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Determining the Views, Current Situations, and Needs of Preschool Teachers about STEAM Education: Case of Turkey

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ABSTRACT This research aimed to determine preschool teachers' views, the current situation, and schools regarding STEM education. A case study, which is a qualitative research approach, was used for this research. The study group was determined by the purposeful sampling method. The research study group comprises 10 preschool teachers with STEM education courses. In the research, semi-structured interviews were conducted to determine preschool teachers' opinions. Semi-structured interviews lasted between 9 and 15 minutes. The interview was analyzed with content analysis. As a result of the research, it was determined that preschool teachers have limited knowledge about STEAM, have positive effects on children, have educational and activity needs, and have difficulty finding resources. According to teachers, STEAM activities for preschool students should be age/level appropriate, selected according to the student's interest, should include science and mathematics subjects, if necessary, the process should be gamified, children should have fun in the process, children should be taken to the center starting from the problem situation, supported by art and art and technological tools.

Keywords: STEAM education, Preschool teachers, Needs

1. INTRODUCTION

One of the important educational challenges in this century is to equip individuals with different skills from different fields in order for them to adapt and survive in a rapidly changing and technologically developing world (Turiman et al., 2012). Individuals need multiple competencies in more than one subject and skills. In addition, the problems faced in today's science and technology-rich society have become more complex than ever. Solving such problems requires solutions from the convergence of multiple disciplines. STEM education is a contemporary approach that helps students gain scientific and technological literacy and keep up with technological and scientific developments and innovations. Researchers define STEM education differently (Angier, 2010; Bybee, 2013; Dare et al., 2019; Herschbach, 2011; Moore et al., 2020). According to Dare et al. (2019), some common features of STEM-related studies can be related to the definition of STEM. These carrying out STEM education in the context of interesting daily life (Bryan et al., 2015; Honey et al., 2014), intentional, explicit connections between science, technology, engineering, and mathematics and their modeling in such a way that they will be used in STEM careers (Bryan et al. 2015; Honey et al., 2014), developing 21st century skills (Bryan et al., 2015; Honey et al., 2014), emphasis is placed on student-centered pedagogies (Breiner et al., 2012; Bryan et al., 2015; Labov et al., 2010; Rinke et al., 2016; Sanders, 2009). Based on these features, Yıldız and Zengin (2023) defined STEM education as an up-to-date approach that centers students from kindergarten to higher education, emphasizes 21st-century skills, and enables multidimensional learning by integrating different fields. Numerous scholars have suggested that the integration of arts and STEM fields can be invaluable and provide many important contributions to core STEM disciplines (Connor et al., 2015; Daugherty, 2013; Boy, 2013; Peppler, 2013; Sousa & Pilecki, 2013; Yakman, 2008). Thus, STEM education emerged by adding art discipline to STEM education. The aim of STEAM education is to provide students with active learning environments where they can become excited, curious, and active learners who can take control of their own learning (Daugherty, 2013). The STEAM approach is an approach that aims to bring solutions to existing approaches in the

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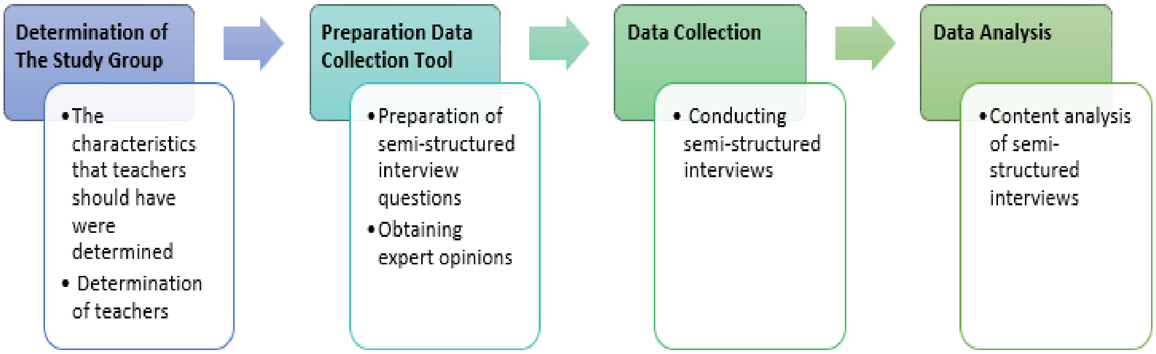

Figure 1 The research flowchart

disciplines of science, technology, engineering, and mathematics from a holistic perspective within the determined limitations of life problems based on real-life information. STEAM requires using 21st-century skills such as entrepreneurship, life, career, critical thinking, learning, and innovation (Honey et al., 2014; Riechert & Post, 2010; Yamak et al., 2014). The skills acquired at an early age significantly affect the later years of life (Yıldız & Zengin, 2021). Researchers agree that STEAM education should be started in preschool (Chesloff, 2013; DeJarnette, 2012; Dilek et al., 2020; Moomaw & Davis, 2010; Scientific and Technological Research Council of Turkey [TÜBİTAK], 2004; Weng & Li, 2020). With STEAM education, children work collaboratively, get concrete experiences through learning by doing, and make sense of their surroundings. In addition, with STEAM education, children can solve problems by using the knowledge they have acquired in science and mathematics disciplines from engineering and technology (Kennedy & Odell, 2014). Therefore, it can be said that starting STEAM education from preschool is important for the future life of individuals (Jamil et al., 2018; Katz, 2010; McClure et al., 2017). There are studies in the related field literature indicating that the STEAM education materials available in early childhood are poor (Butera et al., 2016; Hong Wang et al., 2021; John et al., 2018; Lowrie & Larkin, 2020; Parette et al., 2010; Schroeder & Kirkorian, 2016; Shrestha, 2021; Weng & Li, 2020). In addition, most of the technologies, especially in STEAM-supported activities, are not explicitly designed for specific educational purposes, and the opportunities they provide are known to be insufficiently researched and used in teaching and learning (Bower & Sturman, 2015). Yıldız and Zengin (2023) stated in their research that the number of qualitative studies conducted in preschools in Turkey is limited. Therefore, it is considered that every research to be conducted on STEAM and STEM education in preschool is important for writing. In particular, it is considered that determining the current situation and needs of preschool teachers is important for the dissemination of STEAM/STEM education. This research aimed to determine preschool teachers' views, current situations, and needs regarding STEAM education.

2. METHOD

2.1 General Background

The article is part of the doctoral thesis titled "The Development and Evaluate the Effect of STEAM Activities Supported with Web 2.0 Tools for Preschool Students (Thesis No:806364) ". In this part of the research, a case study, which is one of the qualitative research approaches, was used. A case study describes and examines the research subject in a real environment with defined boundaries (Birinci et al., 2009; Creswell et al., 2007). The limitation in case studies is that the condition can be distinguished from other conditions in terms of place, time, or some physical boundaries (Creswell, 2012). In this context, the situation to be chosen as a research topic may be a person, an administrator, a student, a program, or a group such as a classroom, a school, or a community (Creswell, 2012). If the people conducting interviews or the observations to be made on the subject to be examined can be limited, they can be considered a situation (Merriam, 1998). In this context, determining the study group as preschool teachers who included STEAM/STEM applications in their classrooms was considered a situation. The research flow chart is given in Figure 1.

2.2 Sample

The study group was determined by the purposeful sampling method. In the purposeful sampling method, the analysis units are not selected selectively but include the process of selecting them to serve a specific purpose (Tashakkori & Teddlie, 2003). In other words, in the selection of individuals to be interviewed, it is considered whether they are directly related to the research subject rather than their power to represent the universe (Neuman, 2012; Yıldırım & Şimşek, 2013). In the research, teachers were selected according to the criteria of implementing STEM activities in their classrooms and having knowledge about STEM. In this context, the study group consisted of 10 preschool teachers who met these criteria. The teachers who participated in the semi-structured interviews were given the code names Yaz, Eva, Nur, Aya, Lal, Güz, Ala, Nez, Asu, and Oya.

2.3 Data Collection Tool

In the research, semi-structured interviews were conducted to determine the opinions of preschool teachers. The researcher prepared ten questions. The questions were examined in terms of language, scope, and content validity by three academicians working in two science education and one preschool branch of science who are experts in their field. Necessary arrangements have been made. Three questions were removed from these arrangements, and two were edited regarding language knowledge. In the semi-structured interviews, the following questions were asked: STEAM definitions for preschool teachers, situations for recommending STEAM education, the activities they use and the content of these activities, the effects of the education they use on children, the points where they are struggling and the needs of the children and the problems they are experiencing. The teachers' answers were listened to without interruption, and necessary questions were asked. The interviews were audio recorded. There was no time limit. The interviews lasted a minimum of 9 minutes and a maximum of 15 minutes.

2.4 Data Collection and Analysis

Before the research, the necessary permits were obtained for semi-structured interviews with preschool teachers. The aim of the interviews was explained to the preschool teachers, and the interviews started after the teachers chatted for a while so that they could respond naturally. The semi-structured interviews were recorded on audio. Voice recordings were listened to, transcribed, and edited. Semi-structured interviews were analyzed using content analysis. Content analysis is a technique used in the analysis of qualitative data that allows researchers to discover, meaningfully reveal, and in-depth examine the messages in the data obtained from sources such as voice recordings, written documents, video recordings, or pictures during communication (Fraenkel et al., 2011; Neuman, 2014). Content analysis is defined as the process of bringing together similar data around certain concepts and themes and organizing them in an understandable way (Yıldırım & Şimşek, 2013). In content analysis, qualitative research data are analyzed in four stages: coding the data, finding themes, organizing the codes and themes, and describing and interpreting the findings. In this research, these stages were followed. Two independent researchers created codes and themes to ensure the reliability of the research. The coding performed by two researchers was checked. The numbers of agreement and disagreement were determined, and the reliability of the research was checked using the reliability = consensus/ (consensus + disagreement) formula of Miles and Huberman (1994). A consensus (reliability) of 94% was achieved.

3. RESULT

The definitions by preschool teachers for STEAM education are given in Table 1.

Table 1 shows that Yaz, Eva, Nur, Lal, and Nez define STEAM education as "the combination of science, technology, engineering, art, and mathematics fields." In contrast, Aya, Güz, Ala, Asu, and Oya define it as "the combination of science, technology, engineering, and mathematics fields." Preschool teachers' opinions on the effects of STEAM education are given in Table 2.

All preschool teachers agreed that STEAM activities should be used in the classroom and that STEAM activities have positive effects. When Table 2 is observed, it is seen that many preschool teachers state that STEAM activities are effective in "Gaining the necessary skills for the future."

Table 1 Definitions by preschool teachers for STEAM education

STEAM definition	Yaz	Eva	Nur	Aya	Lal	Güz	Ala	Nez	Asu	Oya
The combination of science, technology, engineering, art, and mathematics fields	X	X	X		X			X		
The combination of science, technology, engineering, and mathematics fields				X		X	X		X	X

Table 2 Preschool teachers' opinions on the effects of STEAM education

The effects of STEAM education	Yaz	Eva	Nur	Aya	Lal	Güz	Ala	Nez	Asu	Oya
Gaining the necessary skills for the future	X	X	X		X		X	X	X	X
Influencing your career choice	X		X					X	X	
Awareness raising	X	X	X			X				
Having a fun time				X		X				

Table 3 Preschool teachers' views on the needs of STEAM education

The need for a teacher	Yaz	Eva	Nur	Aya	Lal	Güz	Ala	Nez	Asu	Oya
The need for in-service training	X	X	X	X	X	X	X	X	X	X
The Need for Content/Resources	X	X	X	X	X	X	X	X	X	X
Material needs		X		X	X		X			
STEAM platform development			X							

Table 4 Preschool teachers about the available contents related to STEAM education

Source	Yaz	Eva	Nur	Aya	Lal	Güz	Ala	Nez	Asu	Oya
Difficulty finding content	X	X	X	X	X	X	X	X	X	X
Making use of the Internet/social networks	X	X	X	X	X		X	X		X
Inability to be sure of the accuracy of existing content	X	X					X	X	X	
Lack of resources in the Turkish language		X			X			X	X	
Differentiating secondary school resources	X		X					X		X

Table 5 Preschool teachers' opinions on STEAM activity content

STEAM Activity Content	Yaz	Eva	Nur	Aya	Lal	Güz	Ala	Nez	Asu	Oya
Event content	X	X	X	X	X	X	X	X	X	X
Suitability for age/level	X	X	X		X		X	X		X
According to student interest	X	X	X			X	X			
Includes Science and Mathematics subjects	X		X		X			X		X
Starting with the problem situation	X						X	X	X	
Supporting with technological tools				X			X			

Table 6 Preschool teachers' opinions on the STEAM activity process

Activity Process	Yaz	Eva	Nur	Aya	Lal	Güz	Ala	Nez	Asu	Oya
To practice with groups of 5-6 people	X		X	X	X	X	X			X
Making an application with family participation					X			X		X
Making a one-to-one application									X	
Frequency of Activity										
Two days a week		X	X		X		X		X	X
One day a week	X			X		X		X		

Yaz, Nur, Nez, and Asu expressed their thoughts in the form of "Influencing career choice," Yaz, Eva, Nur "Creating awareness," and Aya and Güz "Having a fun time." The views of preschool teachers on the needs of STEAM education are given in Table 3.

When Table 3 is examined, it is seen that all preschool teachers stated that they have "In-service training need" and "Content/Resource need" needs. Eva, Aya, Lal, and Nur also emphasized the need for "material needs," and Nur emphasized the need for "STEAM platform development." The opinions of preschool teachers about the available content related to STEAM education are given in Table 4.

Table 4 shows that all preschool teachers stated that they had difficulty finding content. While finding content, Yaz, Eva, Nur, Aya, Lal, Ala, Nez, and Oya "used the internet/social networks," Yaz, Eva, Ala, Nez and Asu "could not be sure of the accuracy of the existing content," Eva, Lal, Nez and Asu "used Turkish sources" Yaz, Nur, Nez, and Oya stated that "they differentiated secondary school resources". Preschool teachers' opinions on what the STEAM activity content should be are given in Table 5.

All teachers agree that STEAM activities should be age/level-appropriate. Many teachers have stated that the activities should be based on students' interests. In addition, Summer, Eva, Nur, Fall, and Ala activities emphasized the need to "include Science and Mathematics subjects, Summer, Fall, Ala, and Nez "To support technological tools." Yaz, Nur, Lal, Nez, and Oya stated that it should "start with a problem situation," while Aya and Nez stated that it should be "gamified." Preschool teachers' opinions on the STEAM activity process are given in Table 6.

In the activity process category, most teachers recommend conducting activities as a group. Lal, Nez, and Oya recommend "practicing with family participation," and Asu recommends "practicing one-on-one." In the frequency of activity category Eva, Nur, Lal, Ala, Asu, and Oya, "Two days a week" and Yaz, Aya, Güz, Nez, "One day a week."

4. DISCUSSION

This research aimed to determine preschool teachers' views, current situations, and needs about STEAM education. When the results obtained from the interviews are examined, teachers who use STEM activities in their classes know the STEM concept. However, some do not have any information about "A," that is, "Art" while explaining the STEAM stand-in. It can be said that preschool teachers have limited knowledge about STEAM. Similarly, there are studies in the literature that determine that teachers have a lack of knowledge about STEAM (Dubek et al., 2021; Herro & Quigley, 2017; Keçeci, 2023; Mercan & Kandır, 2019; Süldür, 2019). It is thought that the reason for this situation is the insufficient information given to teachers about STEAM. Teachers who find it necessary to use STEAM activities in preschool also mentioned the positive effects of STEM education, such as skill acquisition, impact on career choice, and awareness raising. Regarding STEAM education, teachers who emphasized that there are training and activity needs stated that they also need to develop materials and the STEAM platform. The related literature also stated that preschool teachers had insufficient materials (Jamil et al., 2018; John et al., 2018; Park et al., 2017). They also stated that they had difficulty finding content about STEAM activities. They usually used the internet and could not be sure of the accuracy of the sources they found. Studies indicate insufficient engineering education materials for educators or parents in the relevant literature (Butera et al., 2016; Parette et al., 2010; Schroeder & Kirkorian, 2016). Similarly, Hong Wang et al. (2021) stated that the current early childhood science and engineering curricula are weak. In this context, the development of STEAM preschool curricula is important.

Preschool teachers about the STEAM activity content have said that it should be appropriate for the traditional age/level, it should be selected according to student interest, it should include science and mathematics subjects, the process should be gamified, and children should have fun in the process and be taken to the center. In addition, preschool teachers stated that starting with the problem situation should be supported by art and supported by technological tools. When the literature is examined, similarly, STEAM education in preschool, children are centered (Aldemir & Kermani, 2017; Güldemir, 2019; Kermani & Aldemir, 2015; Kewalramani et al., 2020; Lin et al., 2021; Lowrie & Larkin, 2020; Tank et al., 2018; Tippett & Milford, 2017; Weng & Li, 2020), gamified (Dilek et al., 2020), effective use of technology is required (Bagiati et al., 2010), should start with the problem situation (Ng et al., 2022; Simoncini·& Laser, 2018), should be entertaining (Lee, 2006) and engaging (Jamil et al., 2018).

Preschool teachers stated that the STEAM activity process can be performed with small groups of 5-6 people, it can be performed with family participation, and it can be applied one-on-one by a teacher. Research investigating the transition of young children to formal schooling found that early childhood teachers are primarily interested in children's ability to function effectively as part of a group (Dockett & Perry, 2004). Doing STEAM activities in groups during preschool would be more helpful. In addition, most of the teachers stated that it would be enough for STEAM activities to occur two days a week, while some stated that one day a week would be enough.

5. CONCLUSION

The research findings indicated that preschool teachers exhibited limited comprehension of the STEAM definition, with some teachers unable to articulate the nature of the art discipline. In light of these findings, implementing professional development programs for educators is recommended to improve their understanding of STEAM education. Furthermore, the research revealed that preschool teachers expressed a need for training and acknowledged the positive impact of STEAM education on children. The teachers further articulated a need for activities and resources, emphasizing the importance of open-access resources to address their limited resources. The establishment of an e-platform to address these needs is recommended. According to preschool teachers, the development of STEAM activities for preschool students should adhere to the principles of age and level appropriateness, with activities selected based on student interest. The incorporation of science and mathematics topics is recommended when deemed necessary. Gamification is advised to ensure an engaging learning experience, focusing on the process rather than merely the outcome. Incorporating art and technological tools is also recommended, with the problem-solving process centering on the child. In this context, it is recommended that the development of STEAM activities should incorporate these features.

REFERENCES

Aldemir, J., & Kermani, H. (2017). Integrated STEM curriculum: Improving educational outcomes for Head Start children. *Early Child Development and Care*, *187*(11), 1694-1706. https://doi.org/10.1080/03004430.2016.1185102.

Angier, N. (2010). STEM education has little to do with flowers. *The New York Times,* D2.

Bagiati, A., Yoon, S. Y., Evangelou, D., & Ngambeki, I. (2010). Engineering curricula in early education: Describing the landscape of open resources. *Early Childhood Research & Practice*, *12*(2), n2. https://files.eric.ed.gov/fulltext/EJ910909.pdf.

Birinci, G., Kılıçer, K., Ünlüer, S., & Kabakçı, I. (2009). Eğitim teknolojisi alanında yapılan durum çalışması araştırmalarının yöntemsel değerlendirilmesi [Methodological evaluation of case study research in the field of educational technology]. *Uluslararası Bilgisayar ve Öğretim Teknolojileri Sempozyumu. Karadeniz Teknik Üniversitesi, Trabzon.*

Bower, M., & Sturman, D. (2015). What are the educational affordances of wearable technologies? *Computers & Education*, *88*, 343-353. https://doi.org/10.1016/j.compedu.2015.07.013.

Boy, G. A. (2013, August). From STEM to STEAM: toward a human-centred education, creativity & learning thinking. In *Proceedings of the 31st European conference on cognitive ergonomics* (pp. 1-7).

Breiner, J. M., Harkness, S. S., Johnson, C. C., & Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics*, *112*(1), 3–11. https://doi.org/10.1111/j.1949-8594.2011.00109.x

Bryan, L. A., Moore, T. J., Johnson, C. C., & Roehrig, G. H. (2015). Integrated STEM education. In C. C. Johnson, T. J. Moore, & E.

E. Peters-Burton (Eds.), *STEM roadmap: A framework for integrated STEM education* (pp. 23–37). New York, NY: Routledge.

Butera, G., Horn, E. M., Palmer, S. B., Friesen, A., & Lieber, J. (2016). Understanding Science, Technology, Engineering, Arts, and Mathematics (STEAM) within Early Childhood Special Education. *Handbook of Early Childhood Special Education*, 143-161. https://doi.org/10.1007/978-3-319-28492-7_9

Bybee, R. W. (2013). *The case for STEM education: Challenges and opportunities*. NSTA Press.

Chesloff, J. D. (2013). STEM education must start in early childhood. *Education Week*, *32*(23), 27-32. https://d1wqtxts1xzle7.cloudfront.net/72533316/1303.

Connor, A. M., Karmokar, S., & Whittington, C. (2015). From STEM to STEAM: Strategies for enhancing engineering and technology education. *International Journal for Engineering Pedagogy*, *5*(2), 37–47. https://doi.org/10.3991/ijep.v5i2.4458

Creswell, J. W., Hanson, W. E., Clark Plano, V. L., & Morales, A. (2007). Qualitative research designs: Selection and implementation. *The counseling psychologist*, *35*(2), 236-264.

Creswell, J. W. (2012). *Educational research: planning, conducting, and evaluating quantitative research* (4th editionı). Boston: Pearson Education Inc.

Dare, E. A., Ring-Whalen, E. A., & Roehrig, G. H. (2019). Creating a continuum of STEM models: exploring how K-12 science teachers conceptualize STEM education. *International Journal of Science Education*, *41*(12), 1701–1720. https://doi.org/10.1080/09500693.2019.1638531

Daugherty, M. K. (2013). The Prospect of an "A" in STEM Education. *Journal of STEM Education: Innovations and Research*, *14*(2), 10–15. https://www.jstem.org/jstem/index.php/JSTEM/article/view/1744.

DeJarnette, N. (2012). America's children: Providing early exposure to STEM (science, technology, engineering and math) initiatives. *Education*, *133*(1), 77-84.

Dilek, H., Tasdemir, A., Konca, A. S., & Baltaci, S. (2020). Preschool students' science motivation and process skills during inquiry-based STEM activities. *Journal of Education in Science Environment and Health*, *6*(2), 92-104. https://doi.org/10.21891/jeseh.673901.

Dockett, S., & Perry, B. (2004). Starting school: Perspectives of Australian children, parents and educators. *Journal of Early Childhood Research*, *2*(2), 171-189.

Dubek, M., DeLuca, C., & Rickey, N. (2021). Unlocking the potential of STEAM education: How exemplary teachers navigate assessment challenges. *The Journal of Educational Research*, *114*(6), 513-525. https://doi.org/10.1080/00220671.2021.1990002

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2011). *How to design and evaluate research in education* (8th ed.). NY: McGraw-Hill.

Güldemir, S. (2019). *The effect of STEM activities on creativity in preschool* [Unpublished Master's Thesis]. Recep Tayyip Erdoğan University.

Herro, D., & Quigley, C. (2017). Exploring teachers' perceptions of STEAM teaching through professional development: implications for teacher educators. *Professional Development in Education*, *43*(3), 416-438. https://doi.org/10.1080/19415257.2016.1205507

Herschbach, D. R. (2011). The STEM initiative: Constraints and challenges. *Journal of STEM Teacher Education*, *48*(1), 96–112 https://eric.ed.gov/?id=EJ952045

Honey, M., Pearson, G., & Schweingruber, A. (2014). *STEM integration in K12 education: status, prospects, and an agenda for research*. Washington: National Academies Press.

Hong Wang, H., Lin, H. S., Chen, Y. C., Pan, Y. T., & Hong, Z. R. (2021). Modelling relationships among students' inquiry-related learning activities, enjoyment of learning, and their intended choice of a future STEM career. *International Journal of Science Education*, *43*(1), 157-178. https://doi.org/10.1080/09500693.2020.1860266

Jamil, F. M., Linder, S. M., & Stegelin, D. A. (2018). Early childhood teacher beliefs about STEAM education after a professional development conference. *Early Childhood Education Journal*, *46*, 409-417. https://doi.org/10.1007/s10643-017-0875-5.

John, M. S., Sibuma, B., Wunnava, S., Anggoro, F., & Dubosarsky, M. (2018). An iterative participatory approach to developing an early childhood problem-based STEM curriculum. *European Journal of STEM Education*, *3*(3), 07. https://doi.org/10.20897/ejsteme/3867.

Katz, L. G. (2010). STEM in the early years. *Early childhood research and practice*, *12*(2), 11-19.

Keçeci, G. (2023). Determining Pre-Service Science Teachers' Understanding About STEM Education. *Journal of Baltic Science Education*, *22*(5), 833. https://doi.org/10.33225/jbse/23.22.833

Kennedy, T. J., & Odell, M. R. (2014). Engaging students in STEM education. *Science Education Inter*, *25*(3), 246-258. https://files.eric.ed.gov/fulltext/EJ1044508.pdf.

Kermani, H., & Aldemir, J. (2015). Preparing children for success: Integrating science, math, and technology in early childhood classroom. *Early Child Development and Care*, *185*(9), 1504–1527. https://doi.org/10.1080/03004430.2015.1007371

Kewalramani, S., Palaiologou, I., & Dardanou, M. (2020). Children's engineering design thinking processes: The magic of the ROBOTS and the power of BLOCKS (electronics). *EURASIA Journal of Mathematics, Science and Technology Education*, *16*(3). https://doi.org/10.29333/ejmste/113247

Labov, J. B., Reid, A. H., & Yamamoto, K. R. (2010). Integrated biology and undergraduate science education: A new biology education for the twenty-first century? *CBE Life Science Education*, *9*, 10–16. https://doi.org/10.1187/cbe.09-12-0092

Lee, J. S. (2006). Preschool teachers' shared beliefs about appropriate pedagogy for 4-year-olds. *Early Childhood Education Journal*, *33*, 433-441.

Lin, X., Yang, W., Wu, L., Zhu, L., Wu, D., & Li, H. (2021). Using an inquiry-based science and engineering program to promote science knowledge, problemsolving skills and approaches to learning in preschool students. *Early Education and Development*, *32*(5), 695-713. https://doi.org/10. 1080/10409289.2020.1795333.

Lowrie, T., & Larkin, K. (2020). Experience, represent, apply (ERA): A heuristic for digital engagement in the early years. British *Journal of Educational Technology*, *51*(1), 131-147. https://doi.org/10.1111/bjet.12789

McClure, E. R., Guernsey, L., Clements, D. H., Bales, S. N., Nichols, J., KendallTaylor, N., & Levine, M. H. (2017). *STEM starts early: Grounding science, technology, engineering, and math education in early childhood.* New York: The Joan Ganz Cooney Center at Sesame Workshop.

Mercan, Z., & Kandır, A. (2019). Preschool teachers' opinions regarding STEAM approach in education. *Journal of Current Researches on Educational Studies*, *8*(2), 15-28. doi: 10.26579/jocures-9.1.2

Merriam, S. B. (1998). *Qualitative research and case study applications in education.* California: Jossey-Bass.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage.

Moomaw, S., & Davis, J. A. (2010). STEM comes to preschool. *YC: Young Children*, *65*(5).

Moore, T. J., Johnston, A. C., & Glancy, A. W. (2020). A synthesis of conceptual frameworks and definitions. In C. C. Johnson, M. J. MohrSchroeder, T. J. Moore, & E. L. D (Eds.), *Handbook of research on STEM education*, (pp. 3–16). Routledge.

Neuman, D. (2014). Qualitative research in educational communications and technology: A brief introduction to principles and procedures. *Journal of Computing in Higher Education*, *26*, 69-86.

Neuman, W. L. (2012). *Social Research Methods: Quantitative and Qualitative Approaches Volume III* (5th Edition). Istanbul: Publication Room.

Ng, A., Kewalramani, S., & Kidman, G. (2022). Integrating and navigating STEAM (inSTEAM) in early childhood education: An integrative review and in STEAM conceptual framework. *Eurasia Journal of Mathematics, Science and Technology Education*, *18*(7), 2133. https://doi.org/10.29333/ejmste/12174.

Parette, H., Quesenberry, A., & Blum, C. (2010). Missing the boat with technology usage in early childhood settings: A 21st Century view of developmentally appropriate practice. *Early Childhood Education Journal*, *37*, 335-343. https://doi.org/10.1007/s10643-009-0352-x

Park, M. H., Dimitrov, D. M., Patterson, L. G., & Park, D. Y. (2017). Early childhood teachers' beliefs about readiness for teaching science, technology, engineering, and mathematics. *Journal of Early Childhood Research*, *15*(3), 275–291. https://doi.org/10.1177/1476718X15614040.

Peppler, K. (2013). New Opportunities for Interest-Driven Arts Learning in a Digital Age. *Wallace Foundation*.

Riechert, S. E., & Post, B. K. (2010). From skeletons to bridges & other STEM enrichment exercises for high school biology. *The American Biology Teacher*, *72*(1), 20-22. https://doi.org/10.1525/abt.2010.72.1.6.

Rinke, C. R., Gladstone-Brown, W., Kinlaw, C. R., & Cappiello, J. (2016). Characterizing STEM teacher education: Affordances and constraints of explicit STEM preparation for elementary teachers. *School Science and Mathematics*, *116*(6), 300–309. https://doi.org/10.1111/ssm.12185

Sanders, M. (2009). STEM, STEM education, STEMmania. *The Technology Teacher*, *68*(4), 20–26. http://hdl.handle.net/10919/51616

Schroeder, E. L., & Kirkorian, H. L. (2016). When seeing is better than doing: Preschoolers' transfer of STEM skills using touchscreen games. *Frontiers in Psychology*, *7*, 1377. https://doi.org/10.3389/fpsyg.2016.01377

Scientific and Technological Research Council of Türkiye [TÜBİTAK] (2004). *National science and technology policies*, 2003-2023 strategy document. http://www.tubitak.gov.tr/tubitak_content_files.

Shrestha, P. (2021). *Integrating STEAM Education in Preschool and Kindergarten Classrooms: A Case Study* (Doctoral dissertation, California State University, Sacramento).

Simoncini, K., & Lasen, M. (2018). Ideas about STEM among Australian early childhood professionals: How important is STEM in early childhood education? *International Journal of Early Childhood*, *50*(3), 353–369. https://doi.org/10.1007/s13158-018-0229-5

Sousa, D. A., & Pilecki, T. J. (2013). *From STEM to STEAM: Using Brain Compatible Strategies to Integrate the Arts*. Corwin Press.

Süldür, S. (2019). *Determining the opinions of classroom teachers towards STEM education* (Master's thesis).

Tank, K. M., Rynearson, A. M., & Moore, T. J. (2018). Examining Student and Teacher Talk within Engineering Design in Kindergarten. *European Journal of STEM Education*, *3*(3), 10. https://eric.ed.gov/?id=EJ1190717.

Tashakkori, A., & Teddlie, C. (2003). Issues and dilemmas in teaching research methods courses in social and behavioural sciences: US perspective. *International Journal of Social Research Methodology*, *6*(1), 61-77. https://doi.org/10.1080/13645570305055

Tippett, C. D., & Milford, T. M. (2017). Findings from a kindergarten classroom: Making the case for STEM in early childhood education. *International Journal of Science and Mathematics Education*, *15*(1), 67-86. https://doi.org/10.1007/s10763-017-9812-8.

Turiman, P., Omar, J., Daud, A. M., & Osman, K. (2012). Fostering the 21st century skills through scientific literacy and science process skills. *Procedia-Social and Behavioral Sciences*, *59*, 110-116. https://journals.sagepub.com/doi/abs/10.2466

Weng, J., & Li, H. (2020). Early technology education in China: A case study of Shanghai. *Early Child Development and Care*, *190*(10), 1574-1585. https://doi.org/10.1080/03004430.2018.1542383

Yakman, G. (2008). STEAM education: An overview of creating a model of integrative education. In *Pupils' attitudes towards technology (PATT-19) conference: Research on technology, innovation, design & engineering teaching*, Salt Lake City, Utah. https://www.iteea.org/File.aspx.

Yamak, H., Bulut, N., & Dündar, S. (2014). 5. sınıf öğrencilerinin bilimsel süreç becerileri ile fene karşı tutumlarına FeTeMM etkinliklerinin etkisi [The effects of STEM activities on 5th grade students' scientific process skills and attitudes towards science]. *Gazi Üniversitesi Gazi Eğitim Fakültesi Dergisi*, *34*(2), 249-265. https://doi.org/10.17152/gefd.15192.

Yıldırım, A., & Şimşek, H. (2013). *Qualitative Research Methods in Social Sciences* (6th Edition). Ankara: Seçkin Publishing.

Yildiz, S., & Zengin, R. (2021). Effect of science education provided with digital and ın-class games on the scientific process skills of preschool students. *Journal of Science Learning, 4*(4), 385-393. https://doi.org/10.17509/jsl.v4i4.30620

Yıldız, S., & Zengin, R. (2023). Türkiye'de okul öncesi fen eğitimine yönelik yapılan araştırmaların analizi: meta-sentez çalışması. [Analysis of research conducted on preschool education in Turkey: a meta-synthesis study]. *Fırat Üniversitesi Sosyal Bilimler Dergisi*, *33*(3), 1183-1197. https://doi.org/10.18069/firatsbed.1232738