Examining predictive effects of attitudes toward STEM and demographic factors on academic achievement

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The purpose of this study was to explore factors influencing middle school students' academic achievement. In this regard, the study investigated the impact of demographic factors and students' attitudes towards STEM on their achievement. The research sample was drawn from a city located in southeastern Turkey. Multiple regression analysis was carried out to predict how much each subscale of the STEM survey, along with some other predictors as control variables, can be used to estimate achievement. In this present work, the variable of parental education was found significant. Moreover, it was found that the number of siblings, the status of being seasonal agricultural workers, and preschool education are significant predictors, but gender and the possession of a computer at home are not significant predictors. It was further determined that the "learning of science and engineering and the relationship to STEM" sub-dimension of STEM significantly predicted achievement, but the "personal and social implications of STEM", "learning of mathematics and the relationship to STEM", and the "learning and use of technology" sub-dimensions are not significant predictors. The findings suggest that academic achievement and STEM outcomes are somewhat mutually related. Students' positive attitudes toward STEM are promising and indicate the importance of higher achievement.

Introduction

STEM (science, technology, engineering, and mathematics) education has become a widely studied topic within the last few decades. The STEM abbreviation was introduced in the early 2000s in the United States. Especially in the fields of science, mathematics, and engineering, there has been a significant decrease in the number of students in the U.S. (Bybee, 2013; NRC, 2012). In light of these changes, *Next Generation Standards* have been published to increase American students' interest in STEM-related fields (NRC, 2012). These trends occurring in industry-school policies in the U.S. have also become important in Turkey. Educators and stakeholders in Turkey have also emphasised that there will be difficulties in developing the STEM labour force and have sought to take action.

The efficiency of a country's education system depends on the provision of a qualified workforce in various fields of science. The workforce has an undeniable place and importance in the development in every field (Aydin, Sahin & Topal, 2008). It is stated that the STEM career fields of the 21st century may enable countries to improve their economic growth, global competitiveness, innovation, and living standards (Langdon, McKittrick, Beede, Khan, & Dom, 2011). One of the most vital movements in 21st century education, STEM education has been a hope in many countries for raising up a qualified workforce and not falling behind in the global economy. This hope has led countries to give importance to and transition to STEM education. Failures in both national and international exams in Turkey and other factors, such as inequalities in education, have caused the country to make a transition to STEM education. For this purpose, the Republic of Turkey's Ministry of National Education (MoNE) prepared the *STEM Education Report* (2016). This report, prepared by the Directorate General of Innovation and Educational Technologies, highlighted STEM practices and specified the development of knowledge and competencies of students in STEM fields as a national target (MoNE, 2016).

Furthermore, the Turkish Industry and Business Association stated that STEM, integrated into various educational fields, needed to be improved to attain the nation's future goals (TUSIAD, 2014). Guzeller and Akin (2011) investigated the PISA 2009 data and found that students in Turkey had inequalities in their access to computers and the Internet. The findings of the study showed that students' Internet and computer access at school and home differed among regions and that southeastern Anatolia had the lowest access rate. As a result, Turkey has prioritised rectifying this inequality, as have other nations across the world with similar situations. However, to determine whether the outcome (benefit) expected from education in return for investments made in STEM can possibly be achieved, the reasons underlying academic failure should be identified.

Academic achievement is regarded as the primary goal of schools, and schools are judged by students' performance rather than by what teachers do (Ardura & Galán, 2019). Both parents and educators tend to accept performance in reading, literacy, mathematics, and other subjects as the first indicator of school success (McLoughlin & Lewis, 1994). In evaluating academic achievement, general achievement test scores were considered (Fan & Chen, 2001). One of the most important aims of education is to increase student achievement by ensuring that schools have opportunities to be successful. The functional definition of academic achievement is related to achievement in tests. The concept of academic achievement can be defined as the average of the grades taken by students as a result of the measurement and evaluation carried out to check whether students have attained the goals of each course (Steinmayr, Meißner, Weidinger & Wirthwein, 2014).

Students' academic success or failure is crucial for themselves, their families, and the society they belong to. Training academically successful – and potentially workforce-qualified – individuals is one of the most potent tools for societal development. Academic failures that result from various factors, including attendance, gender, parents' attitudes, among others, potentially prevent delivery of the expected quantity and quality of the workforce into timely participation in society. Academic success in school is a critical qualification for success later in life in most societies. Thus, educational researchers, teachers, administrators, and parents aim to improve students' academic achievement. Where achievement is concerned, what mostly comes to mind are skills or knowledge acquired in schools and assessed by teachers' scores (Carter & Good, 1973, cited in Yelgun & Karaman, 2015).

It is argued that student achievement is associated with many variables (Avnet, Makara, Larwin & Erickson, 2019). Socio-economic status (SES) is one of the most critical variables predicting academic achievement (Catterall, Dumais & Hampden-Thompson, 2012). Some dimensions of SES include parents' educational level, students' educational resources, household goods, and the quality of learning environments (Gelbal, 2008; Konstantopoulos, 2005). In general, a student's social class, family income, family structure, educational status, professional status, and other resources are treated as the determinants of SES (Bradley & Corwyn, 2002). SES variables affecting achievement have more influence on children who have social and economic constraints associated with a risk of academic failure. Low SES, negative factors within the family (e.g., divorce and violence), social environment (e.g., neighborhoods with a high crime rate or families with low incomes), lack of resources, and being a member of an immigrant or minority community have adverse effects on achievement (Bulger & Watson, 2006). Furthermore, although resources such as study rooms, computers, books, and additional after-school services, are not addressed as much as other factors, they are also among other dimensions used for determining students' SES (Sirin, 2005).

Several studies have shown a relationship between SES and achievement (Yang, 2003), whilst other studies have indicated that socio-economically disadvantaged children have lower achievement rates compared to their peers (Caro, McDonald & Willms, 2009; Pike, Iervolino, Eley, Price & Plomin, 2006). Variables associated with the parents' SES factors have the most influence on achievement (Wang & Sheikh-Khalil, 2014). Other studies indicate that the parents' educational level is a critical factor in predicting a child's success (Erola, Jalonen & Lehti, 2016). Family structure and available opportunities also play a vital role in children's educational outcomes (Noack, 2004). Fan and Chen (2001) stated that parental involvement in children's education positively affects their academic achievement.

It is also possible to see the effect of parents on students' achievement in every field. For example, parents who value learning mathematics and science provide their children with extrinsic motivation and are influential in their children's interests in these fields (Wild & Lorenz, 2009). Apart from that, a child's family has a substantial impact on their children's volunteering for, participation, and success in STEM fields (Archer et al., 2012; Peralta, Caspary & Boothe, 2013). Therefore, those parents who believe that STEM-related courses are vital for their children's future may encourage them to choose curricular and extracurricular STEM activities (Harackiewicz, Rozek, Hulleman & Hyde, 2012). Moreover, students supported by their parents are more likely to select STEM-related fields. Furthermore, Šimunovi□a, Rei□ Ercegovacb and Buruši□a (2018) showed that parental educational level, one of the determining dimensions of SES, is influential on children's STEM success, beliefs, and activity choices. They also found that parents care about their children's success in STEM more than their children do, and that they also consider STEM subjects more useful than their children do (Šimunovi□a et al., 2018). Alternatively, academic achievement is a crucial variable that affects students' orientation towards STEM careers (Robinson, 2003; Wang, 2013). It is believed that future engineering and technology-related professions will be in greater demand. The employment of graduates in STEM-related fields will be much more common in the future (Carnevale, Melton & Smith, 2011). Therefore, the interest of students in choosing STEM-related fields should be identified before entering the university so that future studies could understand the continuity in STEM-related careers (Sadler, Sonnert, Hazari

& Tai, 2012). Wang (2013) indicated that success in mathematics and science is a significant predictor for a student's orientation to a STEM-related career. Therefore, academic achievement is considered as an important variable in selecting careers in various STEM areas.

Another crucial point is that families in the region for this study's research are generally employed in agriculture and have several children on average. Unfortunately, school-aged children are usually employed in the field at harvest time (September, October, April, May, and June), during which they cannot attend school. The education of children working in seasonal fields may be interrupted, and this practice prevents children from continuing their learning in a cumulative and progressive manner (Uysal et al., 2016). Thus, one emphasis in this study is how to improve academic achievement, and attitudes toward STEM, for such children.

Goal of the study

Given the empirical evidence from the social context of Turkey, more research is needed about how demographic variables can affect academic achievement. This research was conducted to investigate the effect of the following factors on academic achievement: "parents' education level," (father and mother's education), "number of siblings," "computer ownership," "preschool," "children's career choice," and "seasonal agricultural workers". The research question of this study is to investigate whether these factors have an impact on middle school students' academic achievement. In this regard, this paper also investigated the predictor effects of students' attitudes towards STEM, along with the aforementioned factors affecting achievement. In doing so, the sample was drawn from a city located in the southeastern region of Turkey. It is hoped that the results of the study will guide policymakers, researchers, educators, teachers and parents towards improving students' achievement, as factors that influence achievement are also likely to affect STEM education. In this sense, it is necessary to determine significant variables and eliminate non-significant ones that can be used to predict achievement. Moreover, given that most of the studies on this subject have been carried out with students in Western cultures, new studies that examine different cultures and populations might clarify factors influencing achievement.

Methods

In this study, the Science, Technology, Engineering, and Mathematics (STEM) Survey, initially designed by Guzey, Harwell and Moore (2014) and adapted into Turkish by Yilmaz, Koyunkaya, Guler and Guzey (2017) was administered. The survey originally had a pool of 32 items scaled from strongly disagree = 1 to strongly agree = 5. It was assessed for content validity by two STEM specialists in K-5 schools, two K-12 teachers, and two educational researchers who are STEM experts in K-12 school settings (Guzey et al., 2014). After revising and removing some items based on experts' feedback and exploratory factor analyses (EFA), a total of 28 items was retained with four factors: (a) personal and social implications of STEM (F1), (b) learning of science and engineering and the relationship to STEM (F2); (c) learning of mathematics and the relationship to STEM (F3); and (d) learning and use of technology (F4). Guzey et al. (2014) reported a Cronbach's alpha of .91 for the entire survey, and .87, .87, .80 and .77 for each factor, respectively.

Table 1: Dimensions of STEM

Dimensions	Items
1. Personal and social implications of STEM (8 items)	14, 16, 19, 20, 21, 22, 23, 24
2. Learning of science and engineering and the relationship to STEM (6 items)	1, 2, 4, 5, 13, 15
3. Learning of mathematics and the relationship to STEM (6 items)	3, 6, 7, 8, 9, 10
4. Learning and use of technology (4 items)	11, 12, 17, 18

Yilmaz et al. (2017) recently adapted the STEM survey (Table 1) to Turkish literature to identify students' attitudes towards STEM education and benefit stakeholders from its outcomes. It has been independently translated by two experts in the field of English language and science education, which was then translated back into English by an English teacher. The translation was revised by a science teacher and a researcher in science and mathematics education. According to the findings of factor analyses, 24 items were retained after removing four items due to low factor loadings. Yilmaz et al. (2017) also reported a Cronbach's alpha of .89 for the entire survey, and that of .81, .75, .76, and .70 for each factor, respectively.

Participants

Participants in this study were selected based on convenience sampling from five schools (two private and three public schools) in a city located in the southeastern region of Turkey. A total of 550 students in middle schools, 5th (typically 11 years old) through 8th (typically 14 years old) graders in the 2017-2018 academic year, participated in the study. The demographic profiles of the participants are summarised in Table 2.

Variables

The outcome variable was *academic achievement* that was reported from the previous year based on the end-of-year academic results. The predictors were gender, mother education (ME; illiterate = 1, literate = 2, primary school graduate = 3, middle school graduate = 4, and high school or higher educational-level graduate = 5), father education (FE; the same as ME), number of siblings (NoS; no = 0, one or two = 1, three or four = 2, and five or more = 3), computer ownership at home (CO; no = 0 or yes = 1), preschool (PS; no = 0 or yes = 1), STEM career choice (SCC; STEM career choice = 1 or others = 0), seasonal agricultural workers (SAW; no = 0 or yes = 1), and each factor of STEM (F1, F2, F3, and F4). The most important reason for including these somewhat STEM-related predictors is to predict the extent to which each subscale of STEM, along with these predictors as control variables, can be used to estimate *academic achievement*.

Table 2: Demographic profiles of participants

		N	%
Gender	Male	237	52.9
	Female	209	46.6
Mother education	Illiterate	144	32.1
	Literate	70	15.6
	Primary school	127	28.3
	Middle school	43	9.6
	High school or higher	62	13.8
Father education	Illiterate	21	4.7
	Literate	62	13.8
	Primary school	130	29.0
	Middle school	81	18.1
	High school or higher	151	33.7
Number of siblings	None	12	2.7
	1 or 2	55	12.3
	3 or 4	129	28.8
	5 or more	252	56.3
Computer ownership	No	284	63.4
	Yes	160	35.7
Pre-school	No	220	44.6
	Yes	239	53.3
Career choice	STEM career choices	40	8.9
	Others	390	87.1
Seasonal agricultural workers	No	294	65.6
	Yes	152	33.9

Note: These reports are based on data with some missing values.

Results

Factor analyses

Before proceeding with factor analyses, missing data were handled. Of the 550 students, there were some missing data, which were assumed missing completely at random. The missing responses of the STEM items were imputed using the expected-maximisation algorithm in *SPSS version 22.0* (IBM Corp, 2013); however, missing responses of the other variables were excluded by a listwise option. As a result, responses from 416 students were retained for the rest of the analyses.

The same number of four subscales (i.e., factors) was also adapted in this study for confirmatory factor analysis (CFA), which was used to check how well latent variables are represented by the indicators (Suhr, 2006). CFA was implemented in *Mplus* (Muthén & Muthén, 2007) and displayed in Figure 1. The chi-square value was significant (χ^2=500.313, df = 215, p < 0.05) due to the large number of degrees of freedom. However, the chi-square test statistics can be divided by the corresponding degrees of freedom as an alternative criterion for overall model fit (Schreiber, Nora, Stage, Barlow &

King, 2006; Wheaton, Muthén, Alwin & Summers, 1977). The ratio for a good fit (i.e., 2.33), lower than an acceptable cut-off point of three (Browne & Cudeck, 1993), was observed.

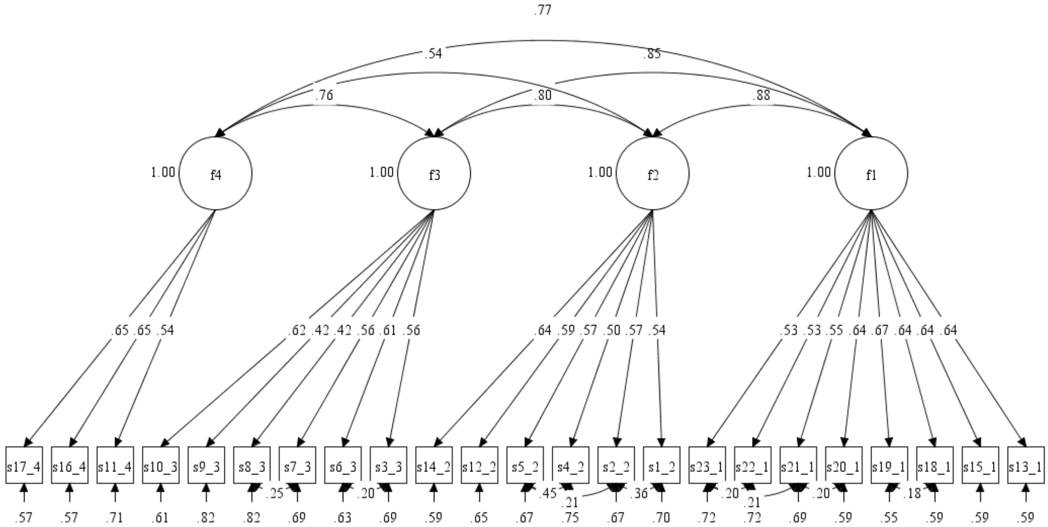

Figure 1: Confirmatory factor analysis for STEM
(use a PDF reader's zoom in function to read)

Furthermore, the Tucker-Lewis index (TLI; Tucker & Lewis, 1973) and the comparative fit index (CFI; Bentler, 1990) were investigated to check the extent to which constructs can be represented by the indicators of the scale. For the STEM scale, the values of TLI and CFI were .91 and .92, respectively, which are above a critical level of 0.90 (Bentler & Hu, 1995). Moreover, values of the root mean square error of approximation (RMSEA) and the standardised root mean square residual (SRMR), .053 and 0.045, respectively, showed a "good fit" of the model to the data (Browne & Cudeck, 1993; Kline, 2011).

The Cronbach's alpha for the entire survey was .91 (23 items). Moreover, the Cronbach alpha of each subscale was .85 for factor 1 (8 items), .79 for factor 2 (6 items), .73 for factor 3 (6 items), and .68 for factor 4 (3 items). These reliability results suggest that student responses to the survey items provide strong evidence of consistency. Next, the students' scores for each of the four factors were calculated based on factor scores weighted by the factor loadings (Tabachnick & Fidell, 2012).

Analyses

Before carrying out multiple linear regression analyses, some assumptions (i.e., *multivariate normality*, *homoscedasticity*, and *multicollinearity*) should be verified. The histogram and normal P-P plot of regression standardised residuals in Figure 2 showed that the multivariate normality assumption was met. The homoscedasticity assumption, the variance of error terms not being highly inflated across the values of predictors, was also investigated via a scatterplot of standardised residuals and predicted values. Figures 2a, 2b and 2c support that the data are equally distributed across all values of predictors.

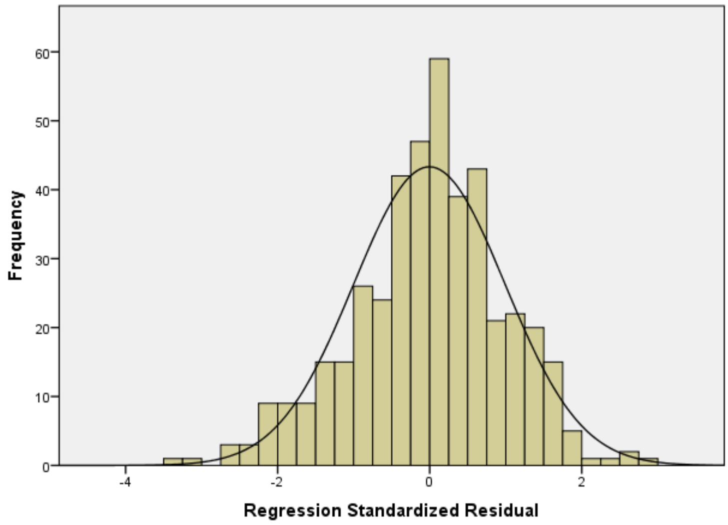

Figure 2a: Histogram

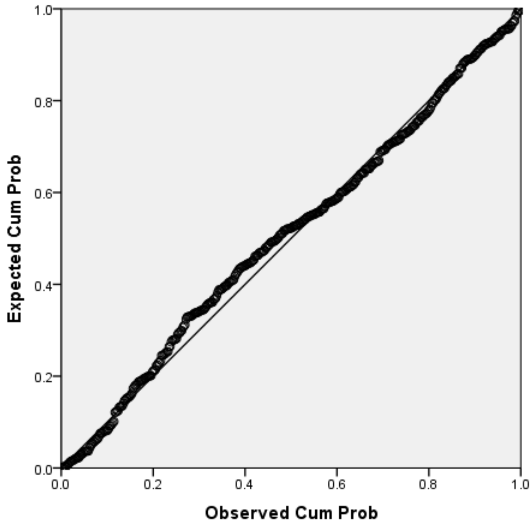

Figure 2b: Normal P-P plot of regression standardised residual

The multicollinearity assumption was further verified based on the level of correlation between the predictors. The highest correlation, 0.62, was observed between F1 and F2, which was lower than 0.80, as seen in Table 3. The multicollinearity assumption was also investigated by the variance inflation factor (VIF) with the highest value of 1.54 (mother's level of education) shown in Table 4, which was lower than the critical value of 10.00.

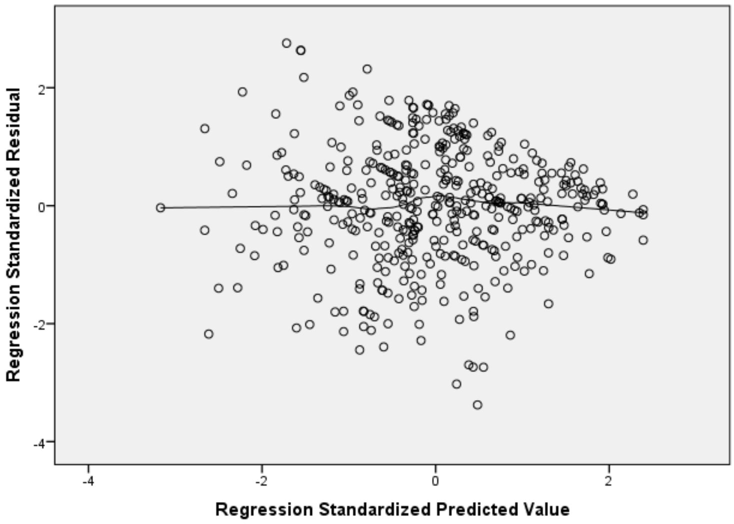

Figure 2c: Scatterplot

Table 3: Correlations

	AA	ME	FE	NoS	CO	PS	SCC	SAW	G	F1	F2	F3
ME	0.40											
FE	0.35	0.53										
NoS	-0.30	-0.41	-0.36									
CO	0.28	0.33	0.32	-0.29								
PS	0.21	0.18	0.20	-0.14	0.21							
SCC	0.14	0.22	0.19	-0.15	0.19	0.06						
SAW	-0.25	-0.25	-0.21	0.26	-0.30	-0.06	-0.07					
G	0.02	-0.02	-0.03	0.07	-0.04	0.01	-0.15	-0.17				
F1	0.32	0.08	0.12	-0.07	0.03	0.01	0.07	-0.08	0.08			
F2	0.40	0.04	0.09	-0.01	0.01	0.10	-0.02	-0.08	0.08	0.62		
F3	0.20	0.09	0.03	-0.07	0.08	-0.03	0.13	-0.03	0.04	0.61	0.50	
F4	0.16	0.09	0.11	-0.05	0.08	0.08	0.07	-0.05	-0.05	0.50	0.29	0.46

Notes: AA = academic achievement; ME = mother education; FE = father education; NoS = number of siblings; CO = computer ownership at home; PS = pre-school; SCC = STEM career choice; SAW = seasonal agricultural workers; G = gender; F1 = Factor 1; F2 = Factor 2; F3 = Factor 3; F4 = Factor 4.

A statistical model for academic achievement

Multiple regression analyses were implemented in this paper to predict how much each subscale of the STEM survey, along with the other predictors as control variables, can be used to estimate *academic achievement* (AA). Predictors included in the model are *gender*, *mother's level of education* (ME), *father's level of education* (FE), *number of siblings* (NoS), *computer ownership at home* (CO), *preschool* (PS), *STEM career choice* (SCC), *seasonal agricultural workers*

(SAW), and *each factor of STEM* (F1, F2, F3, and F4). As noted, the students' scores for each of the four subscales were calculated based on factor scores weighted by the factor loadings.

Table 4: Significant coefficients for the model predicting academic achievement

Variables	*B*	*SE (B)*	*β*	*t*	*p*	VIF
Constant	71.613	3.321		21.56	.000	
ME	2.504	.517	.238	4.843	.000	1.54
FE	1.285	.573	.108	2.242	.025	1.47
SAW	-3.095	1.276	-.101	-2.425	.016	1.11
PS	2.644	1.181	.091	2.239	.026	1.06
NoS	-2.192	.834	-.118	-2.628	.009	1.29
F2	5.383	.592	.364	9.094	.000	1.02
$R = .599$; $R^2 = .359$; $F_{(7,415)} = 38.19$; $p < 0.00$						

Notes: ME = mother education; FE = father education; SAW = seasonal agricultural workers; PS = pre-school; NoS = number of siblings; F2 = Factor 2.

Table 4 displays the model with significant predictors. It was found that 36% of the variance in AA can be explained by the significant predictors included in the study ($F_{(7,415)} = 38.19$, $p < 0.00$). Gender, computer ownership at home (CO), STEM career choice (SCC), and Factor 1, Factor 3 and Factor 4 of STEM (F1, F3 and F4) showed non-significant results. That is, students who have and do not have a computer at home did not show any significant differences in AA. Similarly, there was no difference in achievement between students who want to choose and do not want to choose STEM-related careers. Non-significant findings of "*personal and social implications of STEM*," "*learning of mathematics and the relationship to STEM* (F3)," and "*learning and use of technology* (F4)" to predict AA mean that more positive or negative attitudes towards these factors of STEM did not make any changes in the students' achievement.

$$\widehat{AA} = 71.6 + 2.5 \times ME + 1.3 \times FE - 3.1 \times SAW + 2.6 \times PS - 2.2 \times NoS + 5.4 \times F2 + \varepsilon \quad (1)$$

Equation 1 summarises the model for *academic achievement* based on significant predictors. Note that the following interpretation should be considered for the contribution of each unique predictor to estimate achievement after controlling the other predictors. Furthermore, these estimates show the amount of increase in achievement that would be predicted by a 1-unit increase in the predictor. For example, given the mother's educational level, the model states that there is a 2.5-point increase in achievement as a mother's educational level increases from a lower level to the next higher level, while all the other predictors remain constant. A similar interpretation can be made for the father's educational level. Each level of increase in the father's educational level can lead to a 1.3-point increase in students' achievement.

Another compelling finding is that if students are seasonal workers, which usually takes place during the academic year, their achievement drops 3.1 points compared to their peers who are not seasonal workers. Furthermore, students who have attended preschool are also expected to have 2.6 more points in achievement than those who have not attended. Having more siblings, too, can cause a 2.2-point drop in the students' achievement.

From a STEM perspective, as mentioned earlier, F1, F3 and F4 cannot be used to estimate students' achievement. However, the other STEM factor, "*learning of science and engineering and the relationship to STEM* (F2)", can be used to make some inferences about achievement levels. If students' attitudes toward F2 increase 1 point, a 5.4-point higher achievement level can be observed.

Moreover, in comparing the standardised coefficients (β) of the model in Equation 1, "*learning of science and engineering and the relationship to STEM* (F2)" dimension (.364) is the most influential predictor of achievement. However, attending preschool (.091) is the least significant predictor of achievement. It is interesting to observe that a higher level of education on the mother's part (.238) increases the achievement of students more than a higher level of education on the father's part (.108). Another interesting finding is that having more siblings (-.118) can cause a more significant drop in students' achievement than in students who are seasonal workers (-.101).

Discussion and conclusions

This study investigated the effects of gender, parental education, number of siblings, computer ownership, preschool education, seasonal agricultural workers, students' career choice in a STEM-related area, and attitudes toward each subscale of STEM on academic achievement. According to Konstantopoulos (2005), individuals' socioeconomic situation is directly correlated to their academic achievement.

In this present work, it was determined that the variables of parental education were a significant predictor of academic achievement. In particular, the mother's level of education had a more positive impact on achievement than the father's level of education. Parental education has a direct and positive effect on children's academic achievement (Archer et al., 2012). It has been shown that students' achievement increases as the educational level of parents increases (Gelbal, 2008; Erdas-Kartal, Dogan & Yildirim, 2017; Erdem-Keklik, 2011; Shoraka, Arnold, Kim, Salinitri & Kromrey, 2015; Nonoyama, 2006). For instance, Erdas-Kartal et al. (2017) using PISA 2006 data for 15-year-old students found that "the level of father education," among other variables, is the most predictive of achievement in science. Another study by Gelbal (2008) showed that "the level of [the] mothe[r's] education" has made considerably important contributions to academic achievement. Furthermore, Šimunovića et al. (2018) predicted the importance of higher parental education for children to get better educated in STEM-related fields.

Gender is a commonly used variable for students' achievement and STEM. Therefore, the effect of gender on achievement was investigated in this study because the region where the study took place still has some gender discrimination embedded within its culture. However, we found that gender had no effect on predicting academic achievement. In the literature, some studies showed that achievement could be different in favour of either male or female students. Unlike findings in this study, achievement in science and mathematics at the national level (Bulut, Gur & Sriraman, 2010; Bursal, 2013) and at the international level, such as the TIMSS and PISA studies (Martin, Mullis & Kennedy, 2007; Mullis, Martin, Foy & Arora, 2012) was found to be in favour of female students. Nonetheless, some studies presented significant differences in favour of male students in STEM-related fields (Unfried, Faber & Wiebe, 2014).

The population of the province where the sample was drawn has the highest population of children (46.7%) in Turkey (TU□ K, 2017). Therefore, the number of children (or the number of siblings), one of the clues about the socio-economic status of the family, was included in the study. It was found that the number of siblings is a significant predictor of academic achievement. Thus, it can be said that an increase in the number of siblings can cause lower achievement due to limited opportunities because they must share those resources with other family members. This finding coincides with studies in which the number of siblings negatively influences achievement (Kilic & Hasiloglu, 2017).

Preschool is one of the most vital steps in an individual’s education (Cevik-Buyuksahin, 2017). Another finding obtained from this study was that individuals' preschool education status, which was a distinct factor, can be used to predict achievement. Several national (Agirdag, Yazici & Sierens, 2015; Isikoglu-Erdogan & Simsek, 2014; Yoleri & Tanis, 2014) and international studies (Anders, Grosse, Rossbach, Ebert & Weinert, 2013; Melhuish et al., 2013) have argued that completing preschool education would increase future academic achievement.

We found that the achievement of students who went to preschool was higher than students who did not attend. This finding is consistent with the Agirdag et al. (2015) finding that preschool attendance was related to higher academic achievement, even though children from wealthy families benefited more than children from middle-class and lower-class families. Therefore, this is similar to 2015 PISA reports that showed that students who have attended preschool performed better than those who have not (OECD, 2016).

Another result found in the current study is that a majority of students (63.4%) do not have a computer at home; therefore, there is no Internet access or computer program to use for educational purposes. In the study, having a computer at home is found to be a non-significant predictor of achievement. It was also determined that the “learning and use of technology (F3)” sub-dimension of STEM did not predict achievement. In other words, we can state that high or low-achieving students cannot be separated according to their attitudes towards F3. This result supports the conclusion that adolescents' computer use is not necessary for academic success. It was indicated by Aypay (2010) that the use of information communication technologies and the academic achievement of Turkish students are not correlated. In another study conducted by Calvani, Fini, Ranieri and Picci (2012), it is stated that providing access to information technologies at home and school is necessary but not sufficient to improve performance in education.

In contrast, other studies do not support this finding (Fuchs & Woessman, 2004). For example, Erdas-Kartal et al. (2017), according to PISA 2006 data, showed a positive correlation between achievement and computer access at school and home. Higher academic achievement was observed for students who do not have Internet access at home in Turkey; nonetheless, students who have Internet access at home in Finland and Korea showed higher levels of achievement. A reason for obtaining different results in Turkey compared to other countries can be related to the intended use of information technology. In a study conducted by Aypay (2010) based on PISA 2006 data, the use of computers was divided into two factors; "computer use for computer software" and "computer use for entertainment and Internet." The point to emphasise here is that the effective use of information technologies is essential.

In the study, it was observed that the academic achievements of middle school students who did not think about choosing a STEM-related career, such as engineering, had no effect on their opinions about a career choice. It could be due to being at a young age with a lack of knowledge about professions. When students are in the upper levels, students' professional maturity and career development levels increase (Creed, Patton & Prideaux, 2007; Keller, 2004). Olson (2009) stated that high school is the most critical timeframe for a large number of scientists and engineers in developing their career choices. However, career counselling services to advise students about STEM-related fields are limited in Turkey. Therefore, these reasons can be considered relevant to the findings of this study.

Furthermore, student achievement can affect the recommendation as to whether students should be employed as seasonal agricultural workers (SAW). This study revealed that the status of being SAW affected students' achievement. Research results showed that the achievement level of SAW is lower than those who have attended school. This is similar to results of a study conducted by Tabcu (2015). According to Tabcu's (2015) study, the inability to attend school for students who are SAW had a negative effect on achievement, that is, students' absence from school adversely affects academic achievement.

In this study, it was determined that the "*learning of science and engineering and the relationship to STEM* (F2)" sub-dimension significantly predicted academic achievement. This situation can be explained in a way that students with more positive attitudes towards F2 showed higher academic achievement. All these findings suggest that academic achievement and STEM outcomes are mutually related. Positive attitudes of students about STEM are promising and can predict the importance of high achievement.

Suggestions

In countries like Turkey, policymakers, educators, and other stakeholders should reduce inequality in education in terms of gender and socioeconomic status, to enhance the quality of education. First, STEM education can be made compulsory and integrated into the national curriculum; thus STEM education can also be provided for disadvantaged students with out-of-school learning environments. In particular, computers, Internet services, Web 2.0 tools, and GPS/GIS and robotics programming applications can be provided for the disadvantaged students in this region. Second, the academic achievement of disadvantaged students, along with their STEM training, can be improved by projects. For instance, some projects can be carried out with the involvement of industrial, agricultural and governmental organisations, and parents. Furthermore, some project-based learning environments that are relevant for local agricultural or urban activities can be organised to create strong parental interest in what their children are learning and doing at school and also to attract community interest. It may be possible to actualise individual or small group projects that require a fieldwork component, which could be designed similar to whatever is done in their seasonal agricultural work. In doing so, seasonal agricultural work can be turned into an advantage instead of a threat to academic success for children.

Moreover, positive attitudes towards STEM can be gained by improving the quality of preschool education. This issue should be reconsidered, aiming to make preschool education a requirement for all students, because Turkey is lagging in status among OECD countries in this regard. To be successful in the newly introduced STEM education program in Turkey, preschool education should be supported and equality in education should be ensured in a fair manner. This research is essential in terms of revealing the factors affecting the academic achievement of students, especially in the southeast region of Turkey. In-class activities should be appropriate to the students' level of readiness; in particular, low and intermediate level students should be supported to overcome academic deficiencies.

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