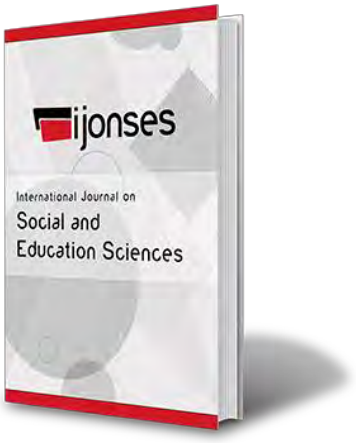

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Reflections of STEAM Education on Children According to Early Childhood and Primary School Teachers

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Reflections of STEAM Education on Children According to Early Childhood and Primary School Teachers

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Abstract

In this study, we examined STEAM education's reflections and implicit functions on children according to the views of early childhood and primary school teachers who applied STEAM education. We conducted the study within the scope of phenomenology design, one of the qualitative research designs. The participants were ten teachers who had previously received STEAM education and applied STEAM education in their classroom and were determined by the snowball sampling method. We collected the data with semi-structured interviews and analyzed them with content analysis. We explained our findings with three themes: 1) opportunities for collaborative learning with peers, 2) values, and 3) opportunities for skill development. According to the results, STEAM education encouraged children to make friends, work together, have fun, develop positive commitment, and take responsibility. STEAM education enabled children to cooperate, share, take responsibility, and develop friendships among children. In addition, STEAM education contributed to many skills of children, such as empathy, problem-solving, scientific process, analytical thinking, aggressiveness, self-control, and critical thinking. In this respect, the study provides evidence for the illusions of STEAM education for children.

Introduction

Each new phase of life carries the traces of the previous one (Berk, 2013; Bredekamp, 2015). In this respect, the skills gained in the early years and primary school period form the basis for the secondary school period and the rest of life. Therefore, the skills children need in their early years should be supported. To support these skills, STEM (Sneideman, 2013), an integration-based thinking process that includes science, mathematics, technology, and engineering disciplines, draws attention to offering an interdisciplinary perspective to education and having the potential to meet today's needs. STEM is built on the idea that disciplines cannot be thought of independently because they coexist in nature (Moomaw, 2013). Integrating the disciplines in question (science, mathematics, engineering, technology) is essential in preparing children for the century they are. STEM education supports children's achievements by developing problem-solving, collaboration, scientific process, and design thinking (Bender, 2018; Bureekhampn & Mungmee, 2020; NRC, 2011). In addition, STEM education plays an essential role in economic development and shaping culture with its integrated structure (Cooper & Heaverlo, 2013).
Experience-based education offers active learning opportunities by putting individuals at the center of learning

(Dewey, 2016). In this respect, STEM education helps students to make the learned knowledge experiential, understand interdisciplinary interaction, and to establish the connection between engineering and science (STEM National Education Report, 2017). When the literature is examined, it is seen that STEM education supports many skills, including 21st-century skills of individuals (NRC, 2011; Slough & Milam, 2008; TÜSİAD, 2014). These skills are problem-solving, innovative, and creative thinking, self-confidence, logical thinking, scientific process skills, critical thinking, analytical thinking, and identifying relationships between concepts (Bender, 2018; Bybee, 2010; Bureekhampn & Mungmee, 2020; Stohlmann, Moore, Roehrig & McClelland, 2011; Roterham & Willingham, 2010). In this respect, studies have proven that STEM education contributes to many skills of individuals (Başaran & Erol, 2021; Breiner, Harkness, Johnson & Koehler, 2012; Erol, 2021; Erol, Erol & Başaran, 2023; Popa & Ciascai, 2017). In addition, studies emphasize that education should be started from early childhood (Brenneman, Lange & Nayfeld, 2019; Tippett & Milford, 2017; Quigley & Herro, 2016).

Recently, "art" has been included in STEM in line with the criticisms regarding the lack of creativity and innovation in STEM education (Conradty & Bogner, 2018; Daugherty, 2013). Adding art to STEM disciplines is a way to make math, science, technology, and engineering more interesting for students (Peppler & Wohlwend, 2018). Art integration is consciously combining ideas and skills from the arts with other disciplines to open new ways of experiencing or gaining knowledge. Art integration offers new ways to represent knowledge and understand complexity (Peppler & Wohlwend, 2018; Wahyuningsi et al., 2020). STEAM education emphasizes interdisciplinary collaboration and links between standards and assessments in the arts and other disciplines.

The primary purpose of STEAM education is to enable children to establish relationships between concepts and to develop critical thinking, collaboration, problem-solving, and creativity skills for children to understand STEAM areas (DeJarnette, 2018). Studies focus on how STEAM education supports children's creative problem-solving skills, improving their knowledge, skills, and meanings and solving 21st-century problems (Liao, 2016). STEAM applications also develop curiosity, creativity, or collaboration skills that directly affect learning (Chesloff, 2013). STEAM education contributes to children's academic success at the next level (Morgan et al., 2013). In addition, a study determined that children's communication, cooperation, and creativity skills improved through dance-integrated robotic applications (Sullivan & Bers, 2018). These results are essential for the effectiveness of STEAM education.

In the context of discussions, in this study, we determine the reflections and implicit functions of STEAM education on children from the perspective of teachers who apply STEAM education with children in their classrooms. One reason for this is that the teachers who implement the education in question know the children better and make more effective decisions about the change in children after the implementation, rather than using various measurement tools because activities applied outside the intended target during STEAM education can bring many values and skills to children. For example, a researcher researching STEAM education's creative thinking and problem-solving skills (Erol, Erol, & Başaran, 2023) can implicitly impart cooperation, communication, positive peer relations, and social values to children, apart from the purpose they aim for. At this point, it is crucial to determine the opinions of teachers who apply STEAM education in their classrooms to determine the implicit functions of STEAM education. Many studies demonstrate STEAM education's

effectiveness (Basaran & Erol, 2021; Morgan et al., 2013; Sullivan & Bers, 2018). However, according to the teachers who apply STEAM education, it is not focused on the children's achievements. This study aims to contribute to this direction. Within the scope of the study, we seek answers to the following sub-questions.

1) According to the teachers, what are the reflections of STEAM education on children's peer relations and collaborative learning?
2) According to the teachers, what are the reflections of STEAM education on children's learning of values?
3) According to teachers, which skills does STEAM education contribute to children?

Method

Model of The Research

Since the study was structured in the context of teachers' views on the reflections of STEAM education on children and its implicit functions, we conducted the research within the scope of phenomenology design, one of the qualitative research designs. Phenomenology examines and explains experiences, concepts, events, and situations (Creswell, 2013; Merriam, 2018). For this reason, we preferred the phenomenology design to determine the structures, such as skills and values teachers think STEM education used in their classrooms has developed in children other than the intended purpose.

Participants of The Study

We identified early childhood and primary school teachers who had implemented STEAM education activities before starting the research. The children's ages in the teachers' classrooms range from 5 to 9. The participants consist of 10 teachers working in different districts of Istanbul who received STEAM education and applied it in their classrooms. We determined the participants of the study with the snowball sampling method. In this sampling, a reference person is selected regarding the subject of the study, and other people are reached through this person (Biernacki & Waldorf, 1981). Demographic information of the participants is presented in Table 1.

Table 1. Descriptive Information on Participants

Participant code	Age	Professional seniority	Gender	District where he served	Grade level of STEM education
K-1	29	5 years	Female	Esenler	Preschool Age 5
K-2	31	7 years	Female	Zeytinburnu	Preschool Age 5
K-3	33	9 years	Male	Esenyurt	Primary School 3rd Grade
K-4	28	5 years	Male	Avcılar	Primary School 4th Grade
K-5	34	12 years	Male	Başakşehir	Primary School 3rd Grade
K-6	35	13 years	Female	Beşiktaş	Preschool Age 6
K-7	28	4 years	Female	Güngören	Primary School 1st Grade
K-8	29	5 years	Female	Şişli	Preschool Age 5
K-9	31	6 years	Female	Bahçelievler	Primary School 2nd Grade
K-10	32	9 years	Female	Sarıyer	Primary School 4th Grade

Data Collection and Research Context

The study used a semi-structured interview form as a data collection tool. A semi-structured interview is an interview method in which the researcher asks predetermined questions, allowing the researcher to ask different probe questions during the data collection process (Merriam, 2018; Patton, 2015). The relevant literature was examined during the interview form development process, and 11 interview questions were prepared. We sent the prepared interview questions to 2 primary school teachers and four academicians with doctoral degrees in Turkish language and classroom education to get an expert opinion. As a result of the feedback from the experts, we changed some questions and made a pilot application by removing two questions. Thus, we both measured the clarity of the questions and gained experience before the actual application. To increase the richness of data in the interview questions and to deepen the participants' views, we asked some questions described as probes by the flow of the research.

We examined the inter-coder agreement regarding the interview form with Miles & Huberman's (1994) formula. We determined it as .85. In the final version of the form, there are nine open-ended questions (For example, which learning does STEAM education services other than your purpose? Can you explain? What kind of skills does STEAM education serve to support children? Can you explain with examples? How does the STEAM education process support peer relations?). We had face-to-face interviews with the teachers and recorded the interviews with a voice recorder. The interviews lasted approximately 35 minutes. Half of the teachers who applied STEAM education in their classroom or STEAM education in a different classroom applied this education within the scope of their master's or doctoral theses. The other teachers received this training in national education or a different field and implemented them in their classrooms. All teachers who participated in the study had STEAM education or a certificate.

Analysis of Data

We analyzed the data we obtained through the semi-structured interview form with the content analysis method during the research process. Content analysis is scanning qualitative texts in line with repetitive words and themes, reducing it to any qualitative data, and making sense of it (Patton, 2015). In line with the content analysis, we first read all the data and applied this process repeatedly. In the second stage, the data were coded, and we reached the themes by associating the codes. In this direction, we created coding in the form of small notes in the study. We created themes (categories) by combining repeated coding. Data analysis in phenomenological research is divided into intentional extraction, creative variation, and intuitive research. We used creative variation in this research (Merriam, 2018). In this direction, we made abstraction by using an inductive method to reach the coding from the data and the themes from the coding in the data analysis. We did not specify the participants' identities in the research and presented them by coding with "P." For example, “K-1” represents the first participant, K-2, the second participant…… "K-10" represents the tenth participant.

For data analysis, we first transcribed all interview recordings. We read the transcripts and identified statements about the experience. We have listed all the variables related to the relevant phenomenon. We then removed the

variables unrelated to the research phenomenon and identified the overlapping variables. We grouped the variables with the same meaning and formed the units of meaning. We then created a conceptual framework of the phenomenon and expressed it through three themes (see findings). In addition, the themes obtained from the analysis processes were presented under the headings in the findings section, and we discussed them with other study findings in the literature.

Reliability and Validity

Different strategies were followed in the research to obtain valid and reliable data. First, we determined participation in the research voluntarily. In addition, we reflected the research findings to the research under a pseudonym without giving the names of the participants. In addition, to ensure validity, the data were recorded with a voice recorder to prevent data loss, independent researchers checked the data, detailed descriptions were made, and the analyzes were supported with one-to-one quotations from the teacher's statements. We checked the transferability of study findings for different situations. The study examined the coding and theme creation at different times regarding similarities and differences in the later analyses. Thus, we cross-checked the compatibility between the coders and provided coordination. We also used data sources and researcher triangulation (Stake, 2010) to ensure the validation of data from participants.

The Role of Researchers and Ethics

Before starting the study, we obtained approval from the university's social and human studies ethics committee. We also obtained verbal and written consent from the participants and informed them that their interviews would be audio-recorded. We informed the teachers about the confidentiality of the research data. We also informed them that they could leave the study any time and not discuss questions they did not want to answer. During the data collection process, we ensured that the interview occurred objectively. In this direction, we took care not to judge the behavior and words of the participants and not to create expectations in them.

Results

In this study, the reflections of STEAM education on children were examined in the context of the views of early childhood and primary school teachers. According to teachers, STEAM environments do not only serve predetermined purposes. At the same time, STEM environments implicitly impart peer relations, skill teaching, and value education to children. According to the teachers, STEAM education serves not only cognitive, academic success, and permanent learning but also develops children's peer relationships directly or indirectly with STEAM. Three themes were identified in line with the teachers' opinions:

1) opportunities for collaborative learning with friends,
2) values, and
3) opportunities for skill development.

Detailed data on these themes are presented in Figure 1 based on the context of teacher opinions.

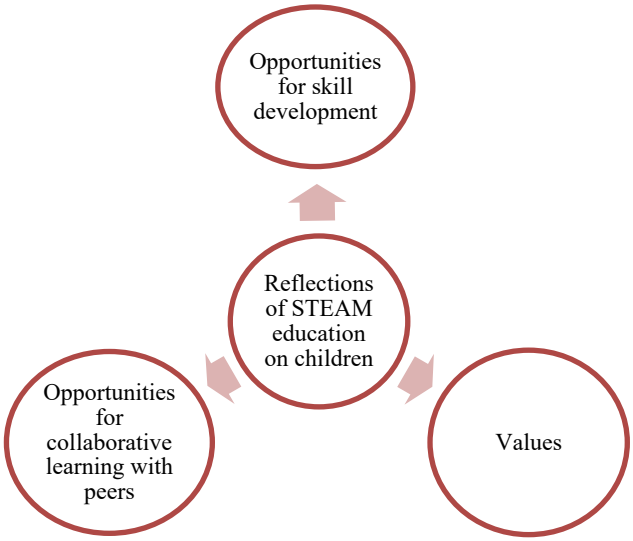

Figure 1. Reflections of STEAM Education on Children According to Teachers

Opportunities for Collaborative Learning with Peers

First, teachers stated that STEAM education offers children collaborative learning opportunities with their friends. Table 2 gives the codes determined for this theme and the distribution of teachers.

Table 2. Codes for Friendship Relations

Theme	Codes	Teachers Expressing Opinion	f
Opportunities for collaborative learning with peers	Creates a Collaborative Working Environment	K-2, K-9, K-7, K-10, K-3, K-5, K-7, K8	8
	Prepares an Environment to Have Fun with Friends	K-1, K-2, K-9, K-6, K-8	5
	Supports Friendships	K-2, K-9, K-7, K-4	4
	Provides New Friendships	K-6, K-9, K-7, K-1, K-3	5
	Positive Addiction	K-7, K-10	2
	Interaction	K-3, K-7, K-6, K-1, K-8	5
	Individual Responsibility	K-3, K-8	2
	Teamwork	K-3	1
	Shared Leadership	K-9	1

According to teachers, STEAM education supports children's social relationships in many ways. STEM education is determinative of children's friendships and peer relationships. STEAM offers social environments where children can play games and understand each other better. STEAM education helps children get to know each other better, establish new friendships, and have fun with their friends. STEAM education strengthens communication between children and supports children's emotional gains beyond cognitive gains. In this respect, STEAM environments provide a natural socialization area. E.g.;

> K-2: "STEAM environments provide social learning environments where children can develop friendships. For example, an introverted child can easily express himself by getting to know his friends better in joint activities. You can make new friends or have fun with friends.

K-6: "A well-designed STEAM environment also improves children's social relationships. Children gain implicit communication with each other and social roles and models. In STEAM, the aim is not directly these gains, but cognitive gains are more prominent. However, it is possible to say that when implicit learning comes into play, it is effective in affective learning".

K-9: "I applied STEAM education in my class in my master's thesis. What caught my attention the most during my education was the development of friendship and peer relations among the students. Because my goal was to develop skills such as scientific process and problem-solving. However, the children enjoyed spending time together, and even the children who did not approve enjoyed doing a job together".

K-7: Peer relationships develop naturally in every social environment. Because man has a social structure, the natural environment of STEAM is already in a structure that supports social relations. With STEAM, children directly learn many skills necessary in social life. For students, many of these skills are also essential skills for friendship.

Teachers stated that STEAM education offers many collaborative learning opportunities to children. Encouraging children to cooperate in the STEAM design processes and working in coordination with the children reflects positively on their cooperation skills. In STEAM education, children's games contribute to many skills, such as togetherness, positive connection, interaction, individual responsibility, teamwork, and shared leadership. E.g.;

K-1: STEAM is learning environments that naturally bring children together. Children come together to solve a problem and get support from each other in solving that problem. In this natural process, children's cooperative learning skills develop.

K-3: Children coming together for a common purpose learn about teamwork, interaction, and individual responsibility. STEAM environments also serve this. STEAM itself has a structure that supports collaboration.

K-8: Collaborative learning requires individual responsibility. However, this responsibility is an individual responsibility towards the group. If he succeeds, he will succeed in the group. Although he is physically independent of the group, the child will reinforce the cooperation because he is emotionally attached to the group. STEAM environments can also do serious work because the child knows that his/her group friends cannot win even when the child works individually.

Values

According to the teachers, STEAM education provides an environment for children to learn values in terms of their latent functions. Table 3 gives the codes determined for this theme and the distribution of teachers.

Table 3. Codes for the Values Theme

Theme	Codes	Teachers Expressing Opinion	f
Values	Solidarity	K-6, K-1, K-3, K-4, K-8, K-9, K-10	7
	Sharing	K-6, K-2, K-5, K-6, K-1, K-7	6
	Responsibility	K-2, K-7, K-5, K-6	4
	Confidence	K-10, K-3, K-5	3

Theme	Codes	Teachers Expressing Opinion	f
	Tolerance	K-4	1
	Friendship	K-6, K-8, K-2, K-5	4
	Equality	K-7	1
	Kindness	K-9	1
	Honesty	K-10, K-4	2
	Patience	K-5	1
	Respect	K-6, K-10	2
	Diligence	K-6, K-7	2

According to teachers, STEAM can be effective in helping children learn values such as cooperation, sharing, trust, tolerance, friendship, equality, kindness, and honesty. Especially during activities, children indirectly gain waiting for their turn, patience, respect, friendship, sharing, self-control, responsibility, helpfulness, hard work, honesty, and aesthetics. In this way, children learn to share without being bound by any coercion. Children develop peer relationships through sharing. The following statements support this category. E.g.

> K-5: Often, our materials are insufficient for activities in STEAM environments, and children need to use some materials together. In this case, he gives the job to the other, and children naturally learn to wait and be patient until their turn comes.
>
> K-2: Children can also perform self-control by taking responsibility for their work in STEAM environments. Children can control their emotions, behaviors, and actions in the STEAM environment, which is a social environment. They can take a more holistic view of the STEAM problems they encounter. They can present what they have learned from STEAM design, their missing and excess aspects, and their positive and negative aspects from their perspectives.
>
> K-6. STEAM learning environments indirectly provide children with many values, such as sharing, helpfulness, and hardworking. Although we do not directly target value education in our activities, these environments serve to gain many values. These values are indispensable in society, that is, peer relations. In this respect, it would not be wrong to say that STEAM supports values, education, and peer relations.
>
> K-8: In original designs, every child can use the materials they brought from home. He gives the materials that he thinks will be more useful to his friend directly to him. This positively affects peer relations between children and can enable them to establish friendships.

Opportunities for Skill Development

Teachers stated that STEAM education has an impact on many skills of children, including 21st century skills. Table 4 gives the codes determined for this theme and the distribution of teachers.

Table 4. Codes For Skills Development Opportunities

Theme	Codes	Teachers Expressing Opinion	f
Opportunities for skill development	Empathy	K-8, K-9, K-10, K-2, K-4, K-7, K-5	7
	Life Skills	K-4, K-5	2

Theme	Codes	Teachers Expressing Opinion	f
	Communication	K-4, K-10, K-3, K-9, K-7	5
	Analytical Thinking	K-1, K-6, K-7	3
	Innovative Thinking	K-4, K-5	2
	Creative Thinking	K-4, K-8, K-2, K-3	4
	Problem Solving	K-6, K-1, K-10, K-4, K-8, K-3	6
	Social Problem Solving	K-4, K-5, K-8	3
	Classification And Observation	K-1	1
	Research	K-3, K-7, K-9	3
	Science Process Skills	K-8, K-4, K-2, K-5	4
	Critical Thinking	K-1, K-9, K-7	3
	Algorithmic Thinking	K-6	1
	Social Participation	K-9	1
	Infer and Predict	K-3	1
	To Decide	K-5	1
	Reflective Thinking	K7	1
	Developing Career Awareness	K-5	1
	Perceiving Change and Continuity	K-8	1
	Entrepreneurship	K-7, K-9, K-1, K2	4
	Self-Control	K-3, K-6, K-9, K-10	4
	Scientific Literacy	K-10	1

According to teachers, through STEAM education, children learn skills such as communication, empathy, life skills, analytical thinking, innovative thinking, creative thinking, problem-solving, social problem-solving, classification and observation, research, scientific process, critical thinking, algorithmic thinking, social participation, inference and prediction, decision making, reflective thinking, entrepreneurship, self-control, scientific literacy. E.g.;

> K-4: STEAM environments provide opportunities for children to acquire certain skills. Children strengthen their social relationships by communicating with each other during designs. A child also gains various life skills through STEAM. For example, they develop original and unique designs by thinking creatively. Creative thinking should not be separated from the social context in which it takes place because children think collectively together and strive to make more creative and beautiful products by looking at each other's designs.
>
> K-10: What I observed during STEAM education was that children solved problems even among themselves through communication. Especially the spirit of togetherness created by the environment brought the children closer together, and they were able to solve their problems more easily.
>
> K-5: STEM education allows children to recognize STEM professions and develop career awareness at an early age, even though this is not our goal. The children were especially interested in engineering professions and were constantly asking me questions.

Discussion and Conclusion

In this study, the reflections of the STEAM education process on children and its latent functions (4-8 years) were examined according to the views of early childhood and primary school teachers. For this purpose, we explained the data obtained with three themes. We have listed the themes as follows; 1) opportunities for collaborative learning with friends, 2) opportunities to learn values, and 3) opportunities to develop skills. First, teachers stated that STEAM education supports children's friendship relations. In addition, according to teachers, STEAM education allows children to develop cooperation with their friends – in solving a problem. Teachers stated that during the STEAM education process, children had the opportunity to work together, do fun activities with their peer groups, and make new friends in this process. The literature emphasizes that STEM education supports collaboration (Capraro, Capraro & Morgan, 2013; Sullivan & Bers, 2018; Simoncini & Lasen, 2018). Garner, Gabitova, Gupta & Wood (2018) stated that children cooperate better during STEAM education. STEAM education enhances collaboration among children and fosters collaboration skills in teachers. For example, Malone et al. (2018) found that STEAM training increased teacher collaboration. The STEAM education process is also fun. Teachers stated that STEAM education makes science and mathematics fun and interesting for children (Jamil, Linder & Dolores, 2018). In this respect, our findings are in line with the literature. In another finding, teachers stated that STEAM education serves children to learn values. STEAM education brings social values to children with the direct or indirect experiences it offers. According to teachers, STEAM education encourages children to cooperate, share, take responsibility, and develop friendships between children. Friendship is an umbrella value that includes other values (Erol, 2022). By establishing friendships, we learn and gain values such as friendship, honesty, sincerity, helpfulness, and sharing (Erol, 2022; Erol & Köksal, 2022). In short, STEAM education also serves value education by supporting healthy friendship relations (Erol, 2022).

Teachers emphasized that STEAM education contributes to a range of children's skills. Teachers stated STEAM education's reflections on many children's skills, such as empathy, problem-solving, scientific process, analytical thinking, and critical thinking. In the 21st century, the need for individuals who can solve problems, think critically and creatively, have developed communication skills, and cooperate has come to the fore (Partnership for 21st Century Learning, 2016). STEM-STEAM education develops individuals' skills such as creative and critical thinking, problem-solving, self-confidence, research, questioning, hypothesis building, theory building, cooperation, imagination, empathy, and tolerance and prepares them for the 21st-century workforce (Ayob, 2020; Sawangmek, 2019; Sullivan & Bers, 2018; Simoncini & Lasen, 2018; Ostler, 2012). Wahyuningsi et al. (2020) emphasized that STEM education directs children to build knowledge, and the added art supports creativity in children. In addition, Erol & Erol (2022) made a systematic analysis of the publications on STEM education in early childhood in Turkey between 2018 and 2021, and as a result of their studies, STEM and STEAM education supports children's scientific process skills, encourages creative thinking and problem-solving, and makes children attend primary school. They emphasized that it supports children's knowledge, skills, and tendencies toward engineering, algorithmic thinking skills, cognitive development, language skills, and visual-spatial reasoning skills. In another study, teachers stated that STEM education improves children's mental habits, prepares them for future academic success and careers, supports development areas holistically, encourages learning by providing fun and exciting environments, and destroys the gender-specific perception of the profession (Erol, 2021).

Limitations and Recommendations

This study has some limitations and assumptions. These limitations and assumptions can be listed as follows: The study is primarily limited to the data collection tools used in the research. The study used only the interview method as a data collection tool. Similar studies can be supported with techniques such as observation. It was assumed that the teachers participating in the study answered the questions sincerely. It would not be correct to state that STEAM education only supports children's cognitive skills. STEAM serves in affective learning (see findings; STEAM contributes to values education). According to the teachers, STEAM supports friendship relations with the collaborative environments it provides, and in this way, it brings some social values to children. In this respect, it should not be forgotten that well-prepared STEAM environments will serve friendship, the development of social skills, and value education. In the context of these results, it has been suggested that teachers can effectively use STEAM education to teach social skills and values and develop friendly relations. At another point, this study was conducted with teachers who applied STEAM education. Other studies to be conducted can compare teachers who do and do not practice STEAM education.

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