Reverse Tullip Education

Social Scientific Centered Issues

June 2020-2(2)
http://dergipark.gov.tr/ssci
ISSN 2687-6221

Received: 27.09.2020
Accepted: 30.09.2020

Investigation of STEAM-Themed Thesis Conducted in Turkey in the Field of Educational Sciences in terms of Visual Arts

[1]İsmail HELVACI

Abstract

The aim of this research is to evaluate the STEAM-themed studies in the field of Educational Sciences in terms of art practices. By examining the national-origined postgraduate thesis about the STEAM approach, it has been requested to reveal the usage nature of the discipline of Art within this holistic structure. In the study, document analysis was used as one of the qualitative research approaches. Descriptive analysis technique was used in analyzing the data. Including 10 master's and 3 doctoral dissertations, a total of 13 publications were examined in the research. Theses are classified according to their types, years of publication, research subject and results for the field of study. Based on the findings of the study, the STEAM approach has been a subject of research for the last two years; it is mostly studied at master's level compared to doctoral dissertations; it has been researched within the Science and Mathematics disciplines. It has been observed that, this approach that puts art at its center has not been studied sufficiently within the scope and perspective of fine arts education. In order to enrich the application examples of STEAM approach and in the name of not to deny the effect of Art within the disciplines that form STEAM, suggestions have been proposed.

Keywords: Fine arts education, interdisciplinary approach, STEM, STEAM.

1. Ph.D. Affiliation, Kastamonu University Education Faculty, ihelvaci@kastamonu.edu.tr

Citation:
Helvacı, İ. (2020). Investigation of STEAM-Themed Thesis Conducted in Turkey in the Field of Educational Sciences in terms of Visual Arts. *Social Scientific Centered Issues*, 2(2), 56-64.

Introduction

The most important requirements of the 21st century are considered to be the ability of individuals to research, question, creativity, think critically and analytically and make decisions (Brophy, Klein, Porstmore & Rogers, 2008; Tyler-Wood, Knezek & Christensen, 2010). Individuals should be able to use different disciplines throughout their education in order to reveal their skills and interests in questioning, researching, creating new products, and making inventions. (Ministry of National Education Innovation and Educational Technologies General Directorate [YEGİTEK], 2018). These needs and requirements cause interdisciplinary approaches to play a key role in education. In this context, STEM, which is an innovator of the interdisciplinary approach, is of great importance in the acquisition of complex skills.

The concept of STEM consists of the initials of the disciplines that make up it. Since STEM means “root”, this order in disciplines is also significant. It was used for the first time in educational literature in 2001 by Judith A. Ramaley, director of The National Science Foundation (Yıldırım & Altun, 2015). STEM, which has sprouted in the United States, has rapidly gained a place in European countries and Far Eastern education systems. If it is expressed with the simplest point of view; STEM is the product of economic competition. It is the concrete prophecies of the United States for the future in technology and economic war, and reforming the education system on an interdisciplinary basis in order to be a pioneer in competition. STEM is seen as a key to building an innovative and progressive society. (Yılmaz, Koyunkaya, Güler & Güzey, 2017).

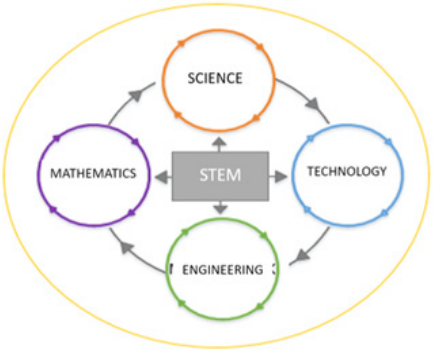

Figure 1. STEM Education Disciplines (Sen, Ay & Kıray, 2018)

Educational scientists advocating STEM education, state that individuals can increase their attitude, success and motivation by dealing with real life problems (Honey, Pearson & Schweingruber, 2014). For this reason, STEM is given great importance in the school system and serious financial resources are allocated. Within the education systems of these schools, there is a design in which project-based learning and engineering design process is carried out (Akgündüz et al., 2015; Avan, Gülgün, Yılmaz & Doğanay, 2019). Although STEM density is perceived as a heavy structure that makes students’ minds awkward, on the contrary, it is the process that develops and raises individuals in every sense. From this point of view, an interdisciplinary change was made in our national education in 2018, and a new curriculum was started to be used on the basis of STEM approach (MoNE, 2018). The use of science and engineering disciplines together in the new curriculum structured with STEM is also seen in the activities in Science textbooks.

The widespread use of STEM in recent years and its inclusion in the educational policies of many countries have brought the cooperation efficiency of different disciplines with STEM to the agenda. STEM and Entrepreneurship (STEM-Entrepreneurship, STEM+E), Programming (STEM-Computing, STEM+C), Environment (E-STEM) disciplines are used together in different fields. One of the most up-to-date interpretations of STEM is STEAM. STEAM is formed by the integration of Art into STEM disciplines (Daugherty, 2013; Shin & Heo, 2020; Torres-Crespo, Kraatz & Pallansch, 2014; Yakman & Hyonyong, 2012).

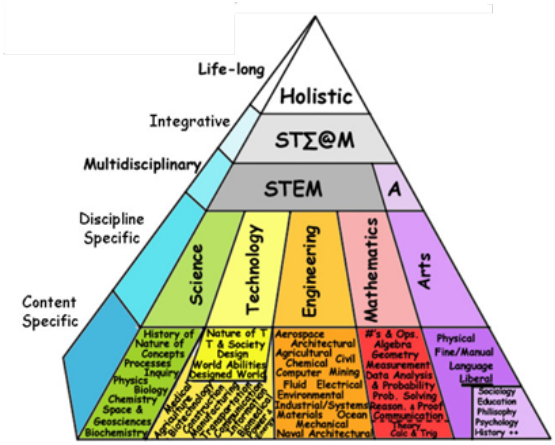

Figure 2. STEAM Pyramid (Yakman,2008)

With STEAM, the uniqueness of the products that emerge due to the nature of STEM within the framework of aesthetic measures is secured with the use of Art. For this reason, STEAM is positioned above the level desired to be reached with STEM (Yakman, 2008). Within the framework of STEAM approach, there are lifelong learning, project/problem-based inquiry and research, specific discipline and specific content sub-dimensions (Biffle, 2016). STEAM refers to a holistic design to develop skills such as scientific ethics, social development, leadership and effective communication. (Park & Ko, 2012).

When the studies on STEM approach are examined (Judson & Sawada, 2000; Roth, 2001; Tal, Krajcik, & Bluemenfeld, 2006; Lam, Doverspike, Zhao, Zhe & Menzemer, 2008; Weber, 2011; Wyss, Heulskamp, & Siebert, 2012; Cotabish, Dailey, Robinson & Hughes, 2013; Knezek, Christensen, Tyler-Wood, & Periathiruvadi, 2013; Watter & Diezman, 2013; Barrett, Moran & Woods, 2014; Robinson, Dailey, Hughes & Cotabish, 2014; Tenaglia, 2017; Yıldırım & Selvi, 2017), it is seen that it has been studied for a long time in different educational levels and subject areas. When studies on the integration of STEM disciplines and Art are examined, it is seen that the effect of using these disciplines together on knowledge, perception, attitude and creativity is examined (Yakman, 2008; Kwona, Namb & Lee, 2011; Sousa & Pilecki, 2013; Jin, Chong & Cho, 2012; Kim, Ko, Han & Hong, 2014; Henriksen, 2014; Jeong & Kim, 2015; Gülhan & Şahin, 2016; Rolling, 2016; Sochacka, Guyotte & Walther, 2016; Ayvacı & Ayaydın, 2017; Batı, Çalışkan & Yetişir, 2017; Cook, Bush & Cox, 2017; Özkan & Umdu-Topsakal, 2017; Cook & Bush, 2018; Gülhan & Şahin, 2018a; Gülhan & Şahin, 2018b; Shin & Heo, 2020). When the relevant studies are examined, it is seen that STEAM studies are generally carried out in the fields of digitally based educators and education, but not enough from the perspective of art educator. The same is true for the number of informative studies on the structure of STEAM studies. However, STEAM, whose adoption is supported worldwide, moves away from the holistic structure and cannot maintain the balance between disciplines due to the intense emphasis on Science and Mathematics (Shin & Heo, 2020). Art, which should be the focus of STEAM, is ignored.

It is thought that the studies related to the STEAM approach will contribute to the literature in determining the level of realizing the connection with Art. From this point of view, this study aims to evaluate STEAM themed studies in the field of Educational Sciences in terms of art practices. In this way, it is thought that by analyzing national researches on the concept of STEAM, awareness will be created for the use of art, which is the heart of STEAM. The aim of the research is to improve the synthetic art perception developed within the STEAM approach and to make this approach useful especially in thesis studies in the national literature.

Limitation of the Study

In the research, the studies in YÖK (Council of Higher Education) Thesis Center database were scanned. The search made with the keyword “STEAM, STEM+A, Science, Technology, Engineering, Mathematics and Art” was filtered by the subject area of “Education and Instruction”. As a result of the investigations, it was determined that 13 theses were about the STEAM approach and were conducted between 2018-2020, and the research was limited to these documents.

Methods

In this study, STEAM-themed studies in the field of Educational Sciences were evaluated in terms of art practices. The research process was carried out using qualitative research approaches. In this context, master's and doctoral theses that have been made in Turkey on STEM education were examined. Document analysis was used in the research. Document analysis is a method that enables researchers to conduct research on information sources such as information, documents, periodicals, primary and secondary sources, articles, and theses and allows researchers to make versatile comparisons (Batdı, 2019; Özkan, 2019; Yılmaz & Yanarateş, 2020).

Scope and Process of the Research

Research has been conducted between the years 2010-2020 within the scope of the thesis performed STEAM theme in Turkey. The research data were obtained through the National Thesis Center affiliated to the Council of Higher Education. During the research process, a search was made using the keywords "STEAM, STEM+A, Science, Technology, Engineering, Mathematics and Art" and the obtained theses were divided into various categories to be examined. The data obtained during the study process are expressed in frequency and percentage tables.

Results

Research findings are categorized as type of thesis, publication year, research subject and field of study, respectively. In Table 1, firstly, the classification results for the types of theses are presented.

Table 1. Classification results for the types of theses

Types of Thesis	f	%
Master's	10	76.92
Doctorate	3	23.08
Total	13	100.00

When Table 1 is examined, it is seen that a total of 13 STEAM-themed theses have been produced since 2010. 76.92% of the theses produced were carried out at the master's level and 23.08% at the doctoral level. This situation may indicate that art practices are a new field in the integration of STEM education and that there is a structure open to improvement. The classification results for the year of publication are presented in Table 2.

Table 2. Classification results for the publication year of theses

Types of Thesis	Publication year	f	%
Master's	2018	1	7.69
	2019	7	53.85
	2020	2	15.38
Doctoral	2019	3	23.08
Total	Between 2010-2020	13	100.00

When Table 2 is examined, it can be said that STEAM-themed studies were first conducted in 2018 and did not attract much attention until 2018. However, it can be stated that in 2019 and afterwards, it attracted a great deal of attention and that there were comparative studies in both graduate and doctoral level. Table 3 shows the research subject and the results regarding the study field.

Table 3. Results regarding to research subject and the field of study

Research subject	Field of Study	Year of Study
Socio-scientific issues	Classroom Education	2018
Attitude towards art, STEAM insights and professional influence	Science and Technology Education	2019
Attitude towards science, STEAM attitudes and career choices	Mathematics and Science Education	2019
Integrated STEAM applications	Classroom Education	2019
STEAM opinions of field experts	Mathematics and Science Education	2019
Effects on visual spatial reasoning skills	Classroom Education	2019
STEAM teacher qualifications	Secondary Science and Mathematics Education	2019
STEAM applications with SCAMPER technique in geography education	Turkish and Social Sciences Education	2019
The impact of STEAM-based approach in visual arts education	Art Education	2019
The effect of STEAM activities on attitude and success towards mathematics lesson	Mathematics Education	2019
Analysis of changes in success and attitudes of 7th grade students with STEM activities by gender	Mathematics Education	2019
Steam-based science teaching	Education Programs and Teaching	2020
STEAM attitudes of primary school students	Classroom Education	2020

When Table 3 is examined, it is seen that STEAM-themed studies are mainly used in classroom education, science education and mathematics education, and that there is not much study in the art education department. When the research topics are examined, it is seen that quite different topics are discussed and many studies are allowed in this field.

Discussions

In this study, national-originated graduate thesis studies in the field of Educational Sciences related to the STEAM approach were evaluated and examined in terms of art practices. In this examination, the publication types, publication years, research subjects and study fields criteria of the theses were taken into consideration in the classifications. When the classification results for the types of 13 theses included in the study are examined; it was determined that 10 master's and 3 doctoral studies were carried out on the basis of STEAM applications.

The concentration at the master's level is not unique to this study subject. The reason for individuals to pursue a master's degree is to strengthen their social status and provide economic contribution with the title of expert (Nas, Peyman & Arat, 2016). In the doctoral phase, there is a deeper research skill development, and the process of discovering new methods and technologies (Ersoy, 2015). Due to the philosophical background differentiating between master's and doctoral studies, the concentration of master's studies is higher than doctoral studies. The STEAM approach (Mercin, 2019), which is considered as an investment in the future for economic progress and a quality formation, is in a structure that needs to seek the best in its scope and stages. In this context, studies in this field are of great importance. The infrequent number of studies, especially at the doctoral stage, can be interpreted as far from expected.

When the classification results for the publication year of the theses were examined, it was found that there was a study on STEAM applications in the last two years. Looking at the history of STEAM, it is seen that holistic interdisciplinary education was developed by Yakman in 2010 (Ayvacı & Ayaydın, 2017; Batı, Çalışkan, & Yetişir, 2017; Braund, 2015; Yakman, 2010; Yılmaz, Gülgün, Çetinkaya & Doğanay, 2018) . In this sense, it can be said that current educational orientations are included in our national field of study within a time interval that can be considered delayed.

The more serious of the aforementioned delay is in question for STEM. The concept, which was founded in the 1950s (Mercin, 2019) and introduced to the educational literature in 2001 (Yıldırım & Altun, 2014), was adopted in our national education system in 2018. This delay in taking the STEM approach into focus shows that the STEM and thus the STEAM approach is newly formed.

When the results of the theses regarding the research subject and the field of study are examined, it is seen that the majority of the STEAM approach is studied by quantitative-based disciplines. The number of studies conducted within the framework of Fine Arts Education is one. It is known that STEAM is an approach born with the necessity of including form and aesthetic measures in STEM (Mercin, 2019). In other words, it is the addition of a design process. Although the STEAM approach way of thinking is not very different from STEM (Watson & Watson, 2013), art integration makes it superior (Yakman, 2008). At this point, STEAM is in a handicap. Art is very important for STEAM, but as seen in the research findings, there is not enough study in the field of fine arts education. If the STEAM approach is studied by embossing science and mathematics disciplines and as if this discipline is under the monopoly of experts, it cannot progress, develop and be absorbed by education systems. In the STEAM approach, if the features of art that develop creativity are ignored and it is postponed, it cannot be said that STEAM is realized.

Conclusions and Recommendations

In this study, national-originated postgraduate thesis studies on the STEAM approach were evaluated in terms of art practices and the following results were obtained:

1. STEAM is a new educational orientation for our literature. Thesis studies have been carried out in this field for the last two years.

2. STEAM approach has been studied in master's research compared to doctoral dissertations.

3. STEAM approach focusing on art has not been studied enough within the scope of fine arts education, and a major and important deficiency has been detected in this field.

In the light of these results, the following recommendations have been made:

Like other derivatives of STEM, STEAM is mostly worked with a quantitative-based perspective. In order to overcome this, STEAM can be studied by considering Art by all disciplines that form it. In this way, it can be possible to make improvements by determining the weak and strong aspects of the approach. Further work is recommended in this area to clarify the framework of the STEAM approach and test its effectiveness.

References

Akgündüz, D., Aydeniz, M., Çakmakçı,G., Çavaş,B., Çorlu, M.S., Öner, T.,& Özdemir,S. (2015). *A report on STEM Education in Turkey: A provisional agenda or a necessity?.* İstanbul Aydın Üniversitesi STEM Merkezi ve Eğitim Fakültesi. Retrieved from http://www.aydin.edu.tr/belgeler/IAU-STEM-Egitimi-Turkiye-Raporu-2015.pdf

Atalay, M. (2019). *Meslek liselerinde steam etkinliklerinin matematik dersine yönelik tutum ve başarıya etkisi* (Unpublished master's dissertation). Erciyes University Instutite of Education, Kayseri, Turkey.

Avan, Ç., Gülgün, C., Yılmaz, A., & Doğanay, K. (2019). STEM eğitiminde okul dışı öğrenme ortamları: Kastamonu bilim kampı. *Journal of STEAM Education,* 2(1), 39-51. Retrieved from https://dergipark.org.tr/tr/pub/steam/issue/48084/601443.

Ayvacı, H. Ş & Ayaydın, A. (2017). *Bilim teknoloji mühendislik sanat ve matematik (STEAM).* (Ed. Çepni, S.) Kuramdan Uygulamaya STEM+A+E Eğitimi, (s. 115- 130). Ankara: Pegem Akademi.

Azkın, Z. (2019). *STEAM (fen-teknoloji-mühendislik-sanat-matematik) uygulamalarının öğrencilerin sanata yönelik tutumlarına, STEAM anlayışlarına ve mesleki ilgilerine etkisinin incelenmesi* (Unpublished master's dissertation). Karamanoğlu Mehmetbey University Instıtute of Science, Karaman, Turkey.

Barrett, B. S., Moran, A. L., & Woods, J. E. (2014). Meteorology meets engineering: An interdisciplinary STEM module for middle and early secondary school students. *International Journal of STEM Education*, 1(1), 1-6.

Batdı, V. (2019). *Meta-tematik analiz.* Batdı, V. (Ed.). Meta-tematik analiz örnek uygulamalar içinde, (s. 1-76). Ankara: Anı Yayıncılık.

Batı, K., Çalışkan, İ & Yetişir, M. İ. (2017). Fen eğitiminde bilgi işlemsel düşünme ve bütünleştirilmiş alanlar yaklaşımı (STEAM). *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, 41, 91-103.

Beşkese, M. B. (2019). *An examination of STEAM teacher competencies* (Unpublished master's dissertation). Boğaziçi University Instutite of Science, İstanbul, Turkey.

Biffle, R. L. (2016). Introduction to STEAM (Science, Technology, Engineering, Arts, and Mathematics) – Course design, organization and implementation. Thomas Collage. Retrieved from https://thomasstorage1. blob.core.windows.net/wp- media/2017/09/RLB3-STEAM-Article-2016-D8-copy.pdf

Braund, M. (2015). A new STEAM age: Towards one culture for learning science. *ICEMST 2015: International Conference on Education in Mathematics, Science & Technology The Eurasia Proceedings of Educational & Social Sciences (EPESS),* 2, 13-17.

Brophy, S., Klein, S., Portsmore, M., & Rogers, C. (2008). Advancing engineering education in P-12 classrooms. *Journal of Engineering Education*, 97(3), 369- 387.

Bozkurt, Y. (2019). *STEM etkinlikleri ile 7. sınıf öğrencilerinin başarı ve tutumlarındaki değişimin cinsiyete göre analizi* (Unpublished master's dissertation). Erciyes University Instutite of Education, Kayseri, Turkey.

Cook, K.L. & Bush, S. B. (2018). Design thinking in integrated STEAM learning: Surveying the landscape and exploring exemplars in elementary grades. *School Science and Mathematics*, 118, 93–103.

Cook, K. L., Bush, S. B, & Cox, R. (2017). From STEM to STEAM: Incorporating the arts in roller coaster engineering. *Science and Children*, 54(6), 86-93.

Cotabish, A., Dailey, D., Robinson, A., & Hughes, G. (2013). The effects of a STEM intervention on elementary students' science knowledge and skills. *School Science and Mathematics*, 113(5), 215-226.

Daugherty, M. K. (2013). The prospect of an" A" in STEM education. *Journal of STEM Education: Innovations and Research*, 14(2),10-15.

Erdönmez, İ (2019). *Özel yetenekli öğrencilerin coğrafya eğitiminde SCAMPER tekniği ile STEAM uygulamaları* (Unpublished master's dissertation). Gazi University Instutite of Education, Ankara, Turkey.

Ersoy, A. (2015). Doktora öğrencilerinin ilk nitel araştırma deneyimlerinin günlükler aracılığıyla incelenmesi. *Pegem Eğitim ve Öğretim Dergisi*, 5, 549-568.

Gülhan, F. & Şahin, F. (2016). Fen-teknoloji-mühendislik-matematik entegrasyonunun (STEM) 5. sınıf öğrencilerinin bu alanlarla ilgili algı ve tutumlarına etkisi. *International Journal of Human Sciences,* 13(1), 602-620.

Gülhan, F., & Şahin, F. (2018a). STEAM (STEM+Sanat) eğitimine yönelik etkinlik uygulaması: Aynalar ve ışık. *Araştırma Temelli Etkinlik Dergisi*, 8(2), 111-126.

Gülhan, F., & Şahin, F. (2018b). STEAM (STEM+Sanat) etkinliklerinin 7. sınıf öğrencilerinin akademik başarı, STEAM tutum ve bilimsel yaratıcılıklarına etkisi. *International Journal of Human Sciences*, 15(3), 1675-1699.

Gürliyenkaya-Baş, G. (2020). *İlkokul öğrencilerinin STEAM tutumlarının belirlenmesi* (Unpublished master's dissertation). Çanakkale Onsekiz Mart University Instutite of Education, Çanakkale, Turkey.

Hallaç, S. (2019). *Disiplinlerüstü bir STEAM yaklaşımı ile hazırlanmış öğretim programının öğrencilerin fizik kavramlarını öğrenmelerine, bilime karşı tutumlarına, STEAM tutumlarına ve kariyer seçimlerine etkisinin incelenmesi.* (Unpublished master's dissertation). Marmara University Instıtute of Education, Istanbul, Turkey.

Helvacı, İ (2019). *Görsel sanatlar eğitiminde STEAM temelli yaklaşımın etkisi* (Unpublished doctoral dissertation). Gazi University Instutite of Education, Ankara, Turkey.

Henriksen, Danah (2014). Full STEAM ahead: Creativity in excellent STEM teaching practices. *The STEAM Journal*, 1(2), 1-7.

Honey, M., Pearson, G., & Schweingruber, H. (Eds.) (2014). *STEM integration in K-12 education: Status, prospects, and an agenda for research.* Washington D.C.: The National Academies.

Jeong, S. & Kim, H. (2015). The Effect of a Climate Change Monitoring Program on Students' Knowledge and Perceptions of STEAM Education in Korea. E*URASIA Journal of Mathematics, Science & Technology Education*, 11(6), 1321-1338.

Jin, Y., Chong, L. M. & Cho, H. K. (2012). *Designing a robotics-enhanced learning content for STEAM Education 2012.* 9th International Conference on Ubiquitous Robots and Ambient Intelligence (URAI) Daejeon, Korea.

Judson, E., & Sawada, D. (2000). Examining the effects of a reformed junior high school science class on students' math achievement. *School Science and Mathematics,* 100(8), 419–425.

Kahya, V. (2019). *Alan uzmanlarının steam eğitimi ile ilgili görüşleri* (Unpublished master's dissertation. Bursa Uludağ University Instutite of Education, Bursa, Turkey.

Kim, D. H., Ko, D.G., Han, M.J. & Hong, S.H., (2014). The effects of science lessons applying STEAM education program on the creativity and ınterest levels of elementary students. J*ournal of the Korean Association for Science Education,* 34(1), 43-54.

Knezek, G., Christensen, R., Tyler-Wood, T., & Periathiruvadi, S. (2013). Impact of environmental power monitoring activities on middle school student perceptions of STEM. *Science Education International,* 24(1), 98-123.

Kolsuz, S. (2018). S*osyo-bilimsel konuların işlenmesinde STEAM uygulamaları* (Unpublished master's dissertation). Afyon Kocatepe University Instutite of Social Sciences, Afyonkarahisar, Turkey.

Kwona, S., Namb, D. & Lee, T. (2011). *The effects of convergence education based steam on elementary school students' creative personality.* T. Hirashima et al. (Eds.) (2011). Proceedings of the 19th International Conference on Computers in Education. Chiang Mai, Thailand: Asia-Pacific Society for Computers in Education

Lam, P., Doverspike, D., Zhao, J., Zhe, J., & Menzemer, C. (2008). An evaluation of a STEM program for middle school students on learning disability related ieps. *Journal of STEM education*, 9(1-2), 21–29.

Mercan, Z. (2019). *Erken steam geleceğe hazırlık programının çocukların görsel uzamsal akıl yürütme becerilerine etkisi* (Unpublished doctoral dissertation). Gazi University Instutite of Education, Ankara, Turkey.

Mercin, L. (2019). STEAM eğitiminde sanatın yeri. *Inonu University Journal of Art and Design,* 9(19), 28-41.

Ministry of National Education. (2018). *Fen bilimleri dersi öğretim programı (3, 4, 5, 6, 7 ve 8. sınıflar)*. Ankara: Milli Eğitim Bakanlığı.

Ministry of National Education Innovation and Educational Technologies General Directorate (2015). *STEM Eğitim Raporu.* Retrieved from http://yegitek.meb.gov.tr/STEM_Egitimi_Raporu.pdf

Nas, S. Peyman, D. & Arat, Ö. G. (2016). Bireylerin yüksek lisans yapma nedenleri üzerine bir araştırma. *Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü Dergisi,* 18(4), 571-599.

Ozkan, G. & Umdu Topsakal, U. (2017). Examining students' opinions about STEAM activities. *Journal of Education and Training Studies,* 5(9), 116-123.

Özkan, U. B. (2019). *Eğitim bilimleri araştırmaları için doküman inceleme yöntemi.* (1.Baskı). Ankara: Pegem Akademi Yayıncılık.

Park, N., & Ko, Y. (2012). *Computer education's teaching-learning methods using educational programming language based on STEAM education. In IFIP International Conference on Network and Parallel Computing* (pp. 320-327). Springer, Berlin, Heidelberg.

Robinson, A., Dailey, D., Hughes, G., & Cotabish, A. (2014). The effects of a science- focused STEM intervention on gifted elementary students' science knowledge and skills. *Journal of Advanced Academics,* 25(3), 189–213.

Rolling, J. H. (2016). Reinventing the STEAM Engine for Art + Design Education. Art Education, 69(4), 4-7.

Roth, W. M. (2001). Learning science through technological design. J*ournal of Research in Science Teaching*, 38(7), 768-790.

Sağat, E. (2020). *STEAM temelli fen öğretiminin üstün zekâlı ve yetenekli öğrencilerin steam performanslarına, tasarım temelli düşünme becerilerine ve STEAM tutumlarına etkisi.* (Unpublished master's dissertation). Mersin University Instıtute of Education, Mersin, Turkey.

Sen, C., Ay, Z., & Kıray, S. (2018). *Research Highlights in STEM Education*. USA: ISRES Publishing.

Shin J., Heo J. (2020) *STEAM-X: An exploratory study adding ınteractive physical activity to the STEAM model.* In: Zaphiris P., Ioannou A. (eds) Learning and collaboration technologies. designing, developing and deploying learning experiences. HCII 2020. Lecture Notes in Computer Science, 12205. Springer, Cham. https://doi.org/10.1007/978-3-030-50513-4_14

Sochacka, N. W., Guyotte, K. W. & Walther, J. (2016). Learning together: A collaborative autoethnographic exploration of STEAM (STEM+theArts) education. *Journal of Engineering Education*, 105(1), 15-42.

Sousa, D. A., & Pilecki, T. (2013). *From STEM to STEAM: Using brain-compatible strategies to integrate the arts*. Thousand Oaks, CA: Corwin.

Tal, T., Krajcik, J. S & Blumenfeld, P. C. (2006). An observational methodology for studying group design activity. *Research in Engineering Design*, 2(4), 722-745.

Tenaglia, T. (2017). *STEAM curriculum: Arts education as an integral part of interdisciplinary learning.* Messiah College Curriculum and Instruction Research Project, Parkway.

Torres-Crespo, M. N., Kraatz, E., & Pallansch, L. (2014). From fearing STEM to playing with it: The natural integration of STEM into the preschool classroom. *SRATE Journal*, 23(2), 8-16.

Tyler-Wood T, Knezek G, Christensen R (2010) Instruments forassessing interest in STEM content and careers. *Journal of Technology and Teacher Education*, 18(2), 341–363.

Uştu, H. (2019). *İlkokul düzeyinde bütünleşik STEM / STEAM etkinliklerinin uygulanması: Sınıf öğretmenleriyle bir eylem araştırması* (Unpublished doctoral dissertation). Necmettin Erbakan University Instutite of Education, Konya, Turkey.

Watter, J. J., & Diezman, C. M. (2013). Community partnerships for fostering student interest & engagement in STEM. *Journal of STEM Education: Innovations & Research,* 14(2), 47-55.

Weber, K. (2011). Role models and informal STEM-related activities positively impact female interest in STEM. T*echnology and Engineering Teacher,* 71(3), 18-22.

Wyss, V. L., Heulskamp, D., & Siebert, C. J. (2012). Increasing middle school student interest in STEM careers with videos of scientists. *International Journal of Environmental and Science Education*, 7(4), 501-522.

Yakman, G, (2008). *STΣ@M Education: an overview of creating a model of integrative education*. Pupils Attitudes Towards Technology. 2008 Annual Proceedings. Netherlands

Yakman, G. (2010). *What is the point of STE@M? - A Brief Overview,* Retrieved from http://www.steamedu.com/2006-2010_Short_WHAT_IS_STEAM.pdf

Yakman, G. & Hyonyong, L. (2012). Exploring the Exemplary STEAM Education in the U.S. as a Practical Educational Framework for Korea. J*ournal of The Korean Association For Science Education,* 32(6), 1072- 1086.

Yıldırım, B. & Altun, Y. (2015). STEM eğitim ve mühendislik uygulamalarının fen bilgisi laboratuar dersindeki etkilerinin incelenmesi. *El-Cezeri Journal of Science and Engineering*, 2(2), 28-40.

Yıldırım, B. & Selvi, M. (2017). An experimental research on effects of STEM applications and mastery learning. *Journal of Theory and Practice in Education*, 13(2), 183-210.

Yılmaz, A., Gülgün, C., Çetinkaya, M., & Doğanay, K. (2018). Initiatives and new trends towards STEM education in Turkey. *Journal of Education and Training Studies,* 6(11a), 1-10.

Yılmaz, A., & Yanarateş, E. (2020). Determination of Metaphorical Perceptions of Prospective Teachers on the Concept of “Water Pollution” Through Triangulation. *Kastamonu Education Journal,* 28(3), 1500-1528. https://doi.org/10.24106/kefdergi.722554

Yılmaz, H., Koyunkaya, M. Y., Güler, F., & Güzey, S. (2017). Fen, Teknoloji, Mühendislik, Matematik (STEM) eğitimi tutum ölçeğinin Türkçe’ye uyarlanması. *Kastamonu Eğitim Dergisi,* 25(5), 1787-1800.