


The Effect of Robotics and Coding Education on Girls' STEM Motivation, Attitude and Career Aspirations

SAGE Open
July-September 2025: 1–15
© The Author(s) 2025
DOI: 10.1177/21582440251382631
journals.sagepub.com/home/sgo


Salih Gülen¹ , İsmail Dönmez¹ , Fatma Betül Şengönül¹ ,
Miyase Aslantaş¹ , Turgut Saritaş² , Ömer Sukenari² , Emrah Eke² , and
Semih Uçar¹ 

Abstract

STEM education aims to develop 21st-century skills, support economic growth and promote gender equality in STEM fields. It is known that gender stereotypes play a significant role in the formation of STEM identity. The most important factor preventing some high school-level female students from pursuing STEM careers is their lack of participation in STEM activities. Female students in high schools have limited opportunities to explore or learn about STEM careers due to the emphasis on verbal and religious courses in their curriculum. However, it is known that women can work more autonomously in scientific activities compared to men. The current study examines the effect of robotics and coding education on the development of girls' STEM careers. The study was conducted at an all-girls high school in Turkey, where the curriculum is predominantly centered on verbal and religious subjects. In the study, a pre-test and post-test experimental design with control group was used. A total of 76 volunteer female students (34 in the experimental group and 42 in the control group) participated in robotics and coding education over a period of 12 weeks. The data were collected using the validated STEM career, motivation and attitude scales and analyzed using *t*-tests, ANOVA and Pearson correlation. The findings revealed that robotics and coding training significantly improved the participants' STEM career aspirations, attitudes and motivations. A strong positive correlation was found between career interest, attitude and motivation. The study also showed that STEM career scores are significantly higher among students who wish to become teachers compared to those considering a career in the fields of health or engineering. However, no significant correlation was found between the participants' parents' education levels, family income and STEM career aspirations.

Plain language summary

How Robotics and Coding Help High School Girls Become More Interested in Science, Technology, and Future Careers

This study explores how learning robotics and coding can help high school girls become more interested in science, technology, engineering, and math—often called STEM. The research took place in a girls-only high school in Turkey, where students usually focus on religious and humanities subjects. Because of this, they often have little chance to learn about or explore STEM topics. A group of students joined a 12-week robotics and coding program, while another group continued with their regular classes. Before and after the program, both groups completed surveys that measured their interest, motivation, and attitudes toward STEM and future careers. The results showed that the girls who

¹Muş Alparslan University, Muş, Turkey

²Ministry of National Education, Muş, Turkey

Corresponding Author:

Salih Gülen, Muş Alparslan University, Muş 49250, Turkey.

Email: sgnova@windowslive.com



participated in the robotics and coding activities became more motivated, had more positive attitudes, and showed greater interest in STEM careers compared to those who did not join the program. Interestingly, students who said they wanted to become teachers had the highest increase in interest toward STEM careers. The study also found that a student's family income or parents' education level did not make a difference in how much they improved. This research shows that even in schools where STEM is not normally taught, hands-on activities like coding and robotics can help girls discover new interests and build confidence in areas like science and technology. It suggests that giving all students—especially girls—access to fun and practical STEM experiences can help close the gender gap and open new career paths.

Keywords

female, robotics and coding, STEM career, STEM motivation, STEM attitude

Introduction

STEM is an educational approach that integrates science, technology, engineering and mathematics (Kelley & Knowles, 2016). STEM education aims to contribute to the economic development of societies, develop 21st-century skills, raise awareness and recognition of STEM disciplines, promote gender equality in STEM fields and encourage the use of STEM skills in everyday life (Lin et al., 2022; Liu et al., 2014). In order for individuals to achieve these goals, they must participate in STEM activities (Gülen, & Dönmez, 2021; Hanson & Krywult-Albańska, 2020).

Women's involvement in STEM fields is low on a global scale (UNESCO, 2024). For example, in the United States, the proportion of women in engineering and computer science is below 20% (National Science Foundation [NSF] & National Center for Science and Engineering Statistics, 2023). In India, 42% of STEM graduates are women, but the labor force participation rate is low among women (Amirtham & Kumar, 2023). In Europe, although the proportion of female researchers varies by country, gender inequality persists, especially in the fields of technology and engineering (European Commission, & Directorate-General for Research and Innovation, 2021). Female representation in STEM fields is low worldwide and women stay away from these fields due to gender roles (Amirtham & Kumar, 2023; Sharma, 2023).

Research showed that there are certain structural and cultural barriers that prevent women from pursuing careers in STEM fields. These barriers include gender stereotypes (Sattari & Sandefur, 2018), low self-confidence and self-efficacy perception (Fisher et al., 2020), family and teacher expectations (Sainz & Müller, 2017), lack of role models (Boateng & Sharman, 2017), traditional division of labor and caring responsibilities (Xu, 2016) and STEM professions being generally considered "male professions" (Schlesinger & Richert, 2019).

Many efforts are underway worldwide to encourage women to pursue STEM careers, persist in these fields and develop STEM identities (McKinnon, 2022). There is a need for specialized efforts to develop STEM identity among women, particularly by drawing on current and technological developments.

Robotics and coding education is of critical importance especially for female students as it offers the opportunity to directly experience the technology and engineering components of STEM education. Women's participation in these fields is limited due to lack of self-confidence, self-efficacy and professional awareness (Küçük & Şişman, 2020; Yabas et al., 2022). Robotics and coding activities contribute to the development of STEM identity in female students by enabling them to learn abstract STEM concepts with concrete tools. Especially hands-on activities create a positive perception that women can take an active role in STEM fields.

The purpose of the current study is to examine the effect of robotics and coding education on female students' STEM motivation, attitudes and career aspirations at a girls' high school with a curriculum heavily focused on verbal and religious subjects. The study aims to evaluate the effect of technology-based interventions in terms of increasing female participation in STEM fields. In this respect, the study can provide guiding data for student groups with similar socio-cultural contexts and contribute to the shaping of educational policies towards gender equality. Thus, the study is a focused and inclusive intervention that includes positive discrimination to ensure equality.

The school where the study was conducted is a public high school that provides education only to female students. The curriculum of this school puts greater emphasis of verbal and religious subjects.

Women and STEM

In Turkey, women's education has been shaped by core courses within a numerical and verbal framework, like

men's, along with other courses that are organized around these core courses. As a result of the education given within the framework of these courses, women generally enter the workforce by choosing professions that are distant from STEM disciplines. Female students enrolled in schools with a humanities-based curriculum generally focus on courses that prioritize verbal skills and religious studies (MoNE, 2020). This naturally reduces opportunities to explore or learn about STEM careers. However, it is known that women can work more autonomously in scientific activities compared to men (Modrek et al., 2021). Although it has been determined that women exhibit low self-efficacy toward STEM disciplines (Fisher et al., 2020), this is not related to their actual self-efficacy. It is related to the limited opportunities to explore and gain experience in STEM disciplines. In fact, it is known that as women gain experience in these disciplines, they are more likely to choose qualified STEM careers (Dönmez & Gülen, 2021).

Societal Perspective

A STEM career can be shaped by societal and cultural values, as well as individuals' own abilities, interests and the role models in their environment (Gülen, 2019; Johnson et al., 2019). In general, when it comes to STEM disciplines, they are initially perceived as male-dominated professions or identities (Sattari & Sandefur, 2018). Factors such as women often being encouraged to prefer or directed towards domestic tasks also play a role in this perception (Taş & Bozkurt, 2021). However, it should be noted that women's work in any discipline does not mean that they are freed from responsibilities related to domestic tasks. Therefore, supportive privileges should be granted to working women in society (Xu, 2016). It should also be noted that traditional gender norms have an impact on STEM identities (Vleuten et al., 2019). For these reasons, it is necessary to address the issue of gender inequality in societies to foster the development of women's STEM discipline identities (Ro et al., 2021). This inequality cannot be eliminated overnight, nor is STEM identity a topic that can be simply explained to women and this is more difficult in societies where cultural and social norms are too suppressive. Women should be provided with opportunities to learn about STEM disciplines (Carlone & Johnson, 2007; Gülen & Yaman, 2019) and these opportunities should be provided from an early age onward (Heybach & Pickup, 2017). It has been observed that educational robotic applications have been widely used in the world in recent years, especially to spark children's interest in STEM at an early age (Küçük & Şişman, 2020).

In Turkey, due to the dominant social perspective, women are still seen as housewives, babysitters or maids

(Taş & Bozkurt, 2021). For example, a study found that male students studying in high school still think that women's place is only in the home (Coşkun & Şentürk, 2010). Although there has been an increase in the number of women pursuing education compared to the past, many still choose single-sex schools, often leading them towards traditionally female-dominated professions (Taş & Bozkurt, 2021). However, it is evident that some high schools, particularly those with a religious focus, have curricula that are distant from STEM disciplines. Indeed, the courses offered in these schools often have either humanity or a religious focus (MoNE, 2021). By selecting elective courses that emphasize STEM subjects, students in these schools can be better prepared for STEM careers. For students to choose these elective courses, it is crucial to provide comprehensive information about STEM education to female students and their parents. It is believed that providing STEM education information to both students and their teachers, followed by robotics and coding activities, can foster STEM career awareness among female students.

Selective Trust

Although the preference for disciplines in STEM education is linked to academic achievement, an individual's beliefs or emotional state also play a role in this preference (Dönmez et al., 2021; Sakellariou & Fang, 2021). Besides academic achievement, there are internal and external factors that influence the STEM identities of women and men (Sainz & Müller, 2017). Individuals' confidence in themselves or their gender plays a significant role in making any choice. Every individual in society has a perception of selective trust. Selective trust refers specifically to the perceived values regarding which gender is associated with a particular profession (Harris & Corriveau, 2011; Taylor, 2013). For example, research has found that most women associate the profession of "engineering" with the concept of masculinity (Schlesinger & Richert, 2019). It is believed that this situation will change because of STEM awareness education programs targeted at women. It is aimed that women's selective trust will change after activities that will help them get to know STEM, learn about STEM professions and actively participate in STEM education programs. Women should be provided with opportunities to benefit from these activities at similar rates to men. Moreover, it is necessary to examine the job opportunities available to men and women in a developing and industrializing society (Hagglund & Leuze, 2020). Since women participating in STEM programs are more likely to choose a STEM discipline (Shahbazian, 2021), activities should be organized to promote STEM in society and facilitate career development in the related field. With the

presence of STEM disciplines in everyday life, it is believed that women, like men, will be able to use these disciplines or interact with them (Schmuck, 2017).

STEM and Technological-Robotic Developments

The technology aspect of STEM education is supported by rapid global developments, the necessity for societies to renew themselves and the formation of innovation skills. The technological advancements occurring worldwide, the need for societies to renew themselves and the demand for innovation skills are driving the growth of STEM education. Software, coding and robotics studies are constantly being updated. Introducing future generations to technology during their school years and enabling them to learn coding, develop simple software and create technological and robotic products will shape their perceptions of future professions (Taş & Bozkurt, 2021). Although women show less interest in coding, software development and robotics compared to men, these subjects are generally well-received by students (Küçük & Şişman, 2020). In general, schools serve as the primary environment for hands-on experience for students who lack access to technological and robotic tools outside the school due to their families' income level and educational background. Especially for female students, access to technological and robotic tools is highly limited due to their involvement in various household chores and societal perspectives. Therefore, the experiences they gain in the school environment are extremely important for self-discovery and developing professional competencies. Women should be introduced to robotics and coding within the scope of STEM education programs.

Schools with a Curriculum Focused on Verbal or Religious Subjects

Student enrolment in schools with a curriculum focused on verbal or religious subjects is carried out based on the requests of parents and students, following consultations with experts, parents and students. Although there are differences, it can be said that these schools are sometimes chosen based on the student's decision, sometimes the parent's and sometimes the joint decision of both (Çınar, 2018; Eriklioğlu, 2019; Sarı, 2021). Parents primarily choose these schools because of their focus on instilling religious and moral values in students (Kara, 2017). Students who graduate from middle schools choose these schools for reasons such as the scores they receive from the central exam (especially high scores) being sufficient to enroll in these schools or the student not wanting to go to low-quality schools (Karadeveci, 2020). Students attending these schools have the same

rights and freedoms as other students attending other types of schools to pursue the careers of their choice. However, one of the goals of these schools is to meet the society's need for imams and female imams. However, as one imam or female imam may be sufficient for a village or neighborhood, the issue of finding jobs for the many students graduating each year arises. Indeed, there are approximately 10,000 academics and 150,000 students engaged in religious studies at the higher education level in Turkey (Genç, 2018). In addition, according to 2019 data, 761,785 students are enrolled in Imam Hatip middle schools, while 498,002 students are attending Imam Hatip high schools. Moreover, according to 2019 data, it is known that only 17% of the approximately 36,000 Imam Hatip high school graduates who applied to a bachelor's program were accepted (Emiroğlu, 2021). This situation also creates difficulties in finding employment and establishing a career. The current study aims to measure the interest of students attending schools with a curriculum heavily focused on verbal and religious subjects in the fields of coding and STEM. In addition, while there are approximately 18 hr of religious-oriented lessons in the 11th and 12th grades of such high schools, there are no courses related to STEM disciplines in their verbal sections (MoNE, 2020, 2021).

It is known that after students are introduced to STEM and their awareness is raised, their level of interest in STEM increases. It has been determined that the implementation of STEM activities contributes to an increase in interest in STEM careers. It has been determined that the increase in an individual's preference for STEM professions is parallel to the increase in both STEM-related in-school and out-of-school activities (Dönmez, 2021). Women need to get to know STEM, develop STEM identities and gain information about career groups (Farrell & McHugh, 2020). In addition to traditional gender-specific career experiences, gaining exposure to professions typically associated with the opposite sex is essential. Moreover, the influence of women's close circles is significant in the formation of STEM identities. Having a role model within the family or immediate social circle positively contributes to the development of a STEM identity among women (Boateng & Sharman, 2017; Johnson et al., 2019). In addition, it is known that STEM programs implemented in science centers, STEM schools or application centers can increase the likelihood of women choosing a STEM discipline (Shahbazian, 2021). For these reasons, it is essential for women to gain experience through STEM activities and participate in events aimed at career development.

The curriculum of schools with a heavy focus on verbal and religious subjects, societal attitudes toward women, selective trust and rapid advancements in

robotics and coding are leading women to question their career paths. In addition to contemporary and democratic policies, it is an undeniable fact that women have as much of a powerful impact as men in the rapidly developing world. Therefore, women should be encouraged to take the lead in participating in the career development processes within STEM disciplines.

Significance of the Study

STEM education aims to develop 21st-century skills such as critical thinking, problem solving and creative productivity in students. It aims to contribute to gender equality by increasing the active participation of women in this field. However, due to traditional gender roles, school curriculum content and inequality of opportunity, many female students are kept away from STEM disciplines. This situation negatively affects both individual career development and the economic and technological development of countries.

Although the positive effects of robotics and coding education programs aimed at increasing awareness and attitudes towards STEM have been proven in the current literature, the majority of these studies have been conducted in co-educational environments or in schools that already implement numerically-focused curricula. However, for students attending girls' high schools in Turkey, where social gender roles are more pronounced and the curriculum is verbally and religiously oriented, such technological education opportunities are quite limited and have not been sufficiently studied.

The current study aims to address this gap by experimentally examining the effects of robotics and coding education implemented in a girls' high school with a verbal and religiously oriented curriculum on STEM attitudes, motivation and career aspirations. The study is also unique in that it focuses on a group of students with low socioeconomic status and limited access to technology. The findings may contribute to the development of applicable educational policies aimed at reducing gender inequality in STEM fields, as well as providing a model intervention for student groups in similar circumstances.

Purpose of the Study

The main purpose of the current study is to examine the effect of robotics and coding training on girls' STEM motivation, attitudes and career aspirations. To this end, the answers to the following research questions were sought.

1. Does the robotics and coding training create a significant difference in girls' STEM motivation, attitudes and career aspirations?
2. Is there a significant correlation between STEM attitudes, motivation and career aspirations and participant variables (parents' education levels, income and intended profession) after the implementation of the robotics and coding training?
3. What is the correlation between the changing STEM attitudes, motivation and career aspirations as a result of the robotics and coding training?

Method

The study employed a pre-posttest experimental design with a control group. Experimental designs are intervention studies focused on the solution of the research problem in a controlled way. The effectiveness of the method used to address the research problem is examined among randomly selected identical groups (Büyüköztürk, 2009; Çepni, 2010).

Research Process

The implementation phase of the study was planned to last 12 weeks, two class hours each week. The activities were conducted by experts and experienced researchers in the field of education (Those who have previously received training in robotics and coding, participated in projects and have academic work).

Table 1 shows the activities conducted within the scope of the robotics and coding training. The activities were conducted in the school's computer lab (The computers were checked before the training and the Mbot coding program was installed).

The 12-week robotics and coding training program implemented in this study aimed to address the four components of STEM education—science, technology, engineering and mathematics—in an integrated manner. The training process was structured in line with the basic principles of STEM education. Each weekly activity was linked to a specific STEM component. The aim was for students to connect theoretical knowledge with real-life problems.

Science: During the work with Mbot robots' sensors, movement mechanisms and light/distance sensors, students experienced basic physics principles (motion, light, distance, speed, etc.) in a practical way.

Table 1. Robotics and Coding Training Program.

Weeks	Subject	Duration (minutes)
Week 1	Pretests	80
Week 2	STEM education, importance, discipline, professions, career	80
Week 3	Introduction to coding with basic features and demonstration of sample applications	80
Week 4	Basic coding principles, sample coding	80
Week 5	Game coding	80
Week 6	Introduction to Mbot coding program and game coding	80
Week 7	Mbot coding program and Mbot robot coding examples	80
Week 8	Mbot robot introduction, Mbot robot usage	80
Week 9	Mbot robot coding	80
Week 10	Mbot robot usage with instructions	80
Week 11	Problem solving with Mbot robot	80
Week 12	Post tests	80

Technology: Through the software used in the coding process (mBlock, block-based programming), students developed digital thinking skills and gained the ability to create algorithms and solve problems using technology.

Engineering: Students applied the engineering design process (planning, prototyping, testing) in the design of the robot, the integration of functional parts and task-based problem solving stages to solve the given tasks.

Mathematics: Mathematical concepts such as loops, variables, angles, time and distance were used while coding.

In addition, weekly sessions included awareness activities related to STEM professions. Each week, students were asked to evaluate the solution process from a STEM perspective. In the second week of the training, information was provided about STEM professions and interdisciplinary relationships and in the following weeks, each task was carried out in relation to at least one STEM component.

This integrated approach ensured that the robotics and coding process was not limited to imparting technical coding skills. It also contributed to the development of students' attitudes towards and interest in STEM disciplines. The educational process was structured to develop a STEM identity, with the aim of helping students internalize scientific thinking and engineering design processes through coding.

The control group did not receive any intervention. This group worked in line with the school's routine curriculum and did not participate in any special STEM activities. They only completed the pre-test and post-test scales during the research period.

Sample

The study was conducted at a girls' public high school in X province (all the participants are female). Parental consent and institutional approval were obtained before the study. A total of 76 ninth and tenth-grade students participated in the study on a volunteer basis. Most of the students live in the dormitory, meaning they receive education as boarding students. Of these students, 34 were assigned to the experimental group (a group consisting of those staying in the dormitory, as the training sessions took place after classes), and 42 were assigned to the control group. Before the activities were completed, two students voluntarily left the experimental group. This high school accepts only girls based on centralized exam scores. All students admitted to the school fall within a certain score range and demonstrate academically homogeneous scores. Additionally, none of the participants had any previous STEM experience. Almost all the students' families are involved in agriculture and animal husbandry and have similar socio-economic characteristics. The table below presents some demographic data of the participants.

Table 2 presents the educational levels of the participants' parents and the family incomes (50,000 TL is approximately 1375 USD). One important point here is that 1.35% of the students' fathers and 16.22% of their mothers are illiterate. None of the mothers have received university or graduate-level education. Finally, none of the participants' family incomes exceed 100,000 TL. In addition, the careers that the participants are considering for the future were determined. According to this, 41.89% of the participants are considering careers in health sector (doctor, nurse, midwife, dentist, etc.), 13.51% in engineering (construction, software, mechanical, etc.), 17.57% in law (judge, prosecutor, lawyer, etc.), 17.57% in teaching (classroom, science, physics, etc.) and 9.46% in other professions (translation, police, etc.).

Data Collection Tools

In the current study, the STEM motivation, STEM attitude and STEM career scales, for which permission was obtained from the authors and reliability and validity studies had been conducted, were used. The same scales were used in the pretest and posttest.

STEM Motivation Scale (SMS); The original scale was developed by Luo et al. (2019) to have 28 items using a Likert type. The scale is a 4-point Likert scale with the response options "Often (4)," "Sometimes (3)," "Very little (2)," "Never (1)." As a result of the reliability and validity studies of the scale adapted to Turkish by Dönmez, 2020, the number of items was reduced to 25.

Table 2. Demographic Information of the Participants.

Variable	Category	f	%	
Father's Education Level	Literate	5	6.76	
	Illiterate	1	1.35	
	Primary	15	20.27	
	Middle	12	16.22	
	High	25	33.78	
	University	13	17.57	
	Postgraduate	3	4.05	
	Total	74	100	
Mother's Education Level	Literate	7	9.46	
	Illiterate	12	16.22	
	Primary	29	39.19	
	Middle	16	21.62	
	High	10	13.51	
		Total	74	100
	Professional Goal	Health	31	41.89
Engineering		10	13.51	
Law		13	17.57	
Teaching		13	17.57	
Other		7	9.46	
		Total	74	100
Family Income Level		Under 50 thousand TL	61	82.43
	50-100 thousand TL	13	17.57	
	Total	74	100	

Moreover, three of the items are negative. As a result of the analysis, the fit indices of the scale were found to be acceptable values: RMSEA: 0.076, SRMR: 0.01, CFI: 0.89 and AGFI: 0.82. In addition, the reliability value of the scale (Cronbach alpha (α) coefficient) was calculated as 0.84. In the current study, this value was found to be 0.88. Some of the items from this scale are as follows (items were randomly selected): “(Item 2) I learn about scientific research, scientists, nature or the environment on my mobile phone,” “(Item 9) I read instructions or access information to learn how to use an item (a watch, mobile phone, or home appliance, etc.),” “(Item 23) I contact people who work in mathematics through my computer.”

STEM Attitude Scale (SAS); The original of the scale was prepared by Friday Institute for Educational Innovation (2012) in a Likert style consisting of 37 items (3 of which are negative). The scale is a 5-point Likert scale with the response options “Strongly disagree (1),” “Disagree (2),” “Neutral (3),” “Agree (4),” “Strongly agree (5).” It was translated into Turkish by Özcan and Koca (2019) and its reliability and validity study was conducted. Accordingly, the fit index values of the scale were determined to be acceptable values: RMSEA: 0.05, CFI: 0.96, RFI: 0.95, NFI: 0.95, SRMR: 0.05. In addition, the reliability value of the scale (Cronbach alpha (α) coefficient) was calculated to be .90. In the current study, it was found to be 0.94. Some of the randomly selected items from this scale are as follows: “(Item 1.6) I

am confident that I can do advanced studies in mathematics,” “(Item 2.4) Knowing science will help me earn my living,” “(Item 3.4) I am curious about how machines work,” “(Item 4.10) When I have many tasks, I can choose which one to do first.”

STEM Career Scale (SCS); The original version of the scale was developed by Kier et al. (2013) and is a Likert-type scale consisting of four sub-dimensions: science, technology, engineering and mathematics. The scale is a 5-point Likert scale with the response options “Strongly disagree (1),” “Disagree (2),” “Neutral (3),” “Agree (4),” “Strongly agree (5).” The scale was adapted into Turkish by Koyunlu Ünlü et al. (2016). As part of the validity and reliability analyses, Confirmatory Factor Analysis (CFA) was conducted and the scale’s four-factor structure was confirmed. The reliability coefficient of the scale was found to be .903. In the current study, the Cronbach’s alpha (α) coefficient was found to be .95. For the scale as a whole and its sub-dimensions, χ^2/df , Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Normed Fit Index (NFI), Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA) were calculated. Some of the randomly selected items from this scale are as follows: “(Item 1.7) I am interested in science-related careers,” “(Item 2.2) I do my math homeworks,” “(Item 3.8) I am interested in careers that use technology,” “(Item 4.4) I work hard on engineering-related subjects at school.”

Data Analysis

In the analysis of the collected data, the SPSS 21 program package was used. Parametric statistical analyses were employed to analyze the data collected from the pre- and post-tests as the scale data met the assumptions of normality, homogeneity of variance and the sample size was sufficient. In the analysis of the data, *t*-test, ANOVA, Pearson Correlation, frequency, percentage and mean were used.

When the normality of the three scales was examined, the Kolmogorov-Smirnov and Shapiro-Wilk tests both yielded *p*-values greater than .05, indicating a normal distribution (Kolmogorov-Smirnov: SCS=0.200, SAS=0.200, SMS=0.200; Shapiro-Wilk: SCS=0.142, SAS=0.046, SMS=0.898). When the homogeneity of the three scales was examined, the *p*-values obtained were greater than .05, indicating that the scale scores were distributed homogeneously (SCS=0.504, SAS=0.644, SMS=0.208) (Table 3.). Multiple independent *t*-tests were applied in the pre-test and post-test comparisons. In order to control the Type I error rate, Bonferroni correction was applied and the α value was redefined as $.05/3 = .017$. Significance interpretations were made based on this new threshold. Additionally, effect size calculations

Table 3. Normality Test Results.

Variable	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
SCS	.091	74	.200*	.975	74	.142
SAS	.089	74	.200*	.966	74	.046
SMS	.063	74	.200*	.991	74	.898

Note. The Kolmogorov–Smirnov test has been reported with the Lilliefors correction. The asterisk (*) indicates that the corresponding value has a $p > .05$.

Table 4. Independent Sample *t*-test Results of the Participants Before the Robotics-Coding Training.

Scales	Groups	N	Mean	Std. Deviation	Std. Error Mean	<i>t</i>	<i>p</i>	n^2
SCS	Experiment	34	3.93	.47	.081	1.828	.072	.043
	Control	42	3.73	.47	.073			
SMS	Experiment	34	2.93	.33	.056	−0.063	.95	.000
	Control	42	2.94	.41	.064			
SAS	Experiment	34	3.73	.51	.087	1.732	.087	.039
	Control	42	3.57	.31	.049			

were expanded. Not only η^2 , but also Cohen's *d* values were calculated for all comparisons with significant differences and included in the results.

According to Cohen (1988), the effect size ranges for Cohen's *d* are as follows. Small effect ($d = 0.2$) indicates that the difference between groups is small and the effect size is low. Medium effect ($d = 0.5$) indicates that the difference between groups is moderate and the effect size is more pronounced. Large effect ($d = 0.8$) indicates that the difference between groups is large and the effect size is high. According to Cohen (1988), the effect size classifications for eta squared are as follows. A small effect ($\eta^2 = .01$) indicates that group differences explain only 1% of the variance and that the effect size is very small. Medium effect ($\eta^2 = .06$) indicates that group differences explain 6% of the variance and that the effect size is moderate. Large effect ($\eta^2 = .14$) indicates that group differences explain 14% of the variance and that the effect size is very large.

Reliability and Validity

The validity and reliability of the scales used in the current study were rigorously examined. In terms of validity, the content validity of the scales was evaluated by field experts and construct validity was tested using Confirmatory Factor Analysis (CFA). According to the CFA results, the factor structures of the scales were confirmed and the fit indices such as RMSEA, CFI, AGFI, NFI and SRMR were found to be within acceptable limits. Furthermore, the criterion validity analyses indicated that the scales are consistent with the literature in terms

of measuring interest in and attitudes toward STEM fields. In terms of reliability, the internal consistency of the scales was evaluated using Cronbach's alpha coefficient and the reliability values of all the scales were found to be above .90. In addition, the consistency of the scales over time was tested using test-retest reliability and high correlation coefficients were obtained. The item-total correlation analyses indicated that each item made a significant contribution to the scale.

In the study, the participants were ensured to take part in the pre-test and post-test in the same environment and at the same time. The data were collected anonymously, scores were entered into the system within the framework of the Likert scale and the data were analyzed using the accepted analysis techniques. The researchers did not intervene in the scores or analyses. It is assumed that all the participants provided objective data.

Results

The findings obtained in the study are presented below. These findings are presented in accordance with the order of the research problems.

The Effect of Robotics and Coding Training on Girls' STEM Motivation, Attitudes and Career Aspirations

These findings were obtained through the analysis of pre-training and post-training data using the *t*-test and are presented in Tables 3 and 4.

Table 4 shows the results of the pre-tests conducted before the robotics and coding training.

Table 5. Post-Test Results: Comparison of Experimental and Control Groups on STEM scales.

Scales	Groups	N	Mean	Std. Deviation	Std. Error Mean	t	p	n ²	Cohen d
SCS	Experiment	32	3.77	.59	.104	2.811	.006	0.099	.67
	Control	42	3.38	.57	.089				
SMS	Experiment	32	2.95	.44	.078	2.479	.015	0.079	.58
	Control	42	2.72	.35	.055				
SAS	Experiment	32	3.82	.57	.101	2.904	.005	0.105	.68
	Control	42	3.43	.57	.088				

Table 6. Significant Difference Between the Intended Profession and SCS, ANOVA.

Groups	Sum of Squares	df	Mean Square	F	p	Homogeneity
Between Groups	8.128	4	2.032	7.307	.000	(p>.05) 0.516
Within Groups	19.187	69	.278			
Total	27.315	73				

Table 7. Tukey Test Results with ANOVA Analysis.

(I) Intended profession	(J) Intended profession	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Teaching	Health	-.85030*	.17424	.000	-1.3384	-.3622
	Engineering	-.97085*	.22180	.000	-1.5922	-.3495
	Law	-.49231	.20683	.133	-1.0717	.0871
	Other	-.53956	.24721	.199	-1.2321	.1529

Note. An asterisk (*) denotes a pairwise mean difference significant by Tukey's HSD at the .05 level ($p < .05$).

According to these results, there is no significant difference between the experimental and control groups in the results of the three scales before the training ($p > .05$).

Table 5 shows the results of the post-tests conducted after the robotics and coding training. According to these results, there is a significant difference between the experimental and control groups in the results of all the three scales after the training ($p < .05$). As a result of the robotics and coding training, a significant difference was found in the STEM career, attitude and motivation scale scores between the experimental group students and the control group students. Cohen's d value was found to be 0.67 for the STEM Career (SCS) scale, 0.58 for the STEM Motivation (SMS) scale, and 0.68 for the STEM Attitude (SAS) scale. These values indicate that all three scales have a moderate effect size (Cohen, 1988). The fact that Cohen's d is greater than 0.2 and less than 0.8 indicates that the results of this study are meaningful and that the intervention has positively changed student motivation, attitude, and career goals.

Correlation Between Robotics and Coding Training and Participant Variables (Parents' Education Level, Income and Intended Profession)

In this section, the correlations between some participant variables (parents' education levels, income and intended profession) and the data obtained from the scales are presented. No significant correlation was found between the participants' scale scores and their parents' education levels. On the other hand, while the participants' scores taken from the STEM Attitude Scale and STEM Motivation Scale do not vary significantly depending on the variable of the intended profession, the scores taken from the STEM Career Scale vary significantly depending on the variable of intended profession in favor of the participants intending to be teachers.

As seen in Table 6, there is a significant correlation between the scores taken from the STEM Career Scale and the variable of intended profession and as these scores are homogenous, Tukey test was conducted to determine which group the difference is in favor of.

As seen in Table 7, the difference is in favor of the participants intending to be teachers. Accordingly, because

Table 8. Relationship Between the Scale Scores of SCS, SAS and SMS.

Variable		SCS	SAS	SMS
SCS	Pearson Correlation	1	.847**	.749**
	Sig. (2-tailed)		.000	.000
	N	32	32	32
SAS	Pearson Correlation	.847**	1	.670**
	Sig. (2-tailed)	.000		.000
	N	32	32	32
SMS	Pearson Correlation	.749**	.670**	1
	Sig. (2-tailed)	.000	.000	
	N	32	32	32

** Correlation is significant at the .01 level (2-tailed).

of the robotics and coding training, a significant difference was observed between the STEM Career Scale scores of the participants intending to be teachers and the participants intending to work in the fields of health-care and engineering.

Correlation Between the Changing STEM Attitude, Motivation and Career Aspirations as a Result of Robotics and Coding Training

Pearson correlation was used to determine this correlation.

In Table 8 relationship between the STEM Career Scale (SCS), STEM Attitude Scale (SAS) and STEM Motivation Scale (SMS) scores were examined using Pearson correlation analysis. The results indicated a positive and significant correlation among all the scales ($p < .01$). The correlation coefficient between SAS and SCS was calculated as .847, between SCS and SMS as .749, and between SAS and SMS as .670. These findings suggest that individuals with a positively changing attitude toward STEM also experience increased motivation, which is directly related to their interest in a STEM career. The increase in students' attitudes and motivation toward STEM after participating in the robotics and coding training positively influenced their orientation toward a STEM career.

Discussion

The current study aimed to investigate the effect of the robotics and coding training on female students' STEM attitudes, STEM motivation and STEM career aspirations. The results indicated that the robotics and coding training significantly enhanced students' interest in STEM careers, motivation and attitudes. In addition, strong positive correlations were found between career interest, motivation and attitude scores, indicating that these variables are interconnected.

Before the training, no differences were found between the experimental and control groups in terms of STEM career, attitude and motivation scores. After the training, it can be said that robotics and coding activities had a significant effect on the participants' STEM careers, attitudes and motivation. These findings suggest that women have positive attitudes and motivation toward robotics and coding and that they can also develop a career in this field. The women in the current study receive an education primarily focused on humanities and religious subjects. However, the results indicate that women are not only inclined to develop skills and gain knowledge in religious or verbal-focused areas but are also capable of easily gaining proficiency in topics such as coding or robotics. These findings show that women, like everyone else, are open to development in coding and the use of robotics. The improvement observed in students who participated in the robotics and coding training is consistent with previous studies highlighting the impact of hands-on, technology-focused learning experiences in encouraging participation in STEM activities (Dönmez, 2021; Küçük & Şişman, 2020). The current study supports the claim that exposure to technological tools such as robotics and coding can enhance career perceptions related to STEM, especially for female students who are underrepresented in these fields (Carlone & Johnson, 2007; Gülen & Yaman, 2019). Similarly, Lyon and Green (2019) found that women, given the opportunities, can develop an interest in computer science and advance their career development, Garcia et al. (2023) highlighted that coding training positively affects attitudes, Yabas et al. (2022) reported an increase in girls' interest in STEM, STEM careers and STEM identities as a result of a robotics training program and Mauk et al. (2020) emphasized that extracurricular computer science/coding clubs or workshops are effective in supporting women's skills.

As a result of the robotics and coding training, correlations between the measured STEM attitude, motivation

and career scores of the participants and some variables (parents' education levels, intended profession and income) were examined. No significant correlation was found between the participants' parents' education levels, family income and scale scores. Although no significant correlation was found between the variable of intended profession and STEM attitude and STEM motivation scale scores, a significant correlation was found between the variable of the intended profession and the scores taken from the STEM Career Scale. The participants who are considering choosing teaching professions (e.g., Primary, Science, Turkish, etc.) in the future have significantly higher STEM career scores compared to those who are considering professions in healthcare (e.g., Doctor, Nurse, Dentist, etc.) and engineering fields (e.g., Civil, Software, Mechanical, etc.). In other words, the greatest change in STEM career scores occurred among the participants who are considering the teaching profession. Students expressing an interest in a teaching career demonstrated significantly higher STEM career scores compared to those considering engineering or healthcare professions. This suggests that the robotics and coding training not only affected students' career choices but also encouraged them to perceive STEM disciplines as valuable, applicable skills in various professional fields. This result is consistent with previous research that shows STEM education can encourage interdisciplinary interest beyond traditional STEM careers (Farrell & McHugh, 2020). Similarly, Lyon and Green (2019) found that women see computer science or coding as an opportunity to support their dream professions.

The fact that STEM career scores are high especially in participants who aim for teaching profession can be interpreted in the context of Pedagogical Content Knowledge (PCK) defined by Gudmundsdottir and Shulman (1987). Students who intend to choose the teaching profession see STEM as more functional and meaningful because they are orientated not only to learn STEM knowledge but also to transfer it to others. This increases their interest in STEM disciplines and is reflected in their career scores. In addition, since these students are more sensitive to learning processes, they tend to evaluate STEM learning within the framework of social responsibility.

In the current study, no significant correlation was found between STEM career aspirations and parents' education level or family income. This situation suggests that the robotics and coding training may provide students with the opportunity to engage with STEM regardless of their socioeconomic background. This finding reinforces the importance of school-based interventions, as students from low-income families are often deprived of access to extracurricular STEM resources (Taş &

Bozkurt, 2021). Indeed, providing school resources for learning about STEM professions is crucial, regardless of gender differences (Hanson & Krywult-Albańska, 2020). In addition, it is known that parents' education levels influence a student's decision to choose or consider STEM professions (Ozfidan et al., 2020). For example, it is said that children of parents who graduated from any STEM discipline are likely to consider a profession in a STEM field until the final years of high school (Starr et al., 2022).

It can be said that there is a significant, positive and strong correlation between the participants' STEM career, attitude and motivation scale scores. As a result of the robotics and coding training, a direct and strong correlation emerged between the participants' measured scores. This situation shows that training affects attitude, motivation and career aspirations and that these factors are interconnected. Similar training programs for women could also lead to an increase in any of the attitude, motivation or career scale scores, which could positively affect the others as well. The findings of the current study are consistent with the existing literature that highlights the positive impact of STEM education on career interest and motivation (McKinnon, 2022; Shahbazian, 2021). Previous studies have emphasized that early exposure to STEM-related activities, such as robotics and coding, can significantly influence career goals (Boateng & Sharman, 2017; Johnson et al., 2019). The results of the current study also confirm that STEM-focused interventions can reduce gender biases that deter women from pursuing STEM careers (Ro et al., 2021). The fact that students primarily educated in humanities and religious curricula can demonstrate significant growth in STEM interests suggests that incorporating STEM elements into curricula can diversify students' career choices (Modrek et al., 2021). This situation is consistent with the argument that the inclusion of technology-based STEM activities in various educational environments can enhance students' interdisciplinary career expectations (Fisher et al., 2020).

The findings are directly related to STEM Identity Theory (Carlone & Johnson, 2007) and Social Cognitive Career Theory (Lent et al., 1994). According to STEM Identity Theory, an individual's self-identification in STEM fields is shaped by the dimensions of competence perception, recognition and performance. In the current study, the positive attitude and motivation of female students towards STEM in the robotics and coding process supported the experience of recognition and competence among the identity components.

In addition, the phenomenon of selective trust can be explained in the context of Social Cognitive Theory. Students' gender-based occupational expectations are shaped by learning through observation and social

feedback. In this context, direct participation in STEM activities was effective in transforming the low self-efficacy and occupational expectations observed in female students.

Conclusion

The robotics and coding training significantly affected women's STEM attitudes, motivation and career aspirations. Based on these findings, it can be said that women would be successful in robotics-coding education or activities. It is believed that women receiving education in robotics and coding or fields related to STEM disciplines will yield positive outcomes.

No significant correlation was found between the participants' scale scores and their parents' education levels or family income as a result of the robotics and coding training. However, a significant difference was observed between the STEM career scores in favor of the participants who are considering the teaching profession.

As a result of the robotics and coding training, a significant, positive and strong correlation was found between the participants' STEM career, attitude and motivation scale scores. This suggests that an increase in one of these scale scores as a result of the robotics and coding training can also affect the others. For example, it can be said that training programs that positively influence STEM attitude or motivation can also have a positive impact on an individual's STEM career.

The findings of the study highlight the need for greater integration of STEM activities in schools with non-STEM-focused curricula. Given that the robotics and coding training significantly improved students' perceptions of STEM careers, policymakers and educators should consider implementing similar programs, especially in schools that are underrepresented in STEM fields.

The findings were systematically discussed on the axis of competence, recognition and performance, which are the three basic components of Carlone and Johnson's (2007) STEM identity theory: The participants' significant improvement in STEM scales indicates that their self-efficacy improved. The fact that they shared their products during the workshop process and received positive feedback from the instructors supported the recognition dimension. Their practical demonstration of STEM skills through robotics and coding activities overlapped with the performance component.

Suggestions

STEM-based elective courses should be promoted in secondary schools with a focus on language and religion. Technology-based applications (robotics, coding, algorithmic thinking) to be integrated into the curriculum

should be increased. Interdisciplinary education programs can be developed to raise STEM awareness among female students at an early age. Robotics and coding education should be designed not only to impart technical skills but also with a view to integration with STEM disciplines. Project-based applications and engineering design processes that enable students to solve real-life problems should be supported. The fact that students aiming for a teaching career showed a high interest in STEM careers in the current study indicates that teachers with STEM awareness can be effective role models in the future. Therefore, teacher training programs should include special modules on STEM pedagogy. Gender-sensitive STEM policies should be developed by the Ministry of National Education and relevant institutions to increase the participation of female students in STEM fields. Pilot STEM centers should be established for female students in rural areas. Raising awareness among families about STEM professions and technological developments can bring about significant change, especially in traditional family structures. In this context, STEM promotion days or parent seminars can be organized in collaboration with schools and families. Follow-up studies should be conducted on students' post-secondary career choices to assess the long-term effects of robotics and coding education. Such research is important for evaluating the sustainability of STEM education. School-based robotics kits, software, and laboratory infrastructure should be supported, especially for students living in low-income or rural areas and access to these resources should be guaranteed for all students. The current study highlights how important STEM education is not only for acquiring technical skills but also for gender equality, career development and self-confidence. Policies and practices developed based on the findings will provide effective steps towards increasing the representation of female students in STEM fields.

The experimental group consisted of dormitory students and the control group consisted of non-dormitory students. This situation indicates that there may be some confounding variables that are outside the intervention. For example, students staying the dormitory may plan their extracurricular time in a more disciplined way, while students living with their parents are likely to encounter more distractions in their daily lives. At the same time, social environment, study support and self-study periods may also differ between groups.

Limitations of the Study

This study was conducted in a girls' high school in Turkey with a religious and verbal-focused curriculum and the sample consisted of 74 volunteer students. Limitations of the study include the small sample size, the fact that it was









conducted in only one school and the inability to monitor long-term effects. The fact that the majority of the participants come from low socioeconomic status and have limited access to technological resources reduces the generalizability of the data obtained.

The contribution of the current study to the field is that it is one of the few experimental studies conducted in girls' schools with religious and verbal-focused curricula, unlike previous studies conducted in schools with mostly numerical content or in coeducational environments. Such practices conducted with female students, especially in non-STEM educational settings, provide a roadmap for increasing STEM awareness. In the study, the short-term effects of the robotics and coding training were measured, and long-term follow-up (for example, after 6 months or 1 year) was not conducted after the intervention. Therefore, the permanence of the positive changes obtained cannot be evaluated. This is one of the main limitations of the study. In future studies, the long-term effects of such trainings should be evaluated with follow-up tests. Finally, the scales used were developed in the West and adapted to the Turkish context. Although validity and reliability studies have been conducted, it should be taken into account that the conceptual premises of the scales may be interpreted culturally differently.

Acknowledgments

Authors would like to thank Muş Alparslan University for providing the financing of the research, Davut Karaçam and the Science High School administrators and students for cooperation.

ORCID iDs

Salih Gülen  <https://orcid.org/0000-0001-5092-0495>
 İsmail Dönmez  <https://orcid.org/0000-0002-7792-0169>
 Fatma Betül Şengönül  <https://orcid.org/0000-0001-8962-0289>
 Miyase Aslantaş  <https://orcid.org/0000-0003-1475-9061>
 Turgut Saritaş  <https://orcid.org/0000-0003-1751-8095>
 Ömer Sukenari  <https://orcid.org/0009-0007-8773-729X>
 Emrah Eke  <https://orcid.org/0009-0008-4515-5600>
 Semih Uçar  <https://orcid.org/0000-0002-6723-3437>

Ethical Considerations

This article was approved by the Scientific Research and Publication Ethics Committee of Muş Alparslan University with the decision numbered 54, dated 06.02.2024. All participants volunteered to take part in the study. Parental consent forms were obtained from the participants' families.

Author Contributions

This research was written with the data of the implementation dimension of the "The Impact of Robotics Coding Education

on the Development of Women's STEM Careers" project, which was launched with the support of Muş Alparslan University. The project team took part in the implementation of the project, conducting training, collecting, analyzing, interpreting and reporting data in accordance with their task distribution. The names of the team members were listed in accordance with their duties and responsibilities. SG: Project implementation coordination, data analysis and reporting, İD: Project preparation, reporting, FBS and MA: Taking part in the implementation of the project, guiding the participants, assisting in the collection of data, TS, ÖS and EK: They took turns as trainers in the preparation and implementation of the project program. They organized the laboratory where the training would be held, provided and installed the tools and equipment. They also helped with the collection of data. SU: They provided communication with the project implementation schools, undertook the project program and management issues.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This study was supported by the Scientific Research Projects Coordination Unit of Muş Alparslan University. Project Number: BAP-24-MMYO-4901-01.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. Due to privacy and ethical considerations involving student participants, the data are not publicly available.

References

- Amirtham, S. N., & Kumar, A. (2023). The underrepresentation of women in STEM disciplines in India: A secondary analysis. *International Journal of Science Education*, 45(12), 1008–1031. <https://doi.org/10.1080/09500693.2023.2179901>
- Boateng, F. K., & Sharman, S. (2017). Unfettering the ball and chain of gender discrimination: Gendered experiences of senior STEM women in Ghana. *Cogent Education*, 4(1), 1418135. <https://doi.org/10.1080/2331186X.2017.1418135>
- Büyükoztürk, Ş. (2009). *Handbook of data analysis in social sciences*. (Sosyal bilimlerde veri analizi el kitabı). Pegem Akademi.
- Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, 44(8), 1187–1218. <https://doi.org/10.1002/tea.20237>
- Çepni, S. (2010). *Introduction to research and project work*. (Araştırma ve proje çalışmalarına giriş). Celepler Matbaacılık.

- Çınar, F. (2018). Expectations of Imam Hatip High School. *Journal of International Social Research*, 11(60), 1243–1259. <http://dx.doi.org/10.17719/jisr.2018.2870>
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.
- Coşkun, M. K., & Şentürk, B. (2010). From traditionalism to “conservative modernity”: The case of Imam Hatip Schools. *Mülkiye Journal*, 34(268), 249–263.
- Dönmez, İ. (2020). Adaptation of STEM motivation scale into Turkish: Validity and reliability study. *YYU Journal of Education Faculty*, 17(1), 486–510. <https://doi.org/10.33711/yyuefd.693825>
- Dönmez, İ. (2021). Impact of out-of-school STEM activities on STEM career choices of female students. *Eurasian Journal of Educational Research*, 20(91), 173–204.
- Dönmez, I., & Gülen, S. (2021). An evaluation of student outcomes in interdisciplinary stem activities: An example of using STEM rubrics. *Baskent University Journal of Education*, 8(2), 377–391.
- Dönmez, I., Gülen, S., & Ayaz, M. (2021). Impact of argumentation-based STEM activities on ongoing STEM motivation. *Journal for STEM Education Research*, 5(3) 78–101. <https://doi.org/10.1007/s41979-021-00062-2>
- Emiroğlu, A. (2021). İmam-Hatip secondary/high schools on the axis of justice and development party and coups. *Chasing History*, 25, 1–13.
- Eriklioğlu, E. N. (2019). *A research on dynamics effecting school preferences of Imam Hatip schools students*. (Master's thesis). Marmara University, Institute of Social Sciences.
- European Commission, & Directorate-General for Research and Innovation. (2021). European citizens' knowledge and attitudes towards science and technology (Special Eurobarometer 516). Publications Office of the European Union. <https://doi.org/10.2775/071577>
- Farrell, L., & McHugh, L. (2020). Exploring the relationship between implicit and explicit gender-STEM bias and behavior among STEM students using the Implicit Relational Assessment Procedure. *Journal of Contextual Behavioral Science*, 15, 142–152. <https://doi.org/10.1016/j.jcbs.2019.12.008>
- Fisher, C. R., Thompson, C. D., & Brookes, R. H. (2020). Gender differences in the Australian undergraduate STEM student experience: A systematic review. *Higher Education Research & Development* 39(6), 1155–1168. <https://doi.org/10.1080/07294360.2020.1721441>
- Friday Institute for Educational Innovation. (2012). Teacher efficacy and attitudes toward STEM survey-science teachers. North Carolina State University.
- Garcia, L., Parker, M., & Warschauer, M. (2023). Coding attitudes of fourth-grade Latinx students during distance learning. *Computer Science Education*, 34(4), 679–717. <https://doi.org/10.1080/08993408.2023.2237366>
- Genç, M. F. (2018). Quality problem of religious education in the case of Imam-Hatip schools and theology faculties. *Turkey Journal of Religious Education Research*, 7, 145–166.
- Gudmundsdottir, S., & Shulman, L. (1987). Pedagogical content knowledge in social studies. *Scandinavian Journal of Educational Research*, 31(2), 59–70.
- Gülen, S. (2019). The effect of STEM education roles on the solution of daily life problems. *Participatory Educational Research*, 6(2), 37–50. <http://dx.doi.org/10.17275/per.19.11.6.2>
- Gülen, S., & Yaman, S. (2019). The effect of integration of STEM disciplines into Toulmin's argumentation model on students' academic achievement, reflective thinking, and psychomotor skills. *Journal of Turkish Science Education*, 16(2), 216–230. <https://doi.org/10.12973/tused10276a>
- Gülen, S., & Dönmez, İ. (2021). Determining the STEM discipline identities of female students. *International Conference on Science and Education (IConSE)*, November 6–9, Antalya/Turkey.
- Hagglund, A. E., & Leuze, K. (2020). Gender differences in STEM expectations across countries: How perceived labor market structures shape adolescents' preferences. *Journal of Youth Studies*, 24(5), 634–654. <https://doi.org/10.1080/13676261.2020.1755029>
- Hanson, S. L., & Krywult-Albańska, M. (2020). Gender and access to STEM education and occupations in a cross-national context with a focus on Poland. *International Journal of Science Education*, 42(6), 882–905. <https://doi.org/10.1080/09500693.2020.1737341>
- Harris, P. L., & Corriveau, K. H. (2011). Young children's selective trust in informants. *Philosophical Transactions of the Royal Society B*, 366, 1179–1187. <https://doi.org/10.1098/rstb.2010.0321>
- Heybach, J., & Pickup, A. (2017). Whose STEM? Disrupting the gender crisis within STEM. *Educational Studies*, 53(6), 614–627. <https://doi.org/10.1080/00131946.2017.1369085>
- Johnson, H. R., Pietri, E. S., Fullilove, F., & Mowrer, S. (2019). Exploring identity-safety cues and allyship among Black women students in STEM environments. *Psychology of Women Quarterly*, 43(2), 131–150. <https://doi.org/10.1177/0361684319830926>
- Kara, F. R. (2017). The progressive education system and Imam Hatip Middle Schools in the context of religious education. *Talim: Journal of Education in Muslim Societies and Communities*, 1(1), 89–118. <http://dx.doi.org/10.12738/talim.2017.1.0001>
- Karadeveci, O. (2020). *Opinions of Imam-Hatip high school administrators on the problems caused by students (Pamukkale and Merkezefendi example)*. (İmam hatip lisesi yöneticilerinin öğrencilerden kaynaklanan sorunlara ilişkin görüşleri (Pamukkale ve Merkezefendi örneği)). Pamukkale University Institute of Educational Sciences.
- Kelley, T., & Knowles, J. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, 3, 1–11. <https://doi.org/10.1186/S40594-016-0046-Z>
- Kier, M. W., Blanchard, M. R., Osborne, J. W., & Albert, J. L. (2014). The development of the STEM career interest survey (STEM-CIS). *Research in Science Education*, 44(3), 461–481. <https://doi.org/10.1007/s11165-013-9389-3>
- Koyunlu Ünlü, Z., Dökmen, İ., & Ünlü, V. (2016). Adaptation of the Science, Technology, Engineering, and Mathematics Career Interest Survey (STEM-CIS) into Turkish. *Eurasian Journal of Educational Research*, 16(63), 21–36. <http://dx.doi.org/10.14689/ejer.2016.63.2>

- Küçük, S., & Şişman, B. (2020). Students' attitudes towards robotics and STEM: Differences based on gender and robotics experience. *International Journal of Child-Computer Interaction* 23–24. <https://doi.org/10.1016/j.ijcci.2020.100167>
- Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior*, 45(1), 79–122. <https://doi.org/10.1006/jvbe.1994.1027>
- Lin, K., Yeh, Y., Hsu, Y., Wu, J., Yang, K., & Wu, H. (2022). STEM education goals in the twenty-first century: Teachers' perceptions and experiences. *International Journal of Technology and Design Education*, 33, 479–496. <https://doi.org/10.1007/s10798-022-09737-2>
- Liu, J., Feenstra, W., Otero, A., & Magrane, K. (2014). STEM Education. *Teaching Elementary STEM Education*. <https://doi.org/10.5220/0004944802700274>
- Luo, T., Wang, J., Liu, X., & Zhou, J. (2019). Development and application of a scale to measure students' STEM continuing motivation. *International Journal of Science Education*, 41(14), 1885–1904. <https://doi.org/10.1080/09500693.2019.1647472>
- Lyon, L. A., & Green, E. (2019). Women in coding boot camps: An alternative pathway to computing jobs. *Computer Science Education*, 30(1), 102–123. <https://doi.org/10.1080/08993408.2019.1682379>
- Mauk, M., Willett, R., & Coulter, N. (2020). The can-do girl goes to coding camp: A discourse analysis of news reports on coding initiatives designed for girls. *Learning, Media and Technology*, 45(4), 395–408. <https://doi.org/10.1080/17439884.2020.1781889>
- McKinnon, M. (2022). The absence of evidence of the effectiveness of Australian gender equity in STEM initiatives. *Australian Journal of Social Issues*, 57(1), 202–214. <https://doi.org/10.1002/ajs4.142>
- MoNE. (2020). *Making changes in the weekly lesson schedule of Imam Hatip Secondary School (İmam Hatip Ortaokulu haftalık ders çizelgesi'nde değişiklik yapılması)*. https://ttkb.meb.gov.tr/meb_iys_dosyalar/2021_08/25102242_ih_ortao-kulu_hdc.pdf Erişim: 02.02.2025
- MoNE. (2021). *Anatolian Imam Hatip High School with Preparatory Class and Anatolian Imam Hatip High School Weekly Course Schedule (Hazırlık Sınıfı Bulunan Anadolu İmam Hatip Lisesi ve Anadolu İmam Hatip Lisesi Haftalık Ders Çizelgesi)*. https://dogm.meb.gov.tr/meb_iys_dosyalar/2021_06/28170320_AIHL_HDC_Ekli.pdf Erişim: 02.02.2025
- Modrek, A. S., Hass, R., Kwako, A., & Sandoval, W. A. (2021). Do adolescents want more autonomy? Testing gender differences in autonomy across STEM. *Journal of Adolescence*, 92(1), 237–246. <https://doi.org/10.1016/j.adolescence.2021.09.003>
- National Science Foundation [NSF], National Center for Science and Engineering Statistics. (2023). Diversity and STEM: Women, Minorities, and Persons with Disabilities 2023 (NSF 23-315). https://nsf.gov/resources/nsf.gov/doc_library/nsf23315-report.pdf?VersionId=OfErRcu.MTEP_KCzcuAfyfIk0cU_XQO
- Özcan, H., & Koca, E. (2019). Turkish adaptation of the attitude towards STEM scale: A validity and reliability study. *Hacettepe University Journal of Education*, 34(2), 387–401. <https://doi.org/10.16986/HUJE.2018045061>
- Ozfidan, B., Duman, J., & Aydin, H. (2020). Parents' perceptions in STEM-oriented public schools: Correlations among ethnic, linguistic, and socio-cultural factors. *Educational Studies*, 48(4), 562–582. <https://doi.org/10.1080/03055698.2020.1793299>
- Ro, H. K., Fernandez, F., & Ramon, E. J. (2021). *Gender equity in STEM in higher education*. Routledge.
- Sainz, M., & Müller, J. (2017). Gender and family influences on Spanish students' aspirations and values in stem fields. *International Journal of Science Education*, 40(2), 188–203. <https://doi.org/10.1080/09500693.2017.1405464>
- Sakellariou, C., & Fang, Z. (2021). Self-efficacy and interest in STEM subjects as predictors of the STEM gender gap in the US: The role of unobserved heterogeneity. *International Journal of Educational Research*, 109. <https://doi.org/10.1016/j.ijer.2021.101821>
- Sarı, M. (2021). Expectations of students and parents who prefer Imam Hatip high schools and level of satisfaction of these expectations. *Gümüşhane University Faculty of Theology Journal*, 10(19), 98–120.
- Sattari, N., & Sandefur, R. L. (2018). Gender in academic STEM: A focus on men faculty. *Gender, Work & Organization*, 26(2), 158–179. <https://doi.org/10.1111/gwao.12249>
- Schlesinger, M. A., & Richert, R. A. (2019). The role of gender in young children's selective trust of familiar STEM characters. *Media Psychology*, 22(1), 109–132. <https://doi.org/10.1080/15213269.2017.1328311>
- Schmuck, C. (2017). *Women in STEM disciplines*. Springer International Publishing. <https://doi.org/10.1007/978-3-319-41658-8>
- Shahbazian, R. (2021). Under the influence of our older brother and sister: The association between sibling gender configuration and STEM degrees. *Social Science Research*, 97. <https://doi.org/10.1016/j.ssresearch.2021.102558>
- Sharma, M. (2023). STEM education and gender income parity in USA 2019. *Social Sciences & Humanities Open*, 8(1). <https://doi.org/10.1016/j.ssaho.2023.100541>
- Starr, C. R., Carranza, P. R., & Simpkins, S. D. (2022). Stability and changes in high school students' STEM career expectations: Variability based on STEM support and parent education. *Journal of Adolescence Journal of Adolescence*, 94(6), 906–919. <https://doi.org/10.1002/jad.12067>
- Taş, B., & Bozkurt, E. (2021). *Research and monitoring report on gender inequalities in the STEM field in Turkey (Türkiye'de STEM alanındaki toplumsal cinsiyet eşitsizlikleri araştırma ve izleme raporu)*. Uçan Süpürge Derneği. <https://www.stgm.org.tr/sites/default/files/2020-12/turkiyede-stem-alanindaki-toplumsal-cinsiyet-esitsizlikleri-arastirma-ve-izleme-raporu.pdf> Erişim: 02.02.2025
- Taylor, M. G. (2013). Gender influences children's selective trust of adult testimony. *Journal of Experimental Child Psychology*, 115(4), 672–690. <https://doi.org/10.1016/j.jecp.2013.04.003>
- UNESCO. (2024). *Call to action: Closing the gender gap in science*. UNESCO. <https://unesdoc.unesco.org/ark:/48223/pf0000388641>.

- Vleuten, M., Steinmetz, S., & Werfhorst, H. (2019). Gender norms and STEM: The importance of friends for stopping leakage from the STEM pipeline. *Educational Research and Evaluation, 24*(6–7), 417–436. <https://doi.org/10.1080/13803611.2019.1589525>
- Xu, Y. (2016). Focusing on women in STEM: A longitudinal examination of gender-based earning gap of college graduates. *The Journal of Higher Education, 86*(4), 489–523. <https://doi.org/10.1080/00221546.2015.11777373>
- Yabas, D., Kurutaş, B. S., & Çorlu, M. S. (2022). Empowering girls in STEM: Impact of the girls meet science project. *Scholl Science and Mathematics, 122*(5), 247–258. <https://doi.org/10.1111/ssm.12540>