Eurasian Journal of Educational Research 91 (2021) 173-204

Eurasian Journal of Educational Research
www.ejer.com.tr

Impact of Out-of-School STEM Activities on STEM Career Choices of Female Students

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ARTICLE INFO

Article History:
Received: 20 Jan. 2020
Received in revised form: 01 Sep. 2020
Accepted: 20 Sep. 2020
DOI: 10.14689/ejer.2021.91.9

Keywords
Cognitive styles, female students, out-of-school, STEM, STEM career development

ABSTRACT

Purpose: The aim of this research was to analyze change of STEM career choices of female students having different cognitive styles who participated in out-of-school STEM activities. Socio-economically disadvantaged, high academic achiever 20 female students participated in the research. Participants received integrated STEM training for six days and met STEM professionals working in universities and technoparks.
Research Methods: The embedded integrated pattern, one of the mixed research methods, was used in the research. Quantitative data consisted of STEM career interest scale, Witkin's hidden figures test and Holland occupational inventory. Interview form was used as qualitative data.
Findings: The results of the study showed that the implementation of out-of-school STEM activities contributed to an increase of STEM career interest. It was seen that there was a significant increase in STEM career interests of the independent participants. Field independent students were more interested in STEM fields. After STEM-related activities, 60% of the participants changed their occupational preferences towards STEM fields. STEM role models were found to support students' thinking about their careers and goal development.
Implications for Research and Practice: Implementing out of school STEM activities and meeting with STEM professionals will contribute to students' career choice in STEM fields. Understanding the cognitive styles of students will contribute to identifying STEM career interests.

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Introduction

One of the most important goals of STEM (science-technology-engineering-math) education is to support student's careers in science, technology, mathematics, and engineering (Bybee, 2013; National Research Council [NRC], 2011). Despite the high interest in STEM careers and the encouragement of scientists, societies, universities, university and government laboratories for the development of scientific-social careers and students' orientation to STEM careers, it is not at the desired level (Clarke et al., 2019). Many countries around the world are striving to raise more individuals for the STEM industries (Hill et al., 2010; Regisford, 2012). Few reports about the STEM fields have been prepared in Turkey. One of the most comprehensive reports has been prepared by Turkey Industrialists and Businessmen's Association (TUSIAD). TUSIAD (2017) published a report and accordingly, in 2023 about 3.5 million of the total employment in Turkey was said to be around 34 million STEM employment. In the period of 2016-2023, it is predicted that the STEM employment requirement will approach 1 million and a deficit of approximately 31% will occur in meeting this need based on undergraduate and graduates. Turkey is the world's 12th largest economy by purchasing power parity in 2030, while in 2050 the economy is expected to be the 11th. Therefore, a qualified workforce is needed in STEM fields (TUSIAD, 2017). In response to this increasing demand, the Ministry of National Education (MoNE, 2018) updated the science curriculum program and incorporated engineering practices into the teaching process at the middle school level. However, the same change did not occur at the upper secondary school level.

Upper secondary school years are critical when students plan their STEM career development in different areas and make career decisions (Falco, 2017; Fouad & Santana, 2017). During upper secondary school, girls get better grades than boys in most mathematics and science classes, but boys perform better than girls in standardized tests (Lindberg, et al., 2010). In a study conducted with high school students, it was found that men were more interested in STEM career than girls. The proportion of men who were interested in a STEM career during high school years remained constant, while this ratio decreased for women (Sadler et al., 2012). Today, more women graduate in science and engineering programs than ever before; however, women with high mathematical abilities choose non-STEM areas more often compared to men with similar abilities (Wang & Degol, 2017). According to the STEM Education Turkey report, it is seen that males prefer STEM fields in university placements rather than females (Akgunduz et al., 2015). Numerous studies within the STEM fields of education show that women tend to be less motivated, interested or less likely to participate in STEM education in comparison to men (Kanny, Sax & Riggers-Piehl, 2014). Although there is a limited understanding of how different the fluctuations between genders in STEM domains, there are significant gender differences between STEM domains (Sadler et al., 2012).

Gender, race, and disadvantaged groups in STEM career interests are a result of individual differences. Individual difference is classified as physical, emotional, and mental characteristics. One of the individual differences is cognitive styles. Cronbach and Snow (1977) define cognitive styles as the information processing strategy that a person prefers when organizing everything he or she sees, remembers, and thinks. More than 40 years of theoretical and experimental research on cognitive styles have been conducted. As a result of these studies, a large number of cognitive styles are defined. According to Witkin et al. (1977), a person who easily breaks down a perception field and easily separates the desired item from his or her context; a person who cannot adequately separate an item from its context and accepts the dominant domain or context is also defined as a dependent individual. Witkin et al. (1977) stated that cognitive style includes ways of memorizing and refreshing information as well as students' ways of processing, acquiring, and approaching information. The fact that we know a cognitive style that a student has also indicate that it will give some clues about student's achievement. Studies examining the relationship between students' cognitive styles (field dependent / field independent) and their academic achievement generally show that students with independent cognitive styles are more successful than field dependent students (Bahar & Hansell, 2000; Karacam & Ates, 2010) in science and math. Field independent students are superior in problem-solving (especially mathematics), learning the structural rules of a language, determining the important aspects of information even if it is badly arranged, applying the learned knowledge to different situations, and determining the structure underlying an idea (Jonassen &Grabowski, 1993). Witkin et al. (1977) state that many mathematicians, chemists, biologists, physicists, and engineers are independent individuals who take the field. In addition, while field independent upper secondary school and university students prefer mathematics, science, art, experimental psychology, engineering, and architecture fields, field dependent students choose more social aspects such as sociology, humanities, clinical psychology, and nursing (Sahin, 2018). When we adopt this theory developed in the 1970s to today, it is seen that these areas are related to the STEM career fields. Therefore, the role of cognitive differences in the development of students' higher education STEM career interest can be examined.

Studies showed that various factors are effective in the orientation of students to STEM fields (Martin-Hansen, 2018). In-school and out-of-school settings designed for STEM professionals and careers increase STEM awareness and interest (Avery, 2013). Out-of-school learning environments increase students' interest in STEM and student chances to pursue a career in STEM (Kitchen et al. 2018). Out-of-school contextual experiences are critical for developing student STEM competencies as well as learning and exploring STEM ideas (Baran et al., 2016). In addition, the presence of role models working in the STEM fields increase students' perceptions and interests of STEM (Stout et al., 2011). Summer camps are one of the most commonly seen programs in out-of-school STEM education having a positive impact on student academic achievement and STEM perception (Nugent et al., 2010). Student interest in STEM topics and careers increased after attending a one-week summer STEM camp that included hands-on STEM activities related to robotics, astronomy, and neurobiology (Mohr-Schroeder et al., 2014). Dabney et al. (2011) found that students who reported that they had engaged in out-of-school science activities a few times a year or more were more likely to be interested in a STEM discipline. In another context, upper-secondary school students who met with scientists while participating in field trips to universities in an out-of-school education program increased their awareness of STEM careers and could picture themselves as scientists (Jensen & Sjaastad, 2013). Research supports the effectiveness of active learning in STEM student participation and performance because these approaches provide experiences that improve students' adaptation to professional activities and positively affect student attitudes and motivation (Graham et al., 2013). Understanding the factors that influence students' STEM career aspirations is crucial to close the gender gap of STEM professionals; moreover, it is among the most crucial factors in upper secondary school learning experiences (Tzu-Ling, 2019). Very little is known about gender roles in pursuing careers in the STEM fields in Turkey. This research focused on the cognitive styles of female students in their orientation towards STEM career interest. The purpose of this research was to examine STEM career preferences of female students with different cognitive styles participating in out-of-school STEM activities. In this research, answers to the following questions were sought.

1. Is there a significant difference between the participants' STEM career interests in out-of-school pre- and post-STEM activities?
2. Is there a significant difference between the cognitive differences of the participants and the pre- and post- STEM activities scores regarding STEM career interests?
3. What are the close and distant images of the participants regarding their cognitive differences and career fields?
4. Has there been any change in the career plans of the participants' pre- and post-STEM activities?
5. Has there been any change in the level of STEM knowledge of the participants' pre- and post-STEM activities?

Method

Research Design

Mixed method research was preferred in the research. Mixed methods research is used to collect, analyze, and reconcile both quantitative and qualitative data in a single research or multiple series of studies to understand the research problem (Creswell & Plano Clark, 2011).

Table 1

Research Pattern

Embedded / Integrated Pattern	
Qualitative (or Quantitative) Pattern Quantitative (or Intel) Data Collection and Analysis (Before-During-After)	Interpretation

In this research, embedded / integrated design, one of the mixed methods research designs, was used. The research started with the collection of qualitative data, then quantitative data were collected. After out-of-school STEM activities were implemented; qualitative and quantitative data were collected, again. Qualitative methods were used to answer the 1st, the 2nd, and the 3rd research questions. Quantitative methods were used to answer the 4th and the 5th research questions.

Participants and Activity Process

This research was funded by Scientific and Technological Research Institutions of Turkey (TUBITAK) 4004 Nature Education and Science Schools Support Program under the name of "Girls are planning their careers with STEAM" in 2019-2020 education and training year. The ethical approval of the research was obtained from Local Education Authorities.

The application of participants was received through the website. Applications were examined by the researcher. The following criteria were taken into account in the selection of the students to participate in the Project; (1) Female students with high academic success (Students with a grade point average of 85 and above in the previous year) (2) Students whose socio-economic level is relatively low (Applications from private school students have not been evaluated) (3) Students whose parents are approved to participate in the project. 20 female students participated in the project. Students make university preferences after grade 11 (upper secondary school) in the Turkish education system. These preferences determine students' professions. Therefore, the project is important for the career planning of participant students. Science, technology, engineering, mathematics, and art themed workshops were realized by expert educators in the project. At the end of the workshops, the students visited the universities and technoparks in the center of Ankara. Students received information and interviewed about the work of professionals working in STEM fields. The activity process is presented in detail in Figure 1. The blue section represents pre- and post-quantitative-qualitative research tools. The yellow section represents STEM activities, and the orange section represents meeting with STEM professionals in universities and technoparks.

Figure 1. *Activity and Research Process*

Instrument and Procedures & Data Analysis

In this research, STEM Career Interest Scale, Witkins Hidden Figures Test, and Holland (RIACT) occupational inventory were used to collect the quantitative data. An interview form was used to collect the qualitative data.

Quantitative data collection tools

In this section, STEM Career Interest Scale, Witkins Hidden Figures Test, and Holland Occupational Inventory, which were used to collect quantitative data, were presented.

STEM Career Interest Scale (STEM-CIS)

In the research, STEM-CIS developed by Kier et al. (2014) was used as data collection tool. The scale was adapted to Turkish by Unlu, Dökme and Unlu (2016). The scale was used with the approval of the original and Turkish adaptation authors by e-mail. The original scale consists of four dimensions: science (11 items), technology (11 items), mathematics (11 items) and engineering (11 items). The highest score on this scale is 220 and the lowest score is 44. The original scale was designed as 5-points

Likert type. In order to calculate the reliability coefficients of the scale, the reliability coefficient (Cronbach's Alpha) values of each sub-dimension were examined. Science, Technology, Engineering, and Mathematics dimensions were formed based on the socio-cognitive career development model. According to the model individual inputs (participation, gender, race-ethnicity, health status), positive or negative environments in the past, learning experiences, the expectation of competence, expectation of outcome, interests, choice objectives, choice behavior, and performance areas important indicators in career choose (Lent, Brown and Hackett, 1994). Self-efficacy, for example, is an individual's belief in his or her capacity to analyze personal goals and decisions. Personal goals express the learner's expectations. Rennie et al. (2003) stated that interest in STEM is effective in choosing a profession. Contextual support means that individuals working in this field support him/her in the environment (Lent et al., 1994).

Witkins Hidden Figures Test

Cognitive style is the typical or habitual problem solving, thinking, perception, and remembering style of the individual (Sujito et al. 2019). In this research, Hidden Figure Test (HFT) was used to determine students' cognitive style tendency to field dependence/ independence. It has been observed that cognitive styles are a criterion for determining the STEM careers interest of middle school students (Donmez, 2018). In this research, it was used to analyze the effect of cognitive styles of upper secondary school female students on the STEM career interests. The Hidden Figure Test (HFT) was developed to determine the level of dependence/independence of each participant. This test was obtained as a result of modification of the hidden figures test. In the test, participants are expected to identify simple geometric shapes from complex geometric shapes over a period of time. The Cronbach α reliability coefficient of the test was found to be 0.82 (Witkin et al., 1977). The test consists of 3 parts. The first part consists of seven other parts and nine questions. The first part must be completed in two minutes and the other two sections in five minutes. The first section consists of relatively simple questions aim at students' practice. The questions in the second and third sections are a bit more difficult than the previous ones and only the scores obtained from these sections are included in the total score.

Table 2

Arithmetic Mean and Standard Deviation of the Hidden Figures Test

Number of Students	Highest Score	Lowest Score	Average	Standard Deviation
20	21	10	15.25	3.72

Table 2. shows the mean and standard deviation values according to the results of the Hidden Figures Test. The formula developed by Alamolhodaei (1996) is used to evaluate the test of the hidden figure test. According to this formula, those who find more accurate shapes than the number obtained by summing a quarter of the standard deviation with the average are classified as field independent, and those who find less accurate shape than the number obtained by subtracting one quarter of the standard

deviation are classified as field dependent. Students whose correct shape numbers are found between these two numbers are classified as students with moderate cognitive style (Karacam & Ates, 2010). According to this;

(A) Field Independent Cognitive Style = 15.25 + 3.72 = 18.97 (correct answers between 19-22)

(B) Field Moderate Cognitive Style = 12-19 correct answers.

(C) Field Dependent Cognitive Style = 15.25- 3.72 = 11.53 (correct answers between 0-12)

Table 3

HFT Scores, Cognitive Styles, and Categories of Participants

Participants	HFT Points	HFT	Category
S1	13	Field Moderate Cognitive Style	B
S2	15	Field Moderate Cognitive Style	B
S3	15	Field Moderate Cognitive Style	B
S4	14	Field Moderate Cognitive Style	B
S5	15	Field Moderate Cognitive Style	B
S6	19	Field Independent Cognitive Style	A
S7	21	Field Independent Cognitive Style	A
S8	11	Field Dependent Cognitive Style	C
S9	19	Field Independent Cognitive Style	A
S10	10	Field Dependent Cognitive Style	C
S11	19	Field Independent Cognitive Style	A
S12	19	Field Independent Cognitive Style	A
S13	19	Field Independent Cognitive Style	A
S14	19	Field Independent Cognitive Style	A
S15	10	Field Dependent Cognitive Style	C
S16	13	Field Moderate Cognitive Style	B
S17	14	Field Moderate Cognitive Style	B
S18	11	Field Dependent Cognitive Style	C
S19	11	Field Dependent Cognitive Style	C
S20	10	Field Dependent Cognitive Style	C

** field independent cognitive style = A, field moderate cognitive style = B, field dependent cognitive style = C*

Table 3 shows the scores of the participants' Hidden Figures Test (HFT). The highest score (S7) was 21 and the lowest score (S15, S20) was 10. The participants had (S6, S7, S9, S11, S12, S13, S14) field independent cognitive style, (S1, S2, S3, S4, S5, S16, S17) field moderate cognitive style, and (S8, S10, S15, S18, S19, S20) field dependent cognitive style.

Holland Occupational Inventory

Holland (RIASEC) occupational inventory was used to determine and search students' tendency of interest and STEM career fields. Holland developed four propositions about the interaction between people and business circles (Kuzgun, 2006). These propositions reflect the interactive structure of Holland's typology theory (Sharf, 2001). This theory can also be explained as person environmental harmony. Holland explains these propositions as follows (Weinrach & Srebalus, 1990): (1) many people can be placed in one of the six personality types considering similarities. These are defined as realist, researcher, artist, social, enterprising, or traditional. (2) There are six types of work environments that correspond to six types of persons. (3) People seek environments in which they can demonstrate their skills and abilities, express their attitudes and values, and take on agreed problems and roles. (4) The interaction between the personality type and the characteristics of the environment determines the behavior of an individual's choice of occupation.

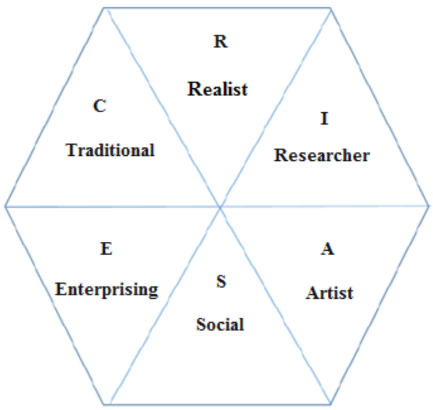


Figure 2. *Holland Occupational (RIASEC) Inventory Dimensions*

In Figure 2, according to the model which is also referred to as RIASEC in Holland's professional inventory, people are defined by the jobs they want to do, and another variable is defined by the people working in the job (Armstrong et al., 2008). Holland (1996) had six types of personality according to the environment of the professional interest person, in which individuals' interests are centered in the choice of profession: Realistic Personality Type: These people have the realistic personality type defined by the letter “R” in Holland's typology. The ability to work with objects is more important than the ability to communicate with people (Sharf, 2001). They prefer professions such as carpentry, driving, farming, piloting, sports, technics, building, marine, engineering, electrics, and mechanic (Holland, 1996; Ivancevich, 2003; Sharf, 2001).

Researcher Personality Type: These people, identified with the letter “I” in Holland's typology, enjoy puzzles and mathematical and scientific problems that they can use in different ways (Sharf, 2001). Microbiologist, biologist, scientist, engineer, chemist, geologist, researcher are suitable jobs for people with this type of personality (Holland, 1996; Ivancevich, 2003; Sharf, 2001).

Artist Personality Type: These people, identified with the letter “A” in the Holland’s typology, enjoy expressing themselves freely and systematically by music, art, or writing (Sharf, 2001). They are generally introverted, emotional, and sensitive, have a wide imagination and are fond of art, music, literature, and aesthetics. Musicians, theater artists, artists, interior designers, writers, decorators, modelers, and industrial designers are suitable jobs for people with this type of personality (Holland, 1996; Ivancevich, 2003; Sharf, 2001).

Social Personality Type: These people, identified by the letter “S” in Holland's typology (Kamasak & Bulutlar, 2015), like to help, teach, serve, and advise other people. Professions such as counseling, clergy, education supervisors, guidance counselors, nursing, social work specialists, psychologists, and counseling can be considered ideal for these people (Holland, 1996; Ivancevich, 2003, Sharf, 2001).

Enterprising Personality Type: People with this type of personality, identified by the letter “E” in Holland's typology, like spending time with others, persuading them or leading, and being popular (Sharf, 2001). Professions such as lawyer, salesman, politician, economist, salesperson, TV producer, manager, and general manager can be considered ideal for these people (Holland, 1996; Ivancevich, 2003; Sharf, 2001).

Traditional Personality Type: People with this type of personality, identified with the letter “C” in Holland's typology, value money and reliability, follow rules and order and avoid uncertain environments (Sharf, 2016). Banker, accounter, secretary and supervisor, public administrator, and tax expertise can be counted as suitable occupations for people with this type of personality (Holland, 1996; Ivancevich, 2003, Sharf, 2001).

Qualitative data collection tools

Interviews

Interview includes formal, informal, or structured, open-ended answers to get people's views on specific issues (Bogdan & Biklen, 2006). Some researchers conduct in-depth interviews for life history information, and others for personal information and beliefs of individuals (Yerrick & Hoving, 2003). The interview technique was used to collect qualitative data in the research. Interview questions were created by the researcher taking the opinions of two field experts. The research was conducted to get the opinions of the participants’ pre- and post-STEM activities to learn the change of student's experience. In this context, the following questions were included; (1) What do science, technology, engineering, art, and math concepts mean to you? (2) Do you want to have a profession in science in the future? Why? (3) Do you want to have a profession in the future in Technology? Why? (4) Do you want to have a profession in Engineering in the future? Why? (5) Do you want to have a profession in the future in Mathematics? Why? (6) Could you please list the three occupations you want to choose in the future?

Data Analysis

Average, standard deviation, t test, and ANOVA test were used for the analysis of the quantitative data. Content analysis was used for the qualitative data. According to Bogdan and Biklen (2006), content analysis is the objective and systematic examination of verbal, written, and other materials and their arrangement according to certain themes. Content analysis is to gather similar data within the framework of certain concepts and themes and to interpret them in a way that the reader can understand. Interviews with the participants were conducted with each student for 30 minutes before the STEM activities and after the STEM activities. Student responses were transcribed by the researcher. The opinions of each participant are arranged in a table.

Results

Quantitative Findings

Is there a significant difference between the participants' STEM career interests in out-of-school pre- and post-STEM activities?

Table 4

Paired t-test Results

	N	Mean	SD	t value		
Pre-STEM activities	20	3.79	0.42	t	df	*p*
Post-STEM activities	20	4.16	0.37	-4.336	19	.000

Table 4 shows the paired t-test results of STEM students. The scores of 20 female students participating in STEM education were obtained from the STEM career interest scale. In the pre-STEM activities, the mean score of the participants was 3.79 and the standard deviation was 0.42. In the post STEM activities, it was seen that the mean score of the participants was 4.16 and the standard deviation was 0.37. *p*-value was calculated to be 0.00 ($p < 0.001$). This value shows that there is a significant difference between the pre- STEM and post- STEM activity scores of the participants. When the table is examined, it is seen that the pre-STEM activities (4.16) score of this value was higher than the pre-test score (3.79). This finding shows that the scores of the participants increased significantly at the end of the STEM-based activities.

Is there a significant difference between the cognitive differences of the participants and the pre- and post- STEM activities scores regarding STEM career interests?

Table 5

Mean and Standard Deviation Values of Participant's Cognitive Styles

Application	Cognitive Style	n	Mean	SD
Pre-STEM activities	Field Independent	7	4.22	.27
	Field Moderate	7	3.52	.25
	Field Dependent	6	3.50	.20
	Total	20	3.79	.42
Post-STEM activities	Field Independent	7	4.49	.20
	Field Moderate	7	4.04	.22
	Field Dependent	6	3.79	.32
	Total	20	4.16	.37

Table 5 shows the scores of the participating students according to their cognitive styles. It was seen that the arithmetic average of the independent STEM career interest scale was 4.22 and the standard deviation was 0.27 (n = 7). It was seen that the mean score for the students with field moderate cognitive style (n = 7) was 3.52 and the standard deviation was 0.25. It was seen that the average of the field dependent participants (n = 6) was 3.50 and the standard deviation value was 0.42. At the end of the STEM activities, according to the STEM career interest scale, the average of the independent participants (n = 7) was 4.49 and the standard deviation value was 0.20; The mean of the participant with a field moderate cognitive style (n = 7) was 4.04 and the standard deviation value was 0.22; It was seen that the average of the students who were field dependent (n = 6) was 3.79 and the standard deviation was 0.37.

Table 6

ANOVA Values of Participant's Cognitive Styles

		Sum of Squares	df	Mean Square	F	Sig.
Pre- STEM activities	Between Groups	2.417	2	1.208		
	Within Groups	1.054	17	.062	19.498	.000
	Total	3.470	19			
Post-STEM activities	Between Groups	1.641	2	.820		
	Within Groups	1.007	17	.059	13.854	.000
	Total	2.647	19			

Table 6 shows the results of ANOVA test comparing field dependent, field moderate, and field independent students. There was a significant difference between the pretest scores between the groups F = 19.498, p = 0.000 (p <0.001). There was a significant difference between the posttest scores between the groups F = 13.854, p = 0.000 (p <0.001). When the table was examined, it was seen that this difference in STEM career interest scale was from field dependent to field independent.

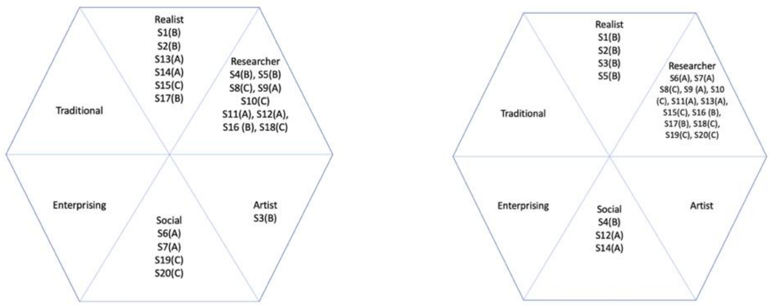
Table 7

Post-Hoc Results of Groups

Dependent Variable	(I) Cognitive style	(J) Cognitive Style	Mean Difference (I-J)	SD	*p*
Pre-STEM activities	Field Independent	Field Moderate	.69846*	.12	.000
		Field Dependent	.72443*	.14	.000
	Field Moderate	Field Independent	-.69846*	.12	.000
		Field Dependent	.02597	.14	.984
	Field Dependent	Field Independent	-.72443*	.14	.000
		Field Moderate	-.02597	.14	.984
Post-STEM activities	Field Independent	Field Moderate	.44927*	.12	.009
		Field Dependent	.69602*	.13	.000
	Field Moderate	Field Independent	-.44927*	.12	.009
		Field Dependent	.24675	.14	.251
	Field Dependent	Field Independent	-.69602*	.13	.000
		Field Moderate	-.24675	.14	.251

Table 7 shows the scores of the participating students according to their cognitive styles. Accordingly, it was seen that the arithmetic average of the independent STEM career interest scale was 4.22 and the standard deviation was 0.27 from the participating students (n = 8). It was seen that the mean (3.5) and the standard deviation of the students with field moderate cognitive style (n = 7) was 0.25. It was seen that the average of the field dependent participants (n = 5) was 3.5 and the standard deviation value was 0.42. At the end of the activities, according to the STEM career interest scale, the average of the independent participants (n = 8) was 4.49 and the standard deviation value was 0.20; The mean of the participant with a field moderate cognitive style (n = 7) was 4.04 and the standard deviation value was 0.22; It is seen that the average of the students who were field dependent (n = 5) was 3.79 and the standard deviation was 0.37.

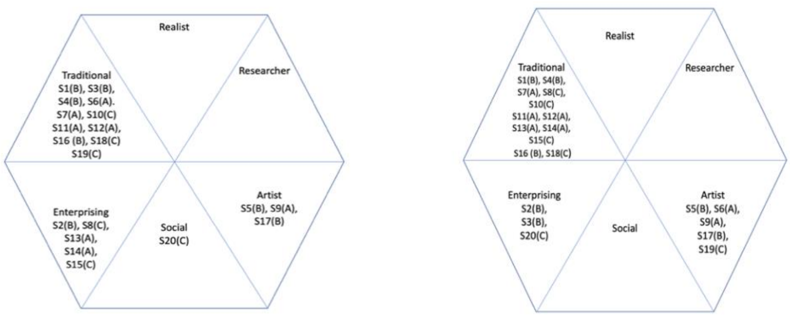
What are the close and distant images of the participants regarding their cognitive differences and career fields?



Pre- STEM activities Post- STEM activities

Figure 3. *The Closest Images of The Participants According to Holland Occupational Inventory*

Figure 3 shows the closest images of Pre- STEM activities and Post- STEM activities according to the Holland occupational inventory. Pre- STEM activities of the participants' images were realist (S1(B), S2(B), S13(A), S14(A), S15(C), S17(B)), researcher (S4(B), S5(B), S8(C), S9(A), S10(C), S11(A), S12(A), S13(A), S16(B), S18(C)), social (S6(A), S7(A), S19(C), S20(C)) and the artist (S3 (B)). Realist (S1 (B), S2 (A), S3 (B), S5 (B)), researcher (S1(B), S2(A), S3 (B), S5 (B)), researcher (S6 (A), S7 (A), S8 (C), S10 (C), S11 (A), S13 (C), S15 (C), S16 (C), S17 (B), S18 (C), S19 (C), S20 (C)), and social (S4 (B), S12 (C), S14 (A)) fields were seen to be chosen. In Pre- STEM activities, it was seen that field dependent, field moderate and independent participants were not in certain patterns. However, for Post- STEM activities, it was seen that the participants were concentrated in the research field. After these STEM activities, it was seen that the participants were concentrated in the field of "Researcher".



Pre- STEM activities Post- STEM activities

Figure 4. *The Most Distant Images of Participants in the Pre- and Post-STEM Activities According to the Holland Occupational Inventory*

Figure 4 shows the most remote fields of the participants in the Pre- STEM activities and Post- STEM activities. The most distant images of the participants in the Pre-STEM activities were traditional (S1(B), S3(B), S4(B), S6(A), S7(A), S10(C), S11(A), S12(A), S16(B), S18(C), S19(C)), enterprising (S2(B) S8(C), S13(A), S14 (A), S15(C)), artist (S5 (B), S9 (A), S17 (B)) and social S20(C) fields. For Post- STEM activities, the choices of students were traditional (S1(B), S4 (A), S7 (A), S8 (C), S10 (C), S11 (A), S12 (A), S13 (A), S14 (A), S15 (C), S16 (B), S18 (C)), enterprising (S2(B), S3(B), S20 (C)), and artist (S5 (B), S6 (A), S9(A), S17 (B), S19 (C)). In Pre and Post STEM activities, it was seen that field dependent, field moderate and independent participants were not in certain patterns. However, after the implementation, it was seen that the participants were concentrated in the traditional and artist field.

Qualitative Findings

Has there been any change in the career plans of the participants' pre- and post-STEM activities?

In Table 8, the first three occupational preferences were asked to the participants for pre- and post-STEM activities. In the pre-STEM, students mostly made occupational preferences such as being an engineer, doctor, and teacher. Although students wanted to work as engineers, they could not determine which engineering profession they wanted to choose. Another finding revealed that students mostly focused on engineering fields in the post-STEM activities, and they knew the characteristics of the engineering department. In the post STEM activities, participants S1(B), S5(B), S6(A), S8(C), S9(A), S11(A), S12(A), S13(A), S14(A), S15(C), S17(B), S20(C) were seen to change their professional preferences. It is observed that 60 percent of the participants have changed their career choices. It was seen that most of the participants who changed their occupation preferences were independent students (%50) followed by moderate dependent students (%25), and finally field dependent students (%25). It was seen that the students were influenced by the STEM experts they met during their university and technopark trips because students' occupational references for mechatronics (S1(B)), aerospace engineering (S5(B), S20(C)), geomatics (S6(A)), chemical engineering (S6(A), S8(C), S11(A), S17(B),), and medicine engineering (S6(A), S8(C), S14(A) were STEM professionals who work at universities and technoparks.

Table 8

First and Last Occupation Preferences of Participants

P.	First Occupation Preferences	Latest Occupation Preferences
S1 (B) *	Pilot, teacher, computer engineer	Mechatronics, computer engineer, software engineering
S2 (B)	Aircraft engineering, electrical and electronics engineering, computer engineering	Aircraft engineering, electrical and electronics engineering, computer engineering
S3(B)	Computer engineering, electrical and electronics engineering, architecture	Computer engineering, software engineering, electrical and electronics engineering
S4(B)	Soldier, prosecutor, pilot	Soldier, prosecutor, pilot

Table 8 Continue

S5(B) *	Doctor, teacher, mechatronics	Aerospace engineering, mechatronics engineering, computer engineering
S6(A)*	Teacher, dentist, engineer	Medicine, geomatics engineering, chemical engineering
S7(A)	Molecular biology and genetics, computer engineering, electrical-electronics engineering	Computer engineering, molecular biology, electrical and electronics engineering
S8(C)*	Doctor (orthopedics, general surgery, pediatrics), teacher, dentist	Medicine (orthopedics, general surgery, pediatrics) engineering, chemistry, geometry engineering
S9(A)*	Computer software engineering, doctor, teacher	Software engineering, architecture, computer engineering
S10(C)	Engineering, pharmacy, veterinary.	Pharmacist (dealing with drugs), engineering, veterinary
S11(A)*	Architect, doctor, teacher	Architecture, chemistry, physics
S12(A)*	Prosecutor, genetic engineer, doctor	Computer engineering, molecular biology, electrical and electronics engineering
S13(A)*	Doctor, engineer, music	Surgeon, software engineering, mechanical engineering
S14(A)*	Soldier, prosecutor, pilot	Medicine, software engineering, computer engineering
S15(C)*	Teacher, doctor, engineer	Electrical Engineering, mechanical engineering, computer engineering
S16(B)	Gynecologist, dentistry, veterinary	Gynecologist, dentistry, veterinary
S17(B)*	Computer/software engineering, architecture, teacher	Computer engineering, chemical engineer, doctor
S18(C)	Chemical engineer, genetic engineer, fashion designer	Chemical engineer, genetic engineer, fashion designer
S19(C)	Software engineering, computer engineering, health	Software engineering, computer engineering, health personnel
S20(C)*	Electrical-electronics engineering, software engineering, lawyer	Computer engineering, electrical and electronic engineering, aerospace engineering

P=Participants

In Table 9, students' opinions about science, technology, engineering, and mathematics can be seen. It was found that students' professional preferences and interpretations overlapped. However, although students were willing to work in the fields of science, technology, and engineering, they were reluctant to study mathematics; (S2 (B), S4(B), S10(C), S11(A), S13(A), S14(A), S17(B), S19(C), S20(C) argue that they only want to use mathematics as an intermediary as part of their work.

Table 9

Participants' Views on STEM Areas

P.	S	T	E	M	Comment (e.g.)
S1(B)	+	+	+	+	…I like to deal with numbers, and I love physics and biology…
S2(B)	+	+	+	-	Math is my favorite subject, but I don't think I can work in this field. I like technical works more…
S3(B)	+	+	+	+	I don't want math, maybe I can use it in my work….
S4(B)	+	+	-	-	…I want to work in the field of science. I love technology, but engineering and math are not for me….
S5(B)	+	+	+	+	…Since I'm a numericalist, math will be in one area of my job.
S6(A)	+	-	+	+	I don't want to, I'm a little scared of technology, I'm scared of coding.
S7(A)	+	+	+	+	…I think of computer engineering relationships with physics, science even in the social sciences, there is science in life…
S8(C)	+	+	+	+	…I want to choose medicine. Counted in the field of science. I want to treat a patient. I want to help people. I want to feel a sense of gratitude….
S9(A)	+	+	+	+	… I want to be an engineer. My interest is to do science and technology, coding and robot making. I want to be an enterprising woman.
Ö10(C)	+	-	+	-	My interest and my ability may be in engineering, in line with science, but I would not want the ones in technology and mathematics…
S11(A)	+	+	-	-	I want to find new things. I love technology. I don't want engineering and math…
S12(A)	+	+	+	+	….I love STEM areas and I believe that I will study…
S13(A)	+	+	+	-	…. I would like to help people who love dealing with something in science research physics, chemistry biology. But math for me…
S14(A)	+	+	-	-	…I don't want to choose a profession directly on mathematics, I want to use mathematics as a tool. software engineering, computer engineering can be my job.
S15(C)	+	+	+	+	…..I want to be in the field of production which could be ASELSAN engineering…

Table 9 Continues

S16(B)	+	+	+	+	….STEM attracts me more because. I love math and science, I want to study medicine field…
S17(B)	+	+	+	-	…There's only one field. I can study computer engineering, and I found interest in designing games on our university visit….
S18(C)	+	+	+	+	…I feel happy in about areas and I see that there are many jobs. I think I'm good in tech, science and mathematics…
S19(C)	+	+	+	-	…STEM means the occupation of the future. I don't want math, maybe I'll use it in a job…
S20(C)	+	+	-	-	…My math grades are good, but I don't think about working in this field, I can't relate to math real life. I can study in science and technology…
Total	**20**	**17**	**17**	**12**	

Has there been any change in the level of STEM knowledge of the participants' pre- and post-STEM activities?

Table 10 shows the participants' views on STEM concepts in the pre-STEM activities and post- STEM activities. The participants were asked what STEM fields and concepts meant. The views of the participants were concentrated around the concept of future (S1, S4, S5, S8, S9, S10, S13). The other concepts were the progress of the country (S5, S10) and career (S2, S4, S9). In addition to STEM concept, concepts such as life (S3), intelligence (S6), fun (S6), thought (S8), miraculous results (S8), diligence (S11), interesting (S11), fiction (S11), societal interview (S11, S12), and creativity (S20) were also mentioned. The features of science; understanding the universe (S12), discoverable (S20) research (S5, S20), the importance of science (S8), discovering nature (S11). Characteristics of technology; facilitating human lives (S20). Features of art, collection of works (S20). The features of mathematics such as rules (S11).

Table 10

Opinions of Participants About STEM Concepts Pre and Post STEM Activities

P.	Pre-STEM activities	Post-STEM activities
S1 (B)	STEM concepts represent an advanced life for me.	STEM is area where we can make life convenient and benefit society.
S2 (B)	Career terms	Science for me universe events, technology; inventions adapted to new systems, engineering; It supplies materials making repair and profession, art; drawing, painting making its own unique processes; math means operations.

Table 10 Continues

S3(B)	It's like living together. It is possible to see art, technology, even in the smallest tool we use. If one is missing, the construction is undermined.	I think of them as a whole. Even when making a pen, we use all of these concepts.
S4(B)	if I can improve myself in these areas, I can make career	I think they are good things to improve myself. These are complementary areas.
S5(B)	It describes the research steps that need to be taken for my future and the progress of my country.	It expresses my future, both the profession I have chosen and the future of my country.
S6(A)	Something it's smart and fun.	Conduct experiments in science, technology is electronic instruments, engineering; construction… Art: painting, mathematics; processes. These are all concepts of intelligence.
S7(A)	No Idea	I think it will be valuable when all of them are intertwined, and more valuable when integrated interdisciplinary
S8(C)	Science is for me the most important tool for the future. I think engineering, mathematics and technology exist thanks to science. When we say art, I think of bringing together things that are pleasing to one's opinion and one's opinion in an orderly or irregular manner. Although each of them expresses many things separately, when used together, miraculous results occur.	I see things as necessary in the future, as occupations of the future. I want to study medicine, without these fields, medicine would be pointless.
S9(A)	They are the concepts that will form the future. Because my dream is to become an engineer in the future.	It revives the occupation that I want to be in the future, and I want to be an engineer in these areas of interest.
S10(C)	It means the future. The better we want the country and the human condition to be in the future, the more we should pay attention to these concepts and focus on them.	I think it means the future. These areas are important to save and facilitate our future.

Table 10 Continues

S11(A)	Science is the discovery of nature, diligence, interesting. Mathematics has been conveyed by fiction for me. For this reason, I am trying to progress by accepting mathematics.	For me, art makes people feel soothing and expressive because if I can draw on a painting, I can play a musical instrument. Even a science-related project uses art. I think these areas can connect. Electronics looks very complex, but art can connect these spaces.
S12(A)	For me, science is the most important thing to be used for societies to negotiate and understand the universe.	The sum of all of these, we can say that the groups of all professions and basic sciences in the world. We can say the most important areas.
S13(A)	These are the areas that have shaped the benefit of society from past to present and will not lose their importance for humanity in the future.	Science, the result of research, ideas, objects, technology; products that make human life easier. Engineering; designing something, art; music picture similar things, mathematics; just a lesson.
S14(A)	No Idea	The future, being planned, tells the features I will be facing in the future environments.
S15(C)	No Idea	It expresses areas of my interest and curiosity.
S16(B)	No Idea	Areas that interest me and arouse curiosity. As a result, they all lead to learning new things.
S17(B)	No Idea	It means my future and my career.
S18(C)	No Idea	I mean the future. Life itself, using technology, science to advance, engineering, all of these include. If the picture is not music, nothing happens, math involves some intelligence and logical thinking.
S19(C)	No Idea	Science interesting things, technology instruments, mathematics numbers, engineering ruler pencil, art picture.
S20(C)	Science: the field of scientific knowledge that can be explored, searched, conveyed by objective judgments. Technology: tools to facilitate human lives. Engineering: there are many areas, and not all of these areas meet in the common denominator. Art; human interest, creativity as a result of the collection of works produced. Math: my knowledge and interest in the course do not go beyond what is described in the course.	Science; experiment, technology; I'm following, my future goals, engineering; among your future goals. I don't like math

S7, S15, S16, S17, S18, S19 did not respond to what STEM fields and concepts meant. After the STEM activities, it was seen that the participants produced more concepts about STEM concepts and contents in the post STEM activities. For STEM content, concepts such as future (S5, S8, S9, S10, S14, S17, S18, S20), profession (S8, S9, S12, S17), convenience (S1, S10), the progress of the country (S5), benefit to society (S1), being planned (S14), important (S12), interest (S15, S16), and curiosity (S15, S16) were used. It was seen that the expression of future and profession came to the forefront. The metaphors they produced were intelligent (S6), complement (S2, S4, S8, S11, S16), and integrated interdisciplinary (S7). Complementary STEM areas were integrated into each other. According to the first application of the concepts of science, technology, engineering, and mathematics which constitute STEM concepts, the participants produced data rich concepts. Science features; universe events (S2), experiment (S6, S20), research (S13), ideas (S13), objects (S13) features of technology; invention (S2), instrument (S6), facilitation (S13), target (S20), engineering; construction-repair (S2), construction (S6), characteristics of art; painting (S2, S6), original (S2), painting (S6, S13, S18), music (S6, S18 S13), mathematical properties; operation (S2, S6), lesson (S13), logic (S18), and intelligence (S6, S18) were among the concepts the participants produced. After the STEM activities, it was seen that all participants could generate ideas against STEM concepts. As a result, the knowledge and experience of participants about STEM concepts were enriched.

Discussion, Conclusion and Recommendations

Out of school activities provide unique opportunities to develop future STEM talent by means beyond the capacity of the allotted school time. Out-of-school programs provide expanded learning, which includes a plethora of content-rich opportunities outside of school time (Bevan & Michalchik, 2013). In this research, the interest of the 11th-grade high school female students towards their career preferences in STEM fields was examined and six-day training sessions were held, and interviews were conducted with STEM professionals in universities and technoparks. According to the quantitative data, it was observed that the interest of the participants in STEM career fields varied significantly between pre- and post-STEM activities. These findings showed that the implementation of out-of-school STEM activities contributed to an increase of STEM career interest. These findings coincide with the assumption that interest in STEM (Baran et al., 2019; Denson et al., 2015; Guzey et al., 2014; Honey et al., 2014) is related to career. The results of the research are in line with Avery (2013) and Kitchen et al.'s (2018) expressions that active learning environments (Graham et al., 2013) increase students' interest in STEM fields and increase their willingness to pursue STEM careers.

Hands-on activities and the personal meeting between participants and university students or professionals are referred to as important factors in several studies on recruitment initiatives (Jensen, 2015, p.187). STEM role models have been found to support students' thinking about careers and goal development (Palmer, Maramba & Dancy, 2011). Participating students met and interviewed with STEM experts during the research. The participants were influenced by STEM as a role model. A factor that is effective in students' careers in STEM fields is that it is important to get detailed information through job interviews with professionals working in STEM fields. These findings (Stout et al. 2011) coincide with their statements. The students who met with STEM professionals were living in the city center. However, students living in rural and remote areas do not have the opportunity to meet with STEM experts. For teachers in rural and remote areas, it can be challenging to provide students with access to role models in STEM; there is evidence that relevant video-based representations of diverse STEM professionals hold promise for supporting disadvantaged students to think about their personal connections to careers (Kier, 2013; Wyss, Heulskamp & Siebert, 2012).

Individual differences of the participants were determined by the Hidden Figure Styles Test. The participants were divided into three groups as field independent, field moderate, and field dependent according to the Hidden Figures Test results. When STEM career interests in the pre- and post-STEM activities were compared with the cognitive styles, it was seen that the STEM career interests of independent students increased more than the dependent students. These results showed that individual differences vary in STEM career interests. As field independent students show that they are more willing to pursue their STEM career interests, it may be a result of their higher analytical thinking skills. Because field independent students are more successful than their field-dependent peers (Karacam & Ates, 2010; Tinajero & Páramo, 1998;) and because they have these analytical skills used in subdisciplines such as science and mathematics (Witkin et al., 1977). It also shows that measures should be taken to develop the STEM career interests of dependent students in the field. Knowing the students' cognitive styles will contribute to the educators taking the necessary precautions. Teachers' cognitive styles were also effective in students' interest in science and math. In further studies, the cognitive styles of students in STEM activities can be compared with teachers' cognitive styles.

Another way to determine the occupational interests of the participants was the occupational inventory developed by Holland. There was no direct relationship between the cognitive styles of the participants and their images according to Holland Occupation Inventory. But there seems to be a relationship between STEM career interests and the Holland Occupation Inventory. However, there was a change in the occupational image of the participants after STEM activities. As a result of STEM activities, the closest image of the participants was found as “Researcher”. Individuals with an image of researcher like puzzles that they can use in different ways, and they like to solve mathematical and scientific problems (Sharf, 2001). Microbiologist, biologist, scientist, engineer, chemist, geologist, researcher are suitable occupations for people with this type of personality (Holland, 1996; Ivancevich, 2003; Sharf, 2001). It was seen that these contents correspond to STEM career fields and science field. “Traditionally”, the most distant image of the participants was found as a result of STEM activities. Banker, accounting, secretary, supervisor, public administration, and tax expertise can be counted as suitable occupations for people with traditional personality (Holland, 1996; Ivancevich, 2003; Sharf, 2001). This relationship shows that the Holland Occupational Inventory can be used to determine STEM occupational interests. If researchers and teachers want to identify and intervene in students' STEM professional interests, Holland Occupational Inventory appears to be a useful tool.

Maltese and Tai (2011) state that the interest in STEM fields is mostly shaped during upper secondary school years. During upper secondary school, the percentage of males interested in a STEM career remained stable at about 39%; however, the rate of girls decreased from 15.7% to 12.7% (Sadler et al., 2012). In pre- and post-STEM activities, participants were asked about their occupational preferences. Qualitative analysis of the results showed that 60% of the participants changed their occupational preferences after STEM activities. Results showed that field independent female students were more prone to STEM career choices. At the end of the STEM activities, it was seen that the participants made career choices for STEM fields. It has been observed that when students gain more experience in STEM fields, their desire to pursue a career in this field will improve. This result is similar to Brown et al.'s (2016) study. Students' career preferences can be changed in the desired direction due to out-of-school learning environments and intervention programs. Therefore, the implementation of STEM activities will contribute to female students' career in STEM fields.

When students were asked why they chose their occupation, it was seen that their interest was an effective factor. Wai et al. (2010) stated that even among mathematically talented students, STEM can contribute significantly to success. Although successful female students were studied in this research, it was seen that students did not want to work directly in the field of mathematics. They stated that they can use mathematics only as a tool in their work. These findings showed that students had a negative image against mathematics. For this reason, it may be suggested to take precautions against prejudice to mathematics. It was seen that the experience of STEM activities of the participating students serves STEM concepts and aims. It was seen that STEM knowledge of students increased after the STEM activities. STEM features such as the future, career, development of the country, and convenience of the students were indicators that STEM practices affected the achievement of the objectives of STEM fields.

The research was conducted with female participants. Gifted students and disadvantaged groups in STEM education practices, their orientation to STEM career interests, and effect of cognitive styles can be examined. Although the STEM career preferences of the participants changed in this research, it can be investigated whether conducting interviews with STEM experts or the STEM activities are more effective in changing student opinions. The research was conducted with female students with high academic achievement. The research could be repeated with students with low academic achievement. In addition, the studies focus on students' internal factors and in and out of class activities. However, future studies can focus on external factors such as family, social environment, friends, and social media that affect success because parents and teachers become even more important in career development for upper secondary school students who have to decide whether to move to higher education or to enter the labor force (Falco, 2017). This research is limited to the successful female students who have completed the 10th grade. It can be thought that the studies carried out with different class levels in different cultures can reach different results.

Acknowledgments

The research quoted in this chapter was supported by Scientific and Technological Research Institutions of Turkey (TUBITAK) 4004 Nature Education and Science Schools Support Program under the name of "Girls are planning their careers with STEAM" (project number 118B900).

Ethics Committee Approval

The ethical approval of the research was obtained from Ankara / Altindag District Education Directorate (Ministry of National Education [MoNE]) with 16.10.2018 date and 19335247 number.

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Okul Dışı STEM Etkinliklerinin Kız Öğrencilerin STEM Kariyer Tercihlerine Etkisi

Atıf:

Donmez, I. (2020). Impact of out-of-school STEM activities on stem career choices of female students. *Eurasian Journal of Educational Research 91, 173-204*, DOI: 10.14689/ejer.2021.91.9

Özet

Problem Durumu: STEM eğitiminin en önemli amaçlarından biri öğrencilerin fen, teknoloji, matematik, mühendislik alanlarında kariyer yapmalarını desteklemektir. Profesyonellerin, toplumların, üniversitelerin bilim insanlarının bilimsel-sosyal teşvik etmelerine rağmen öğrencilerin STEM kariyerlerine alanlarına yönelimleri istenilen düzeyde değildir (Clarke, vd. 2019). Birçok ülke, bilim, teknoloji, mühendislik ve matematik (STEM) endüstrilerine daha fazla birey yetiştirmeyle çabası içindedir (Hill, Corbett ve Rose, 2010; Regisford 2012). Türkiye'de bu beklenti Türkiye Sanayicileri ve İş Adamları Derneği (TUSİAD) tarafından hazırlanan raporda dile getirilmektedir. 2023 yılı için Türkiye'de yaklaşık 34 milyon toplam istihdamın yaklaşık 3.5 milyonunun STEM alanlarına yönelik istihdam olacağı, 2016-2023 döneminde STEM alanlarında çalışacak istihdam gereksiniminin 1 milyona yaklaşacağı ve bu ihtiyacın karşılanmasında lisans ve yüksek lisans mezunları esas alındığında yaklaşık %31 değerinde bir artış olduğuna işaret edilmiştir. Yine raporda Türkiye'nin, 2030 yılında satın alma gücü paritesine göre dünyanın en büyük 12. ekonomisi, 2050 yılında ise 11. ekonomisi olacağını bu nedenle STEM alanlarında nitelikli iş gücü ihtiyacına dikkat çekmiştir (TUSİAD, 2017). Artan bu talebe karşılık olarak Millî Eğitim Bakanlığı (MEB, 2018) fen öğretimi programını güncelleyerek mühendislik uygulamalarını ortaokul seviyesinde öğretim sürecine dahil etmiştir. Ancak aynı değişim lise seviyesinde gerçekleşmemiştir. Öğrencilerin STEM kariyer alanlarına yönelik ilgilerini geliştirmek için tasarlanan okul dışı ortamların etkili olduğu ifade edilmektedir (Avery, 2013; Baran vd. 2019). Ayrıca STEM alanlarında çalışan rol modellerin de olması öğrencilerin STEM algılarının ve STEM kariyer ilgilerinin arttırdığı ifade edilmektedir (Stout vd. 2011). STEM kariyer ilgi alanlarında cinsiyet, ırk, dezavantajlı gruplardan bahsedilmesi aslında bireysel farklılıkların bir sonucudur. Bireysel farklılık fiziksel, duygusal, zihinsel özellikler olarak sınıflanmaktadır. Genel okul uygulamaları ve etkinliklerin Türkiye'de STEM alanlarına kariyer yapmaya yönelik cinsiyet rollerinin etkisi hakkında çok az şey bilinmektedir. Bu nedenle, bu çalışma, Türkiye'de kapsamlı bir çalışmadan yoksun olan STEM alanlarına yönelmede okul dışı öğrenme aracılığı

ile lise kademesinde eğitim-öğretim gören kız öğrencilerin bilişsel stillere odaklanmıştır.

Araştırmanın Amacı: Araştırmanın amacı altı süren okul dışı STEM etkinliklerine katılan bilişsel stilleri farklı kız öğrencilerin deneyimlerinin, STEM alanında çalışan profesyonellerle görüşmelerinin, STEM kariyer tercihlerine etkisini incelemektir. Bu çalışmada şu sorulara cevap aranmıştır. (1) katılımcıların ön uygulama ve son uygulamada STEM kariyer ilgileri arasında anlamlı bir farklılık var mıdır? (2) katılımcıların bilişsel farklılıkları ile STEM kariyer ilgi alanları ilişkin ön uygulama ve son uygulama puanları arasında anlamlı bir farklılık var mıdır? (3) katılımcıların bilişsel farklılıkları ile kariyer alanları ilişkin yakın ve uzak imajları nelerdir? (4) etkinlik öncesinde ve sonrasında katılımcıların kariyer planlarında herhangi bir değişim olmuş mudur? (5) etkinlik öncesinde ve sonrasında katılımcıların STEM alanlarına ilişkin bilgi düzeyinde değişim olmuş mudur?

Araştırmanın Yöntemi: Bu araştırmada karma yöntem araştırması tercih edilmiştir. Araştırmanın nicel boyutunda; STEM kariyer ilgi ölçeği, Holland meslek envanteri, Witkins saklı figürler testi, nitel boyutunda ise görüşme formu kullanılmıştır. Araştırmanın nicel verilerinin analizinde, bağımlı gruplar için ortalamalar, t-testi ve ANOVA kullanılmıştır. Araştırmanın nitel verileri ise, içerik analizi ve sürekli karşılaştırılmalı veri analizi yöntemleri birlikte kullanılarak analiz edilmiştir. Araştırma TÜBİTAK 4004 Doğa Eğitimi ve Bilim Okulları Destekleme Programı kapsamında yapılmıştır. "Kızlar STEAM ile kariyerlerini planlıyor" ismiyle 2019 yılı haziran ayında düzenlenen bu projeye internet ortamından başvurular alınmıştır. Projeye katılan 20 öğrenci şu kriterlere göre seçilmiştir; (1) Derslerinde başarılı olan (bir önceki eğitim-öğretim yılı ders ortalaması 85 üzerinde olan), (2) Sosyo-ekonomik olarak göreceli olarak düşük olan (özel okul öğrencileri kabul edilmemiştir), (3) proje katılmaya istekli olan ve aile onayları da alınan kız öğrenciler katılmıştır. Katılımcı öğrenciler 11. sınıfı bitirmişlerdir. Katılımcıların bir sonraki eğitim-öğretim dönemi sonunda üniversite tercihi yapacağından, STEM kariyer planlaması ve bilgi edinmesi açısından proje önem arz etmektedir. Araştırma bilim, mühendislik, matematik ve sanat temalı atölyeler uzman eğitimciler tarafından gerçekleştirilmiştir. Atölyelerin bitiminde Ankara'nın merkezindeki üniversitelere ve teknokentlere ziyaretlerde bulunarak, katılımcıların STEM alanlarda çalışan profesyonellerden yaptıkları çalışmalar hakkında bilgi almaları sağlanıştır.

Araştırmanın Bulguları: Araştırmada katılımcıların STEM etkinlikleri sonunda STEM kariyer ilgileri karşılaştırıldığında ön test ve son test puanları arasında son test sonuçları lehine anlamlı bir farklılık olduğu görülmüştür. Katılımcıların bilişsel stilleri ile kariyer ilgileri karşılaştırıldığında ise etkinlik sonunda alan bağımsız kız öğrencilerin STEM kariyer ilgilerini anlamlı bir şekilde farklılık olduğu görülmüştür. Holland ilgi envanteri ile katılımcıların en yakın imajlarının araştırmacı, en uzak imajlarının geleneksel alanda yoğunlaştığı görülmüştür. STEM uygulamaları sonrasında katılımcıların %60'ının meslek tercihlerini STEM alanlarına yönelik değiştirdikleri görülmüştür. Etkinlikler sonunda katılımcıların STEM alanlarına yönelik bilgi ve ilgilerinin arttığı görülmüştür. Görüşmeler sonunda öğrencilerin alanda çalışan uzmanlarla görüşmeler yapmasının, STEM alanlarında kariyer yapmalarına yönelik isteklerini arttırdığı ortaya çıkmıştır.

Araştırmanın Sonuçları ve Öneriler: Bu araştırmada 11. sınıfı bitiren kız öğrencilerin STEM alanlarına yönelik kariyer tercihlerine yönelik kariyer ilgileri incelenmiş, altı gün süren STEM eğitimleri düzenlenmiş, STEM alanlarında çalışan bilim insanları ile görüşmeleri sağlanmıştır. Sonuçlar, okul dışı STEM uygulamalarının yürütülmesinin öğrencilerin STEM kariyer alanlarının gelişimine katkı sunduğu görülmüştür. Araştırmada okul dışı STEM etkinliklerinin profesyonellerin desteği ile yürütülmesinin, öğrencilerin STEM kariyer ilgilerini destekleyeceği görülmüştür. Araştırma sonuçlarında katılımcıların bilişsel stilleri ile STEM kariyer ilgi ve tercihleri arasında ilişki olduğu; alan bağımsız öğrencilerin STEM kariyer alanlarına eğilimlerinin alan bağımlılara göre daha fazla olduğu görülmüştür. Bu nedenle öğrencilerin bilişsel stillerinin belirlenmesinin öğrencilere uygulanacak eğitimin ve gerekli yönlendirmelerin belirlenmesi için katkı sunacağı düşünülmektedir. Holland meslek envanterinin öğrencilerin kariyer tercihlerinin belirlenmesinde etkili olduğu görülmüştür. Bu nedenle öğrencilere uygulanacak envanterler kariyer hedeflerini ve öğretim programına yönelik iyileştirmeler konusunda fikir verecektir. Katılımcı öğrencilerin STEM alanlarında çalışan kişiler ile çalıştıkları ortamda bilgi almasının öğrencilerin kariyer tercihlerinde etkili olduğu görülmüştür. Bu nedenle öğrencilerin STEM kariyer ilgilerinin devamlılığı için STEM alanlarında çalışan kişilerle görüşmeler yapması, çalıştığı ortamı gözlemlemesi gerekli olduğu görülmektedir. Araştırma akademik başarısı yüksek kız öğrenciler ile yürütülmüştür, araştırma akademik başarısı düşük öğrenciler, üstün yetenekliler ve risk grupları ile tekrar edilebilir. Bunun yanında yapılan çalışmalar öğrencilerin içsel faktörlerine ve ders içi uygulamalarına odaklanmaktadır. Araştırmacılar başarıyı ilgiyi etkileyen aile, sosyal ortam, arkadaş, sosyal medya gibi dışsal faktörlere odaklanabilir.

Anahtar Sözcükler: Bilişsel stiller, kız öğrenciler, okul dışı öğrenme, STEM, STEM kariyer gelişimi