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Middle School Boys' and Girls' Career Aspirations in Science and Mathematics

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Abstract

The aim of this study is to examine secondary school students' desire to pursue a career in science and mathematics in 2011 and 2015, taking into account gender differences, and to examine how variables related to students' socioeconomic status, motivation and performance predict the desire of female and male students to pursue a career in science and mathematics. The number of books, study environment at home and parents' educational levels were analyzed as SES variables. While motivational variables were students' self-efficacy and task value beliefs, performance related variables were their achievement and engagement. The data of the eighth-grade students from Trends in International Mathematics and Science Study (TIMSS) 2011 and 2015 were analyzed. To investigate the year differences of girls' and boys' career aspirations in science and mathematics, Chi-Square test was performed. In addition, logistic regression analysis was conducted to investigate the relation between students' SES, motivation, performance and career aspirations for 2011 and 2015 data separately. The results have indicated that students' motivation was the strongest and the most common predictor of career aspirations in science and mathematics for boys and girls.

Keywords: career aspirations, science, mathematics, TIMSS

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Introduction

Nowadays, technological revolution is growing more rapidly than ever and has affected many aspects of life and changed the needs of the world. One of the results of this major shift is the increasing need for people employed in STEM fields (science, technology, engineering, and mathematics) for countries. (Briggs, 2017; OECD, 2013; That et al., 2012). Hence, nations have started to revise their educational system in order to raise the coming generation in a much more innovative way and started to direct them towards pursuing a STEM-related career (Lederman, 2008). Females are an underrepresented group in STEM-related careers (e.g., Xie & Shauman, 2004). For example, in Turkey, while there are 64% males in STEM-related occupations, there are only about 36% females working in a STEM field (Turkish Industry and Business Association, 2014). Actually, the reason for this gender gap in STEM careers is not because of achievement; recent relevant research suggests that girls have started to obtain higher grades than

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boys (e.g., Bursal, 2013). Moreover, regarding course attendance, there is no significant difference between them (National Science Board, 2014). Wang and Degol (2013) suggest that the underlining reason for girls' and boys' selection of a STEM career might be linked to their motivational beliefs such as self-efficacy and task value. Besides investigating the relations among motivation, career aspirations, performance, and contextual factors by considering gender differences is important and may help researchers to understand underlying factors of career aspirations and may be helpful to encourage girls toward STEM fields (Wang, 2012).

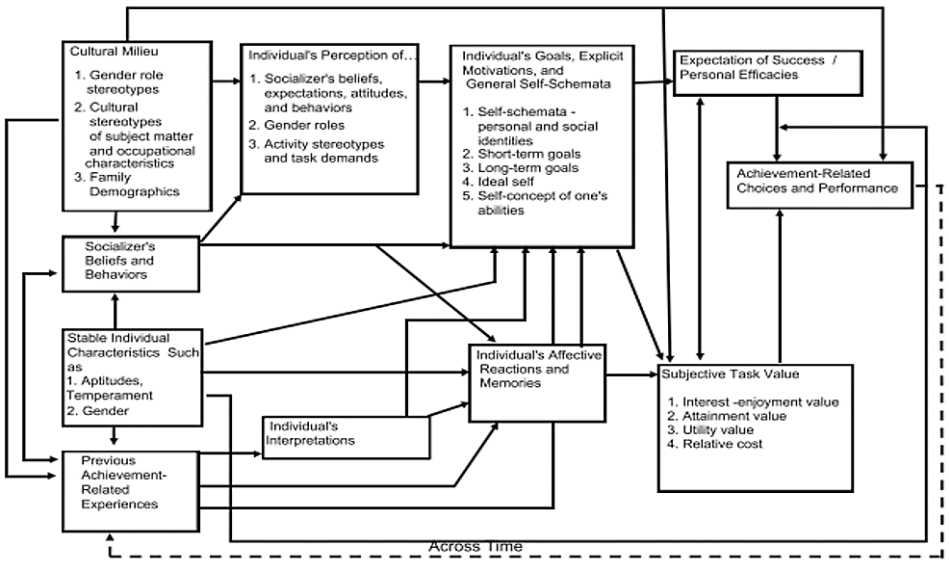
Encouraging people to prefer STEM-elated careers at young ages is critical based on the social and psychological researchers' studies (e.g., Davenport et al., 2021); in addition, it is widely known that people shape their occupational decisions during the adolescence years (Bandura et al., 2001). Moreover, relevant researchers suggest that entering in a STEM pathway starts in childhood and adolescence (Wang & Degol, 2013). Consistently, prior research about STEM careers underlines the importance of secondary school times for career inspiration since it has significant impact on a career decision for upcoming years (Gibbons & Borders, 2010; Jackson et al., 2011). For instance, Sadler and his colleagues (2012) suggest that students' career interest before beginning high school is an important predictor of their career interest in the later stages of high school. Besides, 7th to 9th years is seen as a key period to develop STEM career interest and motivation (Simpkins et al., 2006). Thus, this study aims to investigate the underlying reasons for middle school students' career aspirations in science and mathematics considering gender differences.

Theoretical Framework

To explain people's achievement-related behaviors, expectancy-value theory presents a comprehensive framework about the contextual and psychological factors that underline individuals' performance and career aspirations (Wigfield & Eccles, 2000). According to this theory, if students believe they can accomplish the task (expectation of success) and consider it valuable (task value), they tend to make achievement-related choices, such as career achievements. Along with it, the theory also suggests that students' social contexts such as the school context or house-life context are also important factors to understand individual differences in career aspirations (e.g., Eccles et al., 1997; Eccles, 2007). The theoretical framework of the career choices according to expectancy-value theory is presented in Figure 1. To emphasize, expectancy-value theory analyzes students' academic success, their achievement-related choices and aspirations, including the pursuit of a career, within a wide range (Eccles, 2005). The theory builds on many aspects, such as sociocultural, biological, contextual, psychological and achievement performance factors (Wang & Degol, 2013). In the current study, middle school students' career aspirations were investigated by considering sociocultural, psychological and performance factors of expectancy-value theory.

Figure 1

The Theoretical Framework of the Career Choices According to Expectancy-value Theory from Eccles (2009)



Links Between the Socio-economic Status of Family and Career Interest

Expectancy-value theory underlines the importance of students' social environment such as peers, and family context which can lead students to engage in different educational experiences which affect their career aspirations in STEM (Wang, 2012). For instance, students that come from lower socio-economic status (SES) families are generally seen as disadvantaged in terms of accessing higher education compared to their peers coming from higher SES families (Flores, 2007). Concerning having STEM-related occupations, one of the underrepresented groups is low SES students (Shaw & Barbuti, 2010). For instance, Leslie et al. (1998) found that parents' education level and income affect students' career choice. Actually, SES of students has been one of the main interests of educational researchers for some time. For example, there are studies that investigate the effects of SES on different outcomes such as students' achievement (e.g., Gustafsson et al., 2013) or on motivation (e.g., Tucker-Drob & Harden, 2012). On the other hand, Niu (2017) suggests that although socioeconomic status of family and STEM enrollment is an inequality dimension, it does not get the attention that it deserves. Hence, in the current study, SES was also considered while investigating middle school students' career aspirations in science and mathematics.

Links Between Motivational Beliefs and Career Interest

Expectancy-value theory suggests that students' expectancy and task value beliefs directly affect students' performance related behaviors, achievement related choices, and career aspirations (Wigfield & Eccles, 2000). Task value refers to the answer to the question "Why should I do this task?". In other words, students' task value beliefs are their reasons to engage in a task (Eccles & Wigfield, 2002). Eccles and her colleagues (1983) investigate students' task value beliefs in four components: utility value, intrinsic value, attainment value, and cost. Utility value is concerned with how the task is beneficial for students' personal goals. Intrinsic value means how much students like or enjoy doing the task. Thirdly, attainment value refers to the importance of the relation between the task and students' identity and ideals. The last component of task value, cost, is concerned with the various costs of the task such as economic, social, or psychological costs. (Eccles, 2009; Wigfield & Eccles, 2002). The other motivational component of expectancy-value theory is expectancy for success which refers to the students' beliefs about their performance for upcoming tasks (Eccles et al., 1983; Wigfield & Eccles, 2002). Wigfield and Eccles (2002) proclaim that expectancy success is different from outcome expectations. Besides, it is a bit similar to Bandura's self-efficacy beliefs. Based on this suggestion and the conceptuality of TIMSS data in the present study, students' self-efficacy beliefs were analyzed to represent students' expectancy beliefs. Self-efficacy can be defined as an individual's judgments of his/her capacity towards accomplishing the task successfully. In a simpler manner, the answer of "Can I do this task?" refers to individuals' self-efficacy beliefs (Bandura, 1977; Pintrich & Schunk, 2002; Zimmerman, 2000).

According to the theory, students' motivational beliefs play a prominent role on students' achievement-related behaviors and their career aspirations (Eccles et al., 1983). For instance, Riegle-Crumb et al. (2011) investigated how the self-concept, intrinsic value and achievement predict science/mathematics career aspirations. According to the results, intrinsic value was the most accurate predictor amongst the variables listed. Additionally, in a longitudinal study, Lauermann et al. (2017) investigated the predictive role of motivational beliefs in explaining attaining a mathematics career. They collected the data in four different periods of time: in elementary school years, in high school years (grade 9 and grade 12) and in adulthood. The results confirmed that adolescents' motivational beliefs were the strongest predictor of their adulthood mathematics-related careers. In a recent study, Ahmed and Mudrey (2019) investigated the relation between motivational beliefs and STEM career aspiration. They handled the topics of intrinsic value, utility value and self-concept as motivational beliefs. Results suggest that students' motivation, especially their task value beliefs, are important predictors of their career aspiration in STEM. Briefly, the relevant research confirmed that students who think they have the ability to achieve science or mathematics, and those who enjoy learning them and think that science or mathematics will be useful for their lives, tend to choose a career in science or mathematics.

Links Between Achievement, Engagement and Career Interest

Students' achievement also has an important effect on their career aspirations. Expectancy-value theory also includes this dimension in the framework and suggests that students' competencies affect their achievement-related choices such as their career choice (Eccles, 2009; Wang et al., 2015). To set an example to the link between achievement and career aspiration, Watson et al. (2002) investigated adolescents' career aspirations and suggested that high-achieving female students are more likely to choose prestigious occupations than their lower-achieving peers. Furthermore, students' interactions with learning activities are indicators of their engagement. These interactions can be either observable or unobservable (Deci & Ryan, 2000). According to Fredricks et al. (2004) engagement is a multidimensional structure. The first domain of this structure is behavioral engagement, and it can be defined as students' participation in school activities. Performing the given task or course enrollment can be given as examples of behavioral engagement. The second domain, emotional engagement, is related to students' positive or negative feelings about the class. Thirdly, cognitive engagement refers to students' mental efforts for learning. A relevant research study suggests that students' engagement has a significant influence on students' career aspirations (Durik et al., 2006). The connection between career development and school engagement is a bit controversial while some of the studies suggest that engaging in learning activities related to science or mathematics will influence career choices (Maltese & Tai, 2010; Wang & Degol, 2014). On the contrary some of them suggest that school engagement does not affect students' career development; however, students' career aspirations have an effect on their school engagement (Kenny et al., 2006).

Turkish Educational Context

International assessments like TIMSS provide opportunity to the participating countries to analyze results, compare them with other countries' performance and monitor their educational policy (Fischman et al., 2019). Turkey started to participate in TIMSS in 1999 and both the government and educational researchers are x interested in the results of this international test. For instance, achievement in science or mathematics (Uzun et al., 2010), motivation towards science or mathematics (e.g., Dogan & Barış, 2010) and the school or teacher variables (e.g., Atar, 2014) are some of the issues that were analyzed with TIMSS data from Turkish researchers. However, according to the author's knowledge students' career aspirations are not much analyzed by Turkish researchers from TIMSS perspective.

In 2011, primary schools consisted of two levels: lower primary (grade 1 to 5), and upper primary (grade 6 to 8). Students took proficiency examinations in each grade of upper primary levels. According to the average score of three proficiency examinations, students were able to choose a high school. They could enter a regular high school, science high school or different types of vocational high schools. Science high schools were one of the most popular schools because students who graduate from these kinds of schools were more likely to enter STEM-related programs than their

peers who graduate from a regular high school (Argon & Soysal, 2012). There was an educational reform in 2012 in Turkey, which constituted three new levels: primary school (grade 1 to 4), middle school (grade 5 to 8) and high school (grade 9 to 12). The proficiency examinations were repealed at grade 6 and grade 7. Students took proficiency examinations in grade 8 two times in the first and second semester (Ozturk & Aksoy, 2014). Similar to the previous system, there were different types of high schools and the average score of two proficiency examnations were used as the transition score to enter a high school. Besides, one of the other revisions was done in science curriculum and science-related career introductions had started to take a part of the science programs (MoNE, 2013). Hence, there is a possibility that middle school students of 2015 might have knowledge about science-related occupations more than age-mates of 2011.

Research Questions and Proposed Model

In the light of the aforementioned research, this study aims to investigate i) girls' and boys' career aspirations in science and mathematics in 2011 and 2015, ii) trends in the prediction of girls' and boys' career aspirations in science, and iii) trends in prediction of girls' and boys' career aspirations in mathematics. To reach these aims, the following research questions herewith were examined:

- Are there any significant differences between girls' and boys' career aspirations in science/ mathematics between 2011 and 2015?

- How do the combination of SES, science motivation and science performance predict the likelihood of Turkish middle school students' science career aspirations for girls in 2011 and in 2015?

- How do the combination of SES, science motivation and science performance predict the likelihood of Turkish middle school students' science career aspirations for boys in 2011 and in 2015?

- How do the combination of SES, mathematics motivation and mathematics performance predict the likelihood of Turkish middle school students' mathematics career aspirations in science for girls in 2011 and in 2015?

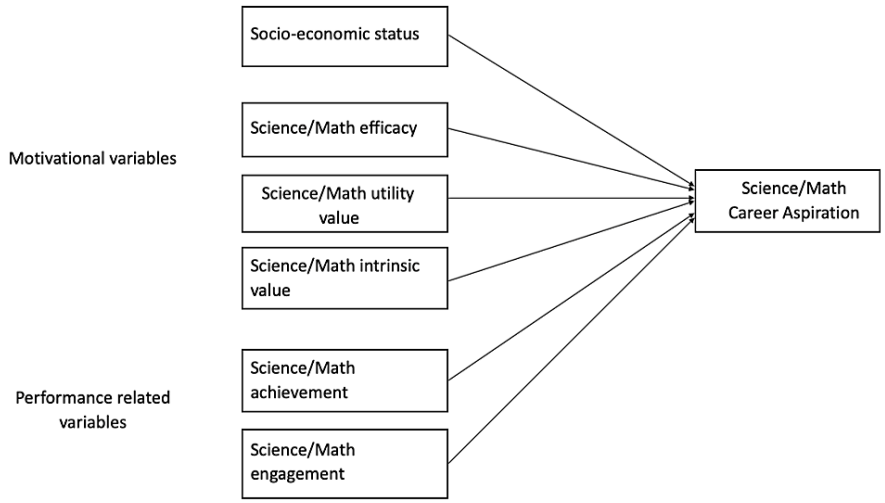
- How do the combination of SES, mathematics motivation and mathematics performance predict the likelihood of Turkish middle school students' mathematics career aspirations in science for boys in 2011 and in 2015?

To address all the research questions except the first one a prediction model was proposed as presented in Figure 2. Moreover, the model was tested based on gender and years for mathematics and science separately. In the light of the expectancy-value model of motivated behavioral choice, students' task value and self-efficacy beliefs were analyzed as their motivational beliefs. Besides, achievement and engagement were analyzed as their performance related behaviors. Furthermore, socio-economic status,

one of the indicators of social context, was also considered while investigating students' science and mathematics related career aspirations.

Figure 2

Prediction Model for Science/Mathematics Career Aspiration



Method

Design of the Study

This study aims to investigate middle school girls' and boys' career aspirations in science and mathematics via using TIMSS 2011 and 2015 data. The combination of correlational and causal-comparative research design was used to investigate the relationship among students' SES, motivation, performance and career aspirations and compare different groups. This research type is used to investigate the differences between groups which already exist without any manipulation (Frankel & Wallen, 2006).

Sample

A two-stage stratified cluster sampling was used to determine the sample of TIMSS. Countries determine stratification variables to select representable samples. For example, Turkey determines geographical region as a stratification variable. In the second stage, schools are sorted by stratification variables. Then the participating schools are selected by systematic sampling method (Joncas & Foy, 2012). 6928 eighth grade, middle school students participated in TIMSS 2011. There were 3414 (49.3%)

girls and 3511 (50.7%) boys in the sample. 56.3% of participants reported that there are between 1-25 books at their homes. In 16.2% of participants' homes, there are more than 100 books. 32.5% of them have neither their own room nor an internet connection at their homes. Regarding TIMSS 2015, 6079 eighth-grade students participated in the study. 48.2% of them were girls and 51.4% of them were boys. While 51.3% of them have 1-25 books, 18.2% of them have more than 100 books at their homes. Besides this, 20.4 % of them are students without an internet connection and with no individual rooms. The demographic description of samples presented in Table 1.

Table 1

Demographic Profiles of Students

	2011		2015	
	Girls frequency (%)	Boys frequency (%)	Girls frequency (%)	Boys frequency (%)
Number of books at home				
0-10 books	554 (16.9)	747 (22.1)	390 (13.3)	589 (18.8)
1- 25 books	1283 (37.2)	1291 (36.7)	1032 (35.1)	1082 (34.5)
26-100 books	978 (27.8)	917 (25.4)	900 (30.6)	935 (29.8)
101- 200 books	359 (10.7)	332 (9.7)	342 (11.6)	280 (8.9)
+ 200 books	226 (7.3)	204 (6.1)	258 (8.8)	217 (6.9)
Home study support				
Neither own room nor internet connection	1079 (31.6)	1153 (32.8)	584 (19.8)	642 (20.5)
Either own room or internet connection	1232 (36.1)	1281 (36.5)	1072(36.4)	1185 (37.8)
Both own room and internet connection	1086 (31.8)	1046 (29.8)	1259 (42.8)	1259 (40.1)
Highest education level of parents				
Universıty or hıgher	235 (6.9)	263 (7.5)	358 (12.2)	394 (12.6)
Post-secondary but not unıversıty	151 (4.4)	163 (4.6)	156 (5.3)	165 (5.3)
Upper secondary	823 (24.1)	759 (21.6)	789 (26.8)	880 (28.1)
Lower secondary	480 (14.1)	497 (14.1)	892 (30.3)	897 (28.6)
Some prımary, lower secondary or no school	1656 (48.5)	1659 (47.2)	654 (22.2)	612 (19.5)
SES category				
Low SES	1827 (53.5)	1955 (55.6)	1146 (38.9)	1228 (39.2)
Middle SES	1459 (42.7)	1423 (40.5)	1577 (53.6)	1721 (54.9)
High SES	126 (3.7)	125 (3.6)	206 (7)	162 (5.2)

Measures

Career Aspirations in Science and Mathematics

In TIMSS, students were asked how much they agree with the statement, x "I would like a job involved with using science." Same question was asked for mathematics, in the same exact format. Since there are some studies that use similar questions to assess students' career aspirations (e.g., Farmer & Chung, 1995; Riegle-Crumb et al., 2011; Watts et al., 2015), it was also analyzed as a single item, career aspiration measure in the present study. There were four possible answer choices: 1 "agree a lot", 2 "agree a little", 3 "disagree a little" and 4 "disagree a lot". Since the purpose of the present study is to investigate students who have a strong aspiration for a career in science and mathematics, "agree a lot" was coded as 1, and the other answers were coded as 0 (Riegle-Crumb et al., 2011). As a result, two dummy variables were obtained from the data.

Socioeconomic Status

In TIMSS, students were asked about the number of books they have at their home, their parents' education level and their home study support amounts. The question about the book quantity had five answer choices: 0-10 books, 11-25 books, 26-100 books, 101-200 books and more than +200 books. Additionally, along with the home study support question students were asked if they have their own room and have internet connection. TIMSS created a continuous variable labelled "home educational resources" with these three questions, since these questions are the common indicators of socioeconomic status in the relevant literature (Buchmann, 2002). This variable was treated as socioeconomic status in the present study.

Engagement and Motivational Beliefs

Within the scope of TIMSS, students' engagement and motivational beliefs about science/mathematics were investigated with four-point Likert scales ranging from 1 (disagree a lot) to 4 (agree a lot).

Self-efficacy. Students' judgements about their capacity to do a task refers to their self-efficacy beliefs (Pintrich & Schunk, 2002). In TIMSS, there is a sub-scale labelled student confidence in science/mathematics. However, Evans (2015) argues that relevant TIMSS items are better to assess students' self-efficacy beliefs rather than their self-confidence according to the definition of these terms. Although self-efficacy and confidence have similarities, Bandura (1977) underlines that they are not the same variables. Moreover, he underlines that self-confidence concerns students' overall feelings; it is not domain specific. Supporting this idea, there are some studies which handle self-confidence scale as self-efficacy (Hwang & Ham, 2021). Hence, in the present study, these items are considered as students' self-efficacy beliefs. There were nine items such as "I usually do well in science/mathematics". The reliability coefficient

of Cronbach's alpha was calculated .87 for the mathematics with both 2011 and 2015 data and for science with 2011 data. Besides that, the reliability coefficient was .84 for the science with 2015 data.

Intrinsic Value. It concerns students' enjoyment of the task (Eccles et al., 1983). TIMSS assesses students' liking or enjoying x learning science with 7 items in 2011, and with 9 items in 2015. Regarding mathematics, there are 6 factors in 2011 and 9 items in 2015 in liking mathematics scale. To keep consistency only common items were used. Hence there were six items such as "I enjoy learning science/mathematics". The reliability coefficient of Cronbach's alpha was calculated .83 for the mathematics with 2011 data and .92 with 2015 data. Regarding science, the coefficient was .81 for 2011 and .87 for 2015.

Utility Value. Students' perceptions about usefulness of the task refers to their utility value beliefs (Eccles et al., 1983). There are 5 items to assess students' utility value in science in TIMSS 2011 data, and 8 items in 2015 data. Parallel questions were asked for students' mathematics value. The example item from this scale is "I think learning science/mathematics will help me in my daily life" The reliability coefficient of Cronbach's alpha was calculated .73 for the mathematics with 2011 data and .86 with 2015 data. Regarding science, the coefficient was .79 for 2011 and .89 for 2015.

Engagement. Behavioral engagement refers to students' participation in learning activities in the class Fredricks et al. (2004). TIMSS assesses students' engagement with five items in 2011 and with 10 items in 2015 in science and mathematics separately. Additionally, students were asked to answer "How much do you agree with these statements about your science/mathematics lessons?" The example item from this scale is "I am interested in what teachers say". The reliability coefficient of Cronbach's alpha was calculated .60 for the mathematics.

Data Analysis Procedure

In the TIMSS web site the data for 2011 (https://timssandpirls.bc.edu/timss2011/international-database.html) and 2015 (https://timssandpirls.bc.edu/timss2015/international-database/) were presented and open for researchers. To create the data for Turkish students International Database (IDB) analyzer version 4.0 was used. It was developed by the IEA Data Processing and Research Center for the Evaluation of Educational Achievement (IEA) to analyze large-scale survey data, and considers sampling weights (IEA, 2013). To work data from different years, two data sets were merged via SPSS (IEA, 2016). Moreover, some of the sub-scales include additional items in 2015 data. Since inputs can affect the regression (Gelman, 2008), all the variables are transformed to z-scores before conducting analyses. After the transformation, none of the correlations was changed.

For the first research question, to compare students' career aspirations regarding years, the Chi-Square test was performed via SPSS 26 with a complex sample module. Chi-Square test has two main assumptions: variables should be ordinal or nominal and independent so that there was no violation of assumptions. For the other

research questions, to predict students' career aspirations, logistic regression analyses were conducted via IDB analyzer. Before performing analyses, assumptions were checked. Firstly, Box-Tidwell test was conducted to check whether the relationships between independent variables and the logic were linear. The interaction of the SES variable was significant, which violates the assumption. However, with large samples this violation is not very concerning (Wuensch, 2012). Moreover, there was no correlation coefficient above .80 among variables, so there was no violation for multicollinearity assumption. Besides, preliminary analyses show that none of the variables has missing value more than 3%, missing data analyses were not conducted. (Tabachnick & Fidell, 2013).

Results

Descriptive Statistics

To investigate middle school students' profile in 2011 and in 2015, descriptive analyses, descriptives for interval variables and frequencies for the nominal variable were conducted.

Career Aspiration in Science and Mathematics

Turkish adolescents' career aspirations in science were approximately 30% in 2011, and 40% in 2015. In addition to that, career aspirations in mathematics were approximately 23% in 2011, and 27% in 2015. Frequencies of these variables are presented in table 2.

Table 2

Descriptive Results for Career Aspiration in Science and Math

	2011		2015	
	Girls	Boys	Girls	Boys
	frequency (%)	frequency (%)	frequency (%)	frequency (%)
want science career	973 (28.3)	1113 (32.1)	1186 (41)	1237 (39.7)
want math career	665 (19.4)	935 (27)	681 (23)	948 (30.6)

Students' Engagement and Motivation Toward Science and Mathematics

Descriptives were used to investigate students' engagement and motivation profiles. According to the results, the profiles of the students indicated that girls tend to engage in science and mathematics at higher rates. Besides, they find science and mathematics valuable and have positive evaluations about their ability to succeed in them. On the

other hand, there were no practical significant differences between girls and boys regarding engagement and motivation. Besides, descriptive results of these variables are summarized in table 3.

Table 3

Descriptive Results for Engagement and Motivational Variables

	2011		2015	
	Girls	Boys	Girls	Boys
	estimate (se)	estimate (se)	estimate (se)	estimate (se)
Motivational Variables				
Math self-efficacy	-.007 (.019)	.046 (.018)	-.039 (.022)	.026 (.013)
Science self-efficacy	.037 (.019)	-.010 (.018)	.094 (.021)	-.023 (.014)
Math intrinsic value	.034 (.018)	-.023 (.017)	.019 (.020)	-.007 (.018)
Science intrinsic value	.099 (.018)	-.082 (.018)	.130 (.019)	-.045 (.014)
Math utility value	.045 (.017)	-.059 (.018)	.075 (.019)	-.047 (.014)
Science utility value	.071(.017)	-.054 (.018)	.105 (.018)	-.037 (.014)
Performance-related Variables				
Engagement in math	.132 (.018)	-.103 (.018)	.099 (.018)	-.021 (.014)
Engagement in science	.114 (.018)	-.100 (.018)	.147 (.017)	-.048 (.014)
Math achievement	.074 (.019)	-.003 (.019)	.064 (.020)	.004 (.014)
Science achievement	.118 (.018)	-.037 (.019)	.161 (.018)	-.034 (.014)

Science and Mathematics Achievement

TIMSS assesses students' performance with a scale range 0-1000, although students' performances generally vary from 300 to 700. Turkish students increased their science scores significantly from 2011 (*mean* = 483) to 2015 (*mean* = 493). However, the effect size value (d = .01) implies that it is too small to consider (Cohen, 1988). Regarding mathematics achievement, there was no significant difference between 2011 (*mean* = 452) and 2015 (*mean* = 458). To emphasize, in all comparisons across disciplines and years, there is no practical significance between groups. The estimation and standard errors of the standardized scores for students' achievements in science and mathematics were also presented in Table 3.

Inferential Statistics

Trends in Students Career Aspirations in Science and Mathematics

Chi-square tests were performed to investigate the differences in middle school students' science and mathematics career aspirations between 2011 and 2015 by considering sampling weights. The analyses were conducted by the complex samples module of SPSSS. Since IBM SPSS Statistics (2020) suggested reporting adjusted F and its degree of freedom, they were considered while investigating the results. Regarding science career aspiration, the results suggest significant difference with small effect between 2011 and 2015 for both girls (F[1, 6356] = 96.144, $p < .01$, $d = .31$) and boys (F[1, 9772] = 46.541, $p < .01$, $d = .20$). On the other hand, the effect of year on students' mathematics career aspiration was statistically significant but practically not significant for both girls (F[1, 6356] = 10.172 $p < .01$, $d = .11$) and boys (F[1, 9772] = 11.260, $p < .01$, $d = .10$).

Relationship between Girls' SES, Motivation, Performance and the Likelihood of Their Career Aspirations in Science in 2011 and in 2015

Binary logistic regressions were conducted to investigate how the combination of independent variables predict students' career aspirations. To evaluate the models' effect size Mcfadden ρ^2 was considered. Mcfadden ρ^2 between .20 to .40 refers to a good fit model (Tabachnick & Fidell, 2013). While investigating independent variables' impact, the bonferonni defined alpha level, .008 (.05/6) was used to reduce type 1 error (Pallant, 2001). Additionally, to investigate the practical significance of independent variables, odd ratio values were converted to Cohen's d (Chinn, 2000). Cohen (1988) suggested lower limits of d value as follows: .20 for small effect, .50 for moderate effect and .80 for large effect.

The first binary logistic regression was conducted to investigate the effects of SES, science motivation, and science performance on the likelihood of middle school girls' science career aspiration in 2011. The model explained 36% (*Nagelkerke* R^2) of the variance and a good fit (Mcfadden $\rho^2 = .25$). According to the model, SES and science achievement were non-significant. While all the motivational variables contributed positively and significantly, students' engagement negatively and significantly contributed to explaining students' science career aspirations. The highest contribution belongs to the students' utility value beliefs ($d = .83$). Self-efficacy beliefs had a small effect ($d = .22$). Although intrinsic value was statistically significant, the effect size was very small to be considered ($d < .20$). The second binary logistic regression was performed to investigate the effects of SES, science motivation and science performance on the likelihood of middle school girls' science career aspiration in 2015. The model explained 47% (*Nagelkerke* R^2) of the variance and a good fit (Mcfadden $\rho^2 = .32$). According to the results, SES and all the motivational variables contribute positively to the model. On the other hand, achievement showed a negative, significant effect on students' career aspiration in science. Similar to the 2011 results,

utility value was the most accurate predictor for the model (d = 1.03) while intrinsic value didn't have significant practical effect (d = .17). Table 4 presents beta values, odd ratios and Cohen's d for the models.

Table 4

Logistic Regression Results for Girls' Career Aspiration in Science

	2011			2015		
	b (SE)	Odds ratio	Cohen's d	b (SE)	Odds ratio	Cohen's d
SES						
Home educational resources	.08 (.10)	1.08	.04	.207 (.06)*	1.23	.11
Motivational variables						
Science Self-efficacy	.391 (.07)*	1.48	.22	.388 (.08)*	1.47	.21
Science Utility value	1.509 (.09)*	4.52	.83	1.871 (.11)*	6.49	1.03
Science Intrinsic value	.309 (.07)*	1.36	.16	.297 (.09)*	1.35	.17
Performance-related variables						
Science achievement	-.04 (.06)	.96	.05	-.246 (.06)*	.78	.14
Science Engagement	-.184 (.07)*	.83	.10	-.062 .(08)	.94	.03
R^2		.37			.47	
Mcfadden ρ^2		.25			.32	

*$p < 0.5$

Relationship Between Boys' SES, Motivation, Performance and The Likelihood of Their Career Aspiration in Science in 2011 and in 2015

A binary logistic regression was conducted to investigate the effects of SES, science motivation and science performance on the likelihood of middle school boys' science career aspirations in 2011. The model explained 36% (*Nagelkerke* R^2) of the variance and a good fit (*Mcfadden* $\rho 2$ = .24). According to the model, SES was not a significant predictor for boys' career aspirations. All the motivational variables except intrinsic value were significantly and positively contributed to the model. From performance

variables, while science engagement had no significant contribution, science achievement had a negative and significant effect on students' career aspirations. Regarding practical significance, utility value had large (d = .73), and self-efficacy had small effect size. The second binary logistic regression was performed to test the model with 2015 data. The model explained 52% of the variance (*Mcfadden* $\rho 2$ = .36). According to the model SES didn't make any significant contribution on boys' science career aspiration. Besides, all of the motivational variables were positively contributed to the model. Moreover, while engagement was not significant, science achievement was negatively and significantly related to boys' career aspirations. In terms of practical significance, only utility had significant and large effect size (d = 1.12). The beta values, odd ratios and Cohen's d are presented in Table 5.

Table 5

Logistic Regression Results for Boys' Career Aspiration in Science

	2011			2015		
	b (SE)	Odds ratio	Cohen's d	b (SE)	Odds ratio	Cohen's d
SES						
Home educational resources	.107 (.05)	1.11	.05	.113 (.05)	1.20	.10
Motivational variables						
Science Self-efficacy	.435 (.07)*	1.54	.24	.287 (.08)*	1.31	.15
Science Utility value	1.324 (.08)*	3.76	.73	2.020 (.64)*	7.54	1.12
Science Intrinsic value	.087 (.07)	1.09	.05	.307 (.06)*	1.36	.17
Performance-related variables						
Science achievement	-.259 (.06) *	.77	.14	-.347 (.05)*	.71	.19
Science Engagement	-.003 (.07)	.99	.005	.067 (.05)	1.07	.04
R^2		.36			.52	
Mcfadden ρ^2		.24			.36	

*$p < 0.5$

Relationship Between Girls' SES, Motivation, Performance and The Likelihood Their Career Aspirations in Mathematics in 2011 and in 2015

Binary logistic regressions were conducted to investigate the effects of SES, mathematics motivation and mathematics performance on the likelihood of middle school girls' mathematics career aspirations in 2011 and in 2015 separately. The model explained .30% (*Nagelkerke* R^2) of the variance in 2011 (Mcfadden $\rho 2$ = .21), and .37 of the variance in 2015 (Mcfadden $\rho 2$ = .26). According to the models, while there was a positive relation between SES and career aspirations in 2015, it lost significance in 2015. Moreover, in both 2011 and in 2015, utility value had significant and moderate impact, self-efficacy and intrinsic value had significant and small effect. Besides, mathematics engagement was non-significant for both of the models. Among performance-related variables, achievement was not practical significant (d = .16). Table 6 presents beta values, odd ratios and Cohen's d for the models.

Table 6

Logistic Regression Results for Girls' Career Aspirations in Mathematics

	2011			2015		
	b (SE)	Odds ratio	Cohen's d	b (SE)	Odds ratio	Cohen's d
SES						
Home educational resources	.132 (.06)*	1.76	.31	.101 (.06)	1.11	.06
Motivational variables						
Science Self-efficacy	.695 (.09)*	2.00	.38	.604 (.10)*	1.83	.33
Science Utility value	.944 (.11)*	2.57	.52	1.120 (.13)*	3.06	.62
Science Intrinsic value	.377 (.08)*	1.46	.21	.594 (.08)*	1.81	.33
Performance-related variables						
Science achievement	-.281 (.07)*	.75	.16	-.187 (.08)	.83	.10
Science Engagement	.005 (.07)	1.01	.05	-.039 (.08)	.96	.02
R^2		.30			.37	
Mcfadden ρ^2		.21			.26	

*$p < 0.5$

Relationship Between Boys' SES, Motivation, Performance and The Likelihood of Their Career Aspirations in Mathematics in 2011 and in 2015

Binary logistic regressions were conducted to investigate the effects of SES, mathematics motivation and mathematics performance on the likelihood of middle

school boys' mathematics career aspirations in 2011 and in 2015 separately. The model explained .29% (*Nagelkerke* R^2) of the variance in 2011 (Mcfadden $\rho 2$ = .20), and .38 of the variance in 2015 (Mcfadden $\rho 2$ = .25). According to the models, there was no significant effect of SES on the model of 2011. Although it was significant in 2015, the effect size was too small to consider (d = .11). Moreover, in both 2011 and in 2015, self-efficacy had significant positive relation with small effect size. Regarding students' value beliefs, utility value had moderate effect for both years, while intrinsic value was not statistically significant in 2011 and had become significant with small effect size in 2015. Besides, mathematics engagement was non-significant, while mathematics achievement had a negative and significant impact regarding boys' career aspirations in mathematics. It may be a suppressor phenomenon to have a negative contribution to the model. Namely, having high correlation with other variables and low correlation with students' career interests may have caused suppressor phenomenon to occur (Pandey & Elliot, 2010). Hence, this does not mean that students who are underachieved tend to be more willing to have a science career than the others. Table 7 presents beta values, odd ratios and Cohen's d for the models.

Table 7

Logistic Regression Results for Boys' Career Aspirations in Mathematics

	2011			2015		
	b (SE)	Odds ratio	Cohen's d	b (SE)	Odds ratio	Cohen's d
SES						
Home educational resources	.071 (.05)	1.83	.33	.115 (.04)*	1.22	.11
Motivational variables						
Science Self-efficacy	.716 (.07)*	2.05	.40	.490 (.06)*	1.63	.27
Science Utility value	.886 (.07)*	2.43	.49	1.314 (.08)*	3.72	.72
Science Intrinsic value	.261 (.07)*	1.30	.14	.450 (.06)*	1.57	.25
Performance-related variables						
Science achievement	-.349 (.06)*	.61	.27	-.451 (.05)*	.64	.25
Science Engagement	-.004 (.06)	.99	.05	-001 (.05)	.99	.05
R^2		.29			.38	
Mcfadden ρ^2		.20			.25	

*$p < 0.5$

Discussion

The purpose of this study was to examine girls' and boys' career aspirations in science and mathematics between 2011 and 2015. Also, another aimed study was to investigate how SES and motivational and performance related variables affect boys' and girls' career aspiration in science and mathematics in the years 2011 and 2015. The combination of the variables that are the number of books, parents' educational level and home study support were handled as SES variables. Students' task value beliefs (utility value and intrinsic value) and self-efficacy beliefs were investigated as motivational beliefs. Finally, performance related variables were represented as students' engagement and academic achievement.

Trends in Students' Career Aspirations in Science and Mathematics

Regarding year differences of middle school students' career aspirations in science and mathematics, the analyses showed that while there were no practical differences between 2011 and 2015 for mathematics career aspiration, there is an increment on students' career aspirations in science from 2011 to 2015, even though it has a small effect. The reason x middle school students tend to pursue a career in science in 2015 more than they did in 2011 can be the educational system of Turkey. In 2013, there was a science curriculum revision which aimed to enhance middle school students' knowledge about careers related to STEM and career introductions had started to take a part of the science programs (MoNE, 2013). As mentioned before, lack of knowledge about x careers can cause lack of interest in those careers (Blotnicky et al., 2018). For instance, Wyss and her colleagues (2012) investigated the effect of videos about scientists on students' career aspirations and observed that students tend to aspire to a science-related career more than they do before experiment. Hence introducing some occupations to middle school students after the 2013 reform may increase their awareness and may draw their attention to careers related to science or mathematics.

Links between SES and Career Aspiration

To investigate underlying reasons for girls' and boys' career aspirations in science and mathematics, students' SES, motivational beliefs and their performance-related behaviors were tested with logistic regression analyses. According to the models, the SES had not significantly contributed to students' career aspirations in all models except the model of 2011 mathematics for girls. Although Turkey is a developing country, there is still gender inequality in terms of accessing education especially amongst the low SES families (Caner et al., 2016). For instance, Tunç (2009) investigated girls' education in a low SES city. The researcher suggests that families tended to withdraw their support for female students on their ongoing education, whereas they encourage boys for education in previous years so SES became significant for girls. In 2015, SES lost significance also for girls. In other words, low-SES students and high-SES students had the desire to have a job related to mathematics or science equally. According to the findings, the gap between girls from different SES statutes became narrower in 2015 for science career aspiration. In Turkey, science or mathematics-related careers, in other

words STEM careers, are believed to provide more financial advantages than other occupations (Bahar & Adıgüzel, 2016). Hence, boys from high SES families and from low SES families may be supported equally to go to a college and to pursue a STEM-related career. Supporting this idea, Correll (2001) suggested that students from low SES families tend to choose STEM careers due to the idea of possibility of having a higher financial income.

Links between Motivational Beliefs and Career Aspiration

The results of the present study confirmed the expectancy-value theory's suggestion which claims students' motivational beliefs directly influence their academic and future choices (e.g., Wigfield & Eccles, 2002). According to the findings, utility value was the common and the strongest variable to predict students' aspirations for a career related to science and mathematics. It had a moderate or large effect on girls' and boys' career aspirations. This means that students, both girls and boys who believe that science or mathematics will be helpful for their life tend to aspire to a career in science or mathematics. This was an expected result since the theory suggests that individuals' motivational beliefs have prominent roles on their career aspirations (Eccles et al., 1983). The relevant research also supports this idea (Ahmed & Mudrey, 2019; Laurmann et al., 2017). In addition to that, when we compare the odd ratio of utility value beliefs, its contribution was increased not only for science, but also for mathematics, which means, in 2015 boys' beliefs about tasks' utility explained their career aspirations more than they did in 2011. On the other hand, the relations were a bit complicated for intrinsic value and self-efficacy. Intrinsic value had a significant effect on students' science career aspirations neither for girls nor boys. Namely, finding science tasks enjoyable did not predict students' pursuing a career related to science. Regarding mathematics, it predicted girls' career aspirations in 2011 and 2015 with a small effect size. It became significant for boys only in the 2015 mathematics model. Besides that, students' self-efficacy had a small effect on all the models except predicting boys' science career aspiration in 2015. To summarize, self-efficacy and utility value were significant while predicting girls' science career aspirations. In the mathematics model, intrinsic value did stand out. It was included in the model, and all motivational variables together predicted girls' mathematics-related career aspirations significantly. In respect to boys' career aspirations, while self-efficacy and utility value had contributed to the model of 2011 science, in 2015, self-efficacy lost its significance and utility value became the only variable that significantly predicted boys' science career aspirations. Since the theory emphasizes the motivational, both efficacy and value, beliefs' importance for individuals' achievement-related choices (Eccles et al., 1983), it was surprising that intrinsic value didn't contribute to boys' and girls' science career aspirations and self-efficacy lost their contribution in 2015 science model for boys. One of the reasons for this unexpected finding may have been caused by medical careers. Being a medical doctor is one of the most popular careers among adolescents (Sikora & Pokropek, 2011). For instance, Yerdelen et al. (2016) investigated middle school students' career plan profiles and suggested that many of the participants reported that they wanted to be a doctor. Being a medical doctor is not only popular for students, but parents also want their child to choose to be a doctor in the future

("Ailelerin meslek tercihi", 2013). This popularity can encourage girls to aspire to a science-related career even though they do not find science enjoyable. Supporting this idea, in a recent study Koşan et al. (2020) investigated medical students' thoughts about their career and suggests that the advantages of being a doctor, such as prestige or high income, become prominent for students. In a further study, this concern should be investigated.

Links between Performance-related Behaviors and Career Aspiration

The results of the current study suggest no significant relation between student engagement and their career aspirations for both girls and boys. In fact, prior results about the relation between student engagement and their career aspirations were also inconsistent. While some suggested that engagement affects students' choices positively (e.g., Wang & Degol, 2014), others suggest it does not significantly affect career aspiration (e.g., Kenny et al., 2006). The reason for this unexpected result might have been caused by the Turkish educational system. Although the Ministry of National Education of Turkey made a revision and the modified curriculum is based on constructivism which emphasizes student-centered instruction, students still receive teacher-centered instruction (Cetin-Dindar, 2016). Student-centered learning environments positively affect students' motivation and attitudes (Dorman, 2001). That's why experiencing traditional learning environments may have no effect on students' aspirations of having a career in science or mathematics x in their future life. Supporting this idea, Kang and Keinonen (2017) investigated the effect of inquiry-based learning experiences on students' career aspirations in science and suggested positive relation between these variables. In another study, Ma and Wang (2001) examined students' career aspirations in a model and they included the model quality and quantity of the instruction. According to the findings, the quality of the instruction was more important than the quantity of instruction, and it had indirect effects on students' career aspirations. Indeed, the possibility of indirect relation should also be considered while discussing the engagement career aspiration relation. Student engagement may affect their pursuit of a career related to science or mathematics over motivation. Besides, in the present study, only one dimension of engagement is investigated. In a further study, engagement can be investigated as a multidimensional form, and the indirect relations can be examined. Achievement was also handled as a performance-related variable in this study. According to the findings, achievement was significant only in mathematics career aspirations for boys. It contributed to girls' career aspirations neither in mathematics nor in science. Due to this solid fact, the reason cannot be that the girls are low achievers. Actually, in accordance with this finding, previous research suggests that although the gender gap in achievement decreased between girls and boys, females are still underrepresented in STEM-related careers (Ceci & Williams, 2010). In a similar way, motivation became prominent while predicting girls' mathematics career aspirations in the findings of this study.

Conclusions

The current study examined a) middle school girls′ and boys′ desire to have a career related to mathematics or science, and b) antecedents′ career aspirations in science and mathematics for boys and girls. The main purpose was to compare boys′ and girls′ underlying reasons of career aspirations based on expectancy-value theory. According to the findings, the common and strongest predictor was utility value. In each model, it contributed a moderate or large effect on students′ career aspirations for both science and mathematics. In fact, it was the only significant predictor of boys′ science career aspirations in science in 2015. Compared to the models of 2011, utility value increased its effect on predicting students' career aspirations. Interestingly, intrinsic value was not significant for boys and girls in predicting their scientific career aspirations. It was an unexpected finding and should be investigated in detail in a further study. The main difference between boys′ and girls′ models is that achievement was only significant for boys. Except for this, the models were similar for boys and girls. This study has some limitations. Firstly, the design of the study was the combination of causal-comparative and correlational research since it does not aim to build a cause-and-effect relationship among variables. Additionally, students′ engagement was investigated as only behavioral engagement. The other aspects of engagement could not be included in the study. Hence, in a further study, researchers can investigate students′ engagement and career aspirations taking all aspects of engagement into consideration.

References

Ahmed, W., & Mudrey, R. R. (2019). The role of motivational factors in predicting STEM career aspirations. *International Journal of School and Educational Psychology, 7*(3), 201–214. http://dx.doi.org/ 10.1080/21683603.2017.1401499

Ailelerin meslek tercihi "doktorluk" (2013; March 21). Hurriyet. Retrieved May 30, 2020, from https://www.hurriyet.com.tr/teknoloji/ailelerin-meslek-tercihi-doktorluk-22865770

Argon, T. & Soysal, A. (2012). Seviye belirleme sınavına yönelik öğretmen ve öğrenci görüşleri. *International Journal of Human Sciences, (9)*2, 446-474.

Atar, H. Y. (2014). Öğretmen niteliklerinin TIMSS 2011 fen başarısına çok düzeyli etkileri. E*ğitim ve Bilim, 39*(172).

Bahar, A., & Adiguzel, T. (2016). Analysis of factors influencing interest in STEM career: Comparison between American and Turkish high school students with high ability. *Journal of STEM Education: Innovations and Research*, *17*(3), 64–69.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84(2), 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories. *Child development*, *72*(1), 187-206. https://doi.org/10.1111/1467-8624.00273

Blotnicky, K.A., Franz-Odendaal, T., French, F. & Phillip J. (2018). A study of the correlation between STEM career knowledge, mathematics self-efficacy, career interests, and career activities on the likelihood of pursuing a STEM career among middle school students. *International Journal of STEM Education*, 5-22. https://doi.org/10.1186/s40594-018-0118-3

Briggs, C. (2017). The policy of STEM diversity: Diversifying STEM programs in higher education. *Journal of STEM Education - Innovations and Research*, *17*(4), 5. https://www.learntechlib.org/p/174403/.

Buchmann, C. (2002). Measuring family background in international studies of education: Conceptual issues and methodological challenges. *Methodological Advances in Cross-National Surveys of Educational Achievement*, 150–197

Bursal, M. (2013). Longitudinal investigation of elementary students' science academic achievement in 4-8th grades: Grade level and gender differences. *Educational Sciences: Theory and Practice*, *13*(2), 1151-1156.

Caner, A., Guven, C., Okten, C., Orcan Sakalli, S., (2016). Gender roles and the education gender gap in Turkey. *Social Indicators Research*, *129*, 1231–1254. https://doi.org/10.1007/s11205-015-1163-7

Ceci, S. J., & Williams, W. M. (2010). Sex differences in math-intensive fields. *Current Directions in Psychological Science*, *19*(5), 275–279. http://dx.doi.org/1010.1177/0963721410383241

Cetin-Dindar, A., (2016). Student motivation in Constructivist learning environment. *EURASIA Journal of Mathematics, Science and Technology Education*, *12*(2): 233–247. https://doi.org/10.12973/eurasia.2016.1399a

Chinn, S. (2000). A simple method for converting an odds ratio to effect size for use in meta-analysis. *Statistics in Medicine, 19*(22). doi: 10.1002/1097-0258(20001130)19:22<3127::aid-sim784>3.0.co;2-m

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Hillsdale, NJ: Erlbaum.

Correll, S. J. (2001). Gender and the career choice process: The role of biased self-assessments. *American Journal of Sociology*, *10*(6), 1691–1730. https://doi.org/10.1086/321299

Davenport, C., Dele-Ajayi, O., Emembolu, I., Morton, R., Padwick, A., Portas, A., ... & Woodward, J. (2021). A theory of change for improving children's perceptions, aspirations and uptake of STEM careers. *Research in Science Education*, *51*(4), 997-1011. http://dx.doi.org/10.1007/s11165-019-09909-6

Deci, E. L., & Ryan, R. M. (2000). The " what" and " why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological inquiry*, *11*(4), 227-268. https://doi.org/10.1207/S15327965PLI1104_01

Doğan, N., & Barış, F. (2010). Tutum, değer ve özyeterlik değişkenlerinin TIMSS-1999 ve TIMSS-2007 sınavlarında öğrencilerin matematik başarılarını yordama düzeyleri. *Journal of Measurement and Evaluation in Education and Psychology*, *1*(1), 44-50. Retrieved from https://dergipark.org.tr/tr/pub/epod/issue/5808/77253

Dorman, J. P. (2001). Associations between classroom environment and academic efficacy. *Learning Environments Research*, *4*, 243–257. https://doi.org/10.1023/A:1014490922622

Durik, A. M., Vida, M., & Eccles, J. S. (2006). Task values and ability beliefs as predictors of high school literacy choices: A developmental analysis. *Journal of Educational Psychology*, *98*(2), 382–393. https://doi.org/10.1037/0022-0663.98.2.382

Eccles, J. S. (2005). Influences of parents' education on their children's educational attainments: The role of parent and child perceptions. *London Review of Education*, *3*(3), 191-204. https://doi.org/10.1080/14748460500372309

Eccles, J. S. (2007). Families, schools, and developing achievement-related motivations and engagement. In J. E. Grusec & P. D. Hastings (Eds.), *Handbook of socialization: Theory and research* (pp. 665–691). The Guilford Press.

Eccles, J. S. (2009). Who am I and what am I going to do with my life? Personal and collective identities as motivators of action. *Educational Psychologist*, *44*(2), 78–89. https://doi.org/10.1080/00461520902832368

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, *53*, 109-132. https://doi.org/10.1146/annurev.psych.53.100901.135153

Eccles, J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Perspective on achievement and achievement motivation* (pp. 75-146). W. H. Freeman.

Eccles, J. S., Midgley, C., Wigfield, A., Buchanan, C. M., Reuman, D., Flanagan, C., & Mac Iver, D. (1997). Development during adolescence: The impact of stage–environment fit on young adolescents' experiences in schools and in families (1993). In J. M. Notterman (Ed.), *The evolution of psychology: Fifty years of the American Psychologist* (pp. 475–501). American Psychological Association. https://doi.org/10.1037/10254-034

Evans, J. A. (2015). *Gender, self--efficacy, and mathematics achievement: An analysis of fourth grade and eighth grade TIMSS data from the United States* (Unpublished doctoral dissertation). Lesley University, Cambridge, MA

Farmer, H. S. Y. B., & Chung, M. A. (1995). Variables related to career commitment, mastery motivation, and level of career aspiration among college students. *Journal of Career Development*, *21*(4), 265–278. https://doi.org/10.1177/089484539502100401

Fischman, G. E., Topper, A. M., Silova, I., Goebel, J., & Holloway, J. L. (2019). Examining the influence of international large-scale assessments on national education policies. *Journal of Education Policy*, *34*(4), 470-499. https://doi.org/10.1080/02680939.2018.1460493

Flores, A. (2007). Examining disparities in mathematics education: Achievement gap or opportunity gap? *The High School Journal*, *91*(1), 29-42. https://doi.org/10.1353/hsj.2007.0022

Fraenkel, J. R., & Wallen, N. E. (2006). How to design and evaluate research in education (6th ed.). New York, NY: McGraw-Hill.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, *74*(1), 59–109. https://doi.org/10.3102/00346543074001059

Gelman, A. (2008). Scaling regression inputs by dividing by two standard deviations. *Statistics in Medicine*, *27*(15), 2865-2873. https://doi.org/10.1002/sim.3107

Gibbons, M., & Borders, L. (2010). A measure of college-going self-efficacy for middle school students. *Professional School Counseling, 13(4), 234–243.* https://doi.org/10.1177/2156759X1001300404

Gustafsson, J.-E., Hansen, K. Y., & Rosén, M. (2013). Effects of home background on student achievement in reading, mathematics, and science at the fourth grade. In M. O. Martin & I. V. S. Mullis (Eds.), *TIMSS and PIRLS 2011. Relationships among reading, mathematics, and science achievement at the fourth grade: Implications for early learning* (pp. 181– 287). Boston: TIMSS & PIRLS International Study Center.

Hwang, J., Ham, Y. (2021). Relationships between self-efficacy and achievement moderated by teacher interaction: an international comparison study. *Mathematics Education Research Journal, 33*(1), 135–162. https://doi.org/10.1007/s13394-019-00280-3

IBM SPSS Statistics (2020, April 16). *How do I get chi-square tests with SPSS Complex Samples crosstabs?*. IBM Support. https://www.ibm.com/support/pages/how-do-i-get-chi-square-tests-spss-complex-samples-crosstabs.

International Association for the Evaluation of Educational Achievement. (2016). Help Manual for the IDB Analyzer. https://www.iea.nl/data.

International Association for the Evaluation of Educational Achievement. (2013). *IDB Analyzer (Computer software and manual).*

Jackson, M. A., Perolini, C. M., Fietzer, A. W., Altschuler, E., Woerner, S., & Hashimoto, N. (2011). Career-related success learning experiences of academically underachieving urban middle school students. *The Counseling Psychologist, 39(7), 1024–1069.* https://doi.org/10.1177/0011000010397555

Joncas, M., and Foy, P. (2012). *Sample Design in TIMSS and PIRLS. Methods and Procedures. Methods and Procedures in TIMSS and PIRLS 2011*. TIMSS and Pirls, International Study Centre, Lynch School of Education, Boston College. http://timssandpirls.bc.edu/methods/pdf/TP_Sampling_Design.pdf

Kang, J., & Keinonen, T. (2017). The effect of inquiry-based learning experiences on adolescents' science-related career aspiration in the Finnish context. *International Journal of Science Education*, *39*(12), 1669-1689. https://doi.org/10.1080/09500693.2017.1350790

Kenny, M. E., Blustein, D. L., Haase, R. F., Jackson, J., & Perry, J. C. (2006). Setting the stage: Career development and the student engagement process. *Journal of Counseling Psychology, 53*(2), 272–279. https://doi.org/10.1037/0022-0167.53.2.272

Koşan, A. M. A., El, T., Korkmaz, G., & Toraman, Ç. (2021). Being a medical student in Turkey: The myths, challenges and reality. *African Educational Research Journal 9*(1). 1-8. https://doi.org/10.30918/AERJ.9S1.21.003

Lauermann, F., Tsai, Y.-M., & Eccles, J. S. (2017). Math-related career aspirations and choices within Eccles et al.'s expectancy–value theory of achievement-related behaviors. *Developmental Psychology, 53*(8), 1540–1559. https://doi.org/10.1037/dev0000367

Lederman, L. M. (2008). Scientists and 21st century science education. *Technology in Society*, *30*(3–4), 397–400. https://doi.org/10.1016/j.techsoc.2008.04.014

Leslie, L. L., McClure, G. T., & Oaxaca, R. L. (1998). Women and minorities in science and engineering: A life sequence analysis. *Journal of Higher Education, 69*(3), 239-276. https://doi.org/10.2307/2649188

Ma, X., & Wang, J. (2001). A confirmatory examination of Walberg's model of educational productivity in student career aspiration. *Educational Psychology*, *21*(4), 443-453. https://doi.org/10.1080/01443410120090821

Maltese, A. V., & Tai, R. H. (2010). Eyeballs in the fridge: Sources of early interest in science. *International Journal of Science Education*, *32*(5), 669–685. https://doi.org/10.1080/09500690902792385

Ministry of National Education [MoNE]. (2013). *İlköğretim Kurumları (İlkokullar ve Ortaokullar) Fen Bilimleri Dersi (3,4,5,6,7 ve 8. Sınıflar) Öğretim Programı.* https://www.meb.gov.tr. Ankara.

National Science Board (2014). *Science and Engineering Indicators 2014.* NSB 14-01. Arlington, VA. https://www.nsf.gov/statistics/seind14/index.cfm/chapter-3

Niu, L. (2017). Family socioeconomic status and choice of stem major in college: An analysis of a national sample. *College Student Journal*, *51*(2), 298–312.

OECD (2013). *OECD skills outlook 2013: First results from the survey of adult skills*. Paris: Organisation for Economic Co-operation and Development. http://dx.doi.org/10.1787/9789264204256-en

Öztürk, F. Z., & Aksoy, H. (2014). Temel eğitimden ortaöğretime geçiş modelinin 8. sınıf öğrenci görüşlerine göre değerlendirilmesi (Ordu ili örneği). *Ondokuz Mayıs Üniversitesi Eğitim Fakültesi Dergisi,* 33(2), 439-454.

Pallant, J. (2001) SPSS survival manual, a step by step guide to data analysis using SPSS for windows (version 10 and 11). London, UK: Open University Press

Pintrich, P. R., & Schunk, D. H. (2002). Motivation in education: Theory, research, and applications. Prentice Hall.

Riegle-Crumb, C., Moore, C., & Ramos-Wada, A. (2011). Who wants to have a career in science or math? Exploring adolescents' future aspirations by gender and race/ethnicity. *Science Education*, *95*(3), 458-476. https://doi.org/10.1002/sce.20431

Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). science education stability and volatility of STEM career interest in high school: A gender study. *Science Education, 96*, 411–427. https://doi.org/10.1002/sce.21007

Shaw, E. J., & Barbuti, S. (2010). Patterns of persistence in intended college major with a focus on STEM majors. *NACADA Journal*, *30*(2), 19-34. https://doi.org/10.12930/0271-9517-30.2.19

Sikora, J., & Pokropek, A. (2011). *Gendered career expectations of students: Perspectives from PISA 2006*, OECD education working papers (Vol. 57). Paris: OECD. Retrieved March 15, 2011, from https://www.oecd-ilibrary.org/education/gendered-career-expectations-of students_5kghw6891gms-en

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs.

Developmental Psychology, 42(1), 70–83. https://doi.org/10.1037/0012-1649.42.1.70

Tabachnick, B. G., & Fidell, L. S. (2013). Using multivariate statistics (6th ed.), Boston: Allyn and Bacon.

That, A. C., Milfort, B. Y. M., & Milfort, M. (2012). *An examination of the information technology job market.* Jobs for the Future. https://www.jff.org/resources/examination-information-technology-job-market/

Tucker-Drob, E. M., & Harden, K. P. (2012). Learning motivation mediates gene-by-socioeconomic status interaction on mathematics achievement in early childhood. *Learning and Individual Differences, 22*(1), 37-45. https://doi.org/10.1016/j.lindif.2011.11.015

Tunç, A. İ. (2009). Kız çocuklarının okula gitmeme nedenleri Van ili örneği. *Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi, 6(*1), 237–269.

Turkish Industry and Business Association. (2014). *STEM alanında eğitim almış iş gücüne yönelik talep ve beklentiler araştırması* [Demand and expectations research for the workforce trained in STEM]. https://tusiad.org/tr/yayinlar/raporlar/item/8054-stem-alaninda-egitim-almis-isgucune-yonelik-talep-ve-beklentiler-arastirmasi

Uzun, N. B., Gelbal, S., & Öğretmen, T. (2010). Timss-R fen başarısı ve duyuşsal özellikler arasında ilişkinin modellenmesi ve modelin cinsiyetler bakımından karşılaştırılması. Kastamonu *Egitim Dergisi*, *18*(2), 531–544.

Wang, M. T. (2012). Educational and career interests in math: A longitudinal examination of the links between classroom environment, motivational beliefs, and interests. *Developmental Psychology, 48*(6), 1643–1657. https://doi.org/10.1037/a0027247

Wang, M. T., & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy-value perspective to understand individual and gender differences in STEM fields. *Developmental Review*, *33*(4), 304–340. https://doi.org/10.1016/j.dr.2013.08.001

Wang, M. T., & Degol, J. (2014). Staying engaged: Knowledge and research needs in student engagement. *Child Development Perspectives*, *8*(3), 137–143. https://doi.org/10.1111/cdep.12073

Wang, M. T., Degol, J., & Ye, F. (2015). Math achievement is important, but task values are critical, too: Examining the intellectual and motivational factors leading to gender disparities in STEM careers. *Frontiers in Psychology*, *6*, 1–9. https://doi.org/10.3389/fpsyg.2015.00036

Watson, C. M., Quatman, T., & Edler, E. (2002). Career aspirations of adolescent girls: Effects of achievement level, grade, and single-sex school environment. *Sex Roles*, *46*(9–10), 323–335. https://doi.org/10.1023/A:1020228613796

Watts, L. L., Frame, M. C., Moffett, R. G., Van Hein, J. L., & Hein, M. (2015). The relationship between gender, perceived career barriers, and occupational aspirations. *Journal of Applied Social Psychology, 45*(1). https://doi.org/10.1111/jasp.12271

Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology*, *25*(1), 68–81. https://doi.org/10.1006/ceps.1999.1015

Wigfield, A., & Eccles, J. S. (2002). The development of competence beliefs, expectancies for success, and achievement values from childhood through adolescence. *Development of Achievement Motivation*, 91–120. https://doi.org/10.1016/B978-012750053-9/50006-1

Wuensch, K. L. (2012). *Binary logistic regression with SPSS*. Retrieved on May 26, 2021 from http://core.ecu.edu/psyc/wuenschk/MV/MultReg/Logistic-SPSS.pdf

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

Xie, Y., Shauman, K. A., & Shauman, K. A. (2004). *Women in science: Career processes and outcomes*. Harvard University Press.

Yerdelen, S., Kahraman, N., & Taş, Y. (2016). Low socioeconomic status students' STEM career interest in relation to gender, grade level, and STEM attitude. *Journal of Turkish Science Education*, *13*, 59-74. https://doi: 10.12973/tused.10171a

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary educational psychology*, *25*(1), 82-91. https://doi.org/10.1006/ceps.1999.1016

Kız ve Erkek Öğrencilerin Fen ve Matematik ile İlgili Kariyer İsteklerindeki Eğilimler

Öz

Bu çalışmanın amacı ortaokul öğrencilerinin, 2011 ve 2015 yılarında, fen ve matematik ile ilgili kariyer yapma isteklerini cinsiyet farklılığını göz önünde alarak incelemek ve öğrencilerin sosyoekonomik durumu, motivasyonu ve performans ile ilgili değişkenlerin kız ve erkeke öğrencilerin fen ve matematik alanlarda kariyer yapma isteğini nasıl tahmin ettiğini incelemektir. Evdeki kitap sayısı, çalışma ortamı ve anne-babanın eğitim seviyesi sosyoekonomik durum göstergesi olarak kabul edilmiştir. Motivasyon değişkenleri öz-yeterlik ve değer verme olarak ele alınırken, öğrenci performansı ile ilgili değişkenler başarı ve katılım olarak ele alınmıştır. Bu çalışmada, TIMSS 2011 ve 2015 verisi kullanılmıştır. Kız ve erkek öğrencilerin fen ve matematik ile ilgili kariyer yapma isteklerindeki yıl farklılığını incelemek için Ki-kare testi yapılmıştır. Ayrıca, kız ve erkeklerin 2011 ve 2015 teki SES, motivasyon, performans değişkenleri ve kariyer yapma isteği arasındaki ilişkiyi incelemek için her yıl verisi ile ayrı ayrı lojistik regresyon analizleri yapılmıştır. Bulgulara göre, motivasyon, kız ve erkek öğrencilerin kariyer yapma isteğini tahmin etmede en güçlü ve ortak değişkendir.

Anahtar sözcükler: kariyer yapma isteği, fen, matematik, TIMSS