-on STEAM-inspired sessions; they were grinning and chatting animatedly the entire time there. Just a small minority of teachers (6.79%) demonstrated STEAM as a combined approach to teaching, while a sizable number of teachers (62%) regarded STEAM as a separate discipline (DeJarnette, 2018). Providing professional development opportunities for the STEAM approach in early childhood education may help teachers integrate the STEAM approach effectively.

Another finding worth discussing was that teachers often do not feel qualified and do not have enough information about STEAM. It has been discovered that teachers lack self-confidence in teaching STEAM to students (Butera et al., 2016) since they typically have fewer qualifications in the four STEAM fields (Aldemir & Kermani, 2017). One reason could be they cannot devote enough time to implementing the STEAM approach rather than continuing with traditional practices. They did not receive any preservice training. The qualifications of teachers need to be raised. They need to receive STEAM-based in-service training. Similar to the current study, previous studies have also revealed teachers' professional development needs (Alghamdi, 2023). Practical training that will enable teachers to feel competent in STEAM-related activities may be beneficial. This might also help them to develop self-esteem during the teaching process. Chen et al. (2021) discovered that teachers with high self-esteem are more confident in STEAM education.

The current study highlighted that there are various problems with accessing training and receiving material support and resources. Likewise, in the study of Baigiati and Evangelou (2015), teachers reported several difficulties with teaching STEAM in the early childhood setting, including practical issues (such as lack of time, instructional resources, administrative support, and collegial support), teacher capacity issues (such as difficulty handling curriculum developed by researchers, lack of subject knowledge, and professional development needs), and student-related issues. Similarly, Park et al. (2017), teachers complained about insufficient instructional resources.

In summary, in the current study, teachers mentioned some problem areas in integrating the STEAM approach in early childhood education. DeJarnette's study (2018) stated that although teachers thought STEAM education was important, they felt they were not ready to implement STEAM activities with their young students. The lack of teacher training programs was also mentioned by Park et al. (2017). As a result of a lack of professional growth, they revealed that teachers lacked the skills required to apply STEAM in their classrooms. As indicated in a study with teachers the results implied that although this professional development program could to some extent enhance teachers' content knowledge and dispositions toward STEAM within two days, teachers' self-efficacy in implementing STEAM activities was still rather weak. (DeJarnette, 2018). Despite having a favourable attitude toward professional development programs, teachers were hesitant to implement STEAM teachings to their students (DeJarnette, 2018). The lack of resources was another issue frequently addressed (Jamil et al., 2018). Teachers' hesitancy could be related to their imperfect comprehension of the STEAM idea. Even for teachers who felt confident about how STEAM education was integrated, they still lacked a clear understanding of how it might be realized at multiple stages and which levels could be realized in the early childhood environment. As argued in the introduction, STEAM can be both a collective name for Science, Technology, Engineering, and Mathematics and an integrative approach to teaching and learning. The understanding of this approach may be more important since it distinguishes STEAM from the traditional subject-based curriculum. However, as indicated in the interviews of Simoncini and Lasen (2018), a small number of early preschool teachers mentioned STEAM as an integrated approach to teaching.

Another purpose of the study was to gather information about children's perspectives on what they are curious about STEAM and the type of activities that they enjoy most. Data showed most of the children were curious about plants and animals. They were fascinated by how plants and flowers develop. They were curious about the species, nutrition and physical characteristics of animals. We also received the answers regarding the moon, sun, stars and space. Their

favourite structures to construct were that resembled things and occasions from their daily lives, such as homes, parking lots, and automobiles.

We also found that the activities that children loved to do at school were art and play activities. We may interpret that children are increasingly exposed to art activities, which they appreciate. According to Bronfenbrenner's ecological theory (Jordan, 2004, as cited in Bronfenbrenner, 1998), the school environment within the microsystem affects the child's development and learning and could determine their preferences. For this reason, the activities the teacher frequently uses may also be the activities the children prefers most. Children's interest in STEAM activities may increase if teachers allocate more time to those activities. If teachers could integrate arts and crafts activities, children may be more interested in STEAM-related topics. Also, the results showed that children have a high interest in play activities. So, if teachers blend play and the disciplines in STEAM in their curriculum, education will be more productive both for children and teachers (Conradty & Bogner, 2020).

The early childhood years are important for building the framework for future STEAM learning, and instructors can engage children in STEAM activities that capitalize on children's prior experiences, knowledge, and interests (Margot & Kettler, 2019). Early meaningful scientific experiences have been found to increase young children's self-belief in their ability to learn, and trigger an appreciation for STEAM (Fleer et al., 2006).

Limitations and Future Directions

The current study has some limitations that one should consider. First, in this research, we collected data with open-ended questions according to the perspectives of teachers and children. Future research may use multiple data collection methods, such as quantitative and mixed methods. Second, our data were collected from only one central city. Including children and teachers from different regions in future studies may be necessary for generalizing the research results. Finally, we followed the one-shot data collection procedure in the current study when determining teachers' and children's perspectives. This situation may limit our ability to assess our participants' views objectively. Future studies may overcome this limitation with longitudinal data collection procedures.

In light of these limitations, we propose that future studies look at approaches to enhance teacher professional development with the objective of boosting teacher efficacy in implementing STEAM in the classroom. Specifically, future studies might examine targeted training programs and the efficacy of specialized training programs that incorporate STEAM principles into early childhood education. These programs should take into account the different degrees of experience and familiarity that instructors have with STEAM subjects. Also, future studies might investigate the impact of forming collaborative learning communities or professional learning networks among teachers so that they may exchange best practices, resources, and issues connected to STEAM education. On the other hand, future studies might investigate the creation and implementation of STEAM curriculum built particularly for early childhood educators, including child-age-appropriate resources and teaching methodologies. Future studies might understand how teacher confidence affects student engagement and learning and can help guide professional development initiatives.

By addressing these issues, future research can contribute to a better understanding of how to successfully support early childhood educators in their attempts to apply STEAM education, thereby improving young children's learning outcomes. Despite all these limitations, the current research can support our understanding of the dissemination of STEAM education in early childhood and how to support teachers who play a vital role in this regard.

Appendix A. Interview Questions for Teachers

Q1. What do you know about STEAM (Science, Technology, Engineering, Mathematics)?
Q2. What kinds of materials do you have in your classroom that are appropriate for STEAM fields?
Q3. What types of activities do you use to include STEAM-related concepts and skills in the education process?
Q4. Which of the STEAM fields do you mostly conduct activities for? Why?
Q5. Where do you get support when preparing STEAM activities?
Q6. How do you think concepts related to STEAM fields can be taught better?
Q7. Do you feel competent in implementing STEAM activities? Why?
Q8. How can the problems you encounter while preparing STEAM activities be solved?

Appendix B. Interview Questions for Children

Q1. What are you curious about about plants and animals?
Q2. What are you curious about about space?
Q3. What do you like to build in the class?
Q4. What experiments do you want to do more of at school?
Q5. What are your favourite activities to do at school?

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Declarations

Ethical Approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declare that they have no conflict of interest.

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