Article

Personality, Motivation, and Math Achievement Among Turkish Students: Evidence from PISA Data

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Abstract

Using the Turkish portion of the Programme for International Student Assessment dataset ($N = 4{,}848$; 51% boys, 49% girls; age, $M = 15.81$ years, $SD = 0.28$), this study investigated factors associated with mathematics achievement among Turkish students. Three different models were estimated using the method of balanced repeated replication with Fay's method and taking into account the presence of five plausible values of the dependent variable. Results showed that male students and older students had better mathematics proficiency. Socio-economic status and school resources also played a significant role in explaining student achievement in mathematics. Finally, students who were more open to problem solving, who attributed their failure to external factors, and who were intrinsically motivated to learn mathematics achieved higher scores. Policy implications are provided.

Keywords

student achievement, personality, motivation, PISA, Turkey

Introduction

Student academic achievement has received extensive attention from policy makers and researchers. Results from international assessments such as the

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Trends in International Mathematics and Science Study (TIMSS) or the Programme for International Student Assessment (PISA) are frequently used as the basis for educational policy debates around the world. The TIMMS has been conducted by the International Association for the Evaluation of Educational Achievement every four years since 1995 and aims to test student achievement in mathematics and science. The target population includes children in fourth and eighth grades. Usually, more countries participate in eighth-grade assessments when students are at least 13.5 years old (Meisenberg & Woodley, 2013). PISA has been conducted by the Organisation for Economic Co-operation and Development (OECD, 2014b), every three years since 2000, and its objective is to assess the competencies of high-school students in three domains: mathematics, reading, and science. The PISA target population consists of "students who are between 15 years 3 months and 16 years 2 months of age at the time of assessment and who are enrolled in school and have completed at least six years of formal schooling" (OECD, 2014b, p. 22). TIMSS testing measures how students perform in important areas of current mathematics curricula, as agreed upon by participating countries, while PISA asks students to analyze real-life problems and situations using their mathematical competency and content knowledge. As such, PISA claims to measure mathematical proficiency in everday life and "workforce knowledge" (Wu, 2010).

To investigate salient factors associated with student achievement, the present study adopted the Turkish portion of PISA data from the 2012 assessment, conducted in 65 countries. Of the three domains of mathematics, reading, and science, PISA emphasizes one at each round, while the other two are given less attention until a subsequent round (OECD, 2013a). The primary domain in PISA 2012 was mathematics; hence we chose to focus on mathematics achievement in this study. In mathematics, Turkey ranked 32nd among 34 OECD countries participating in PISA 2012, and ranked 42nd in general. Turkish students displayed a performance approximately half a standard deviation below the OECD mean (448 against the OECD average of 500).

Several studies have shown that PISA scores predict important outcomes such as school retention (Ehmke, Drechsel, & Carstensen, 2008; Schleicher, 2007), grades obtained in later years (Fischbach, Keller, Preckel, & Brunner, 2013), and future earnings (Schleicher, 2010). Considering the low scores obtained by Turkish students, it is important to analyze factors associated with this performance. Accordingly, the objective of the present study was to investigate such factors associated with mathematics achievement among Turkish high-school students using the Turkish portion of the PISA 2012 dataset as personality and motivation; there is little prior empirical research involving the association between these variables and student achievement in Turkey.

Research on determinants of student achievement dates back to the Coleman Report (1966), which analyzed students' academic achievement from a production function perspective. The output of education (student achievement) was related to several input variables such as school characteristics, students' family background, or peer influences (Hanushek, 2008). The Coleman Report showed that students' family background plays a significant role in explaining achievement while the impact of school related variables was not significant. Subsequently, the Coleman Report has been heavily criticized, and several studies documented that school resources were positively related to student achievement with effect sizes large enough, ranging from .1 to .27 of a standard deviation (Mayer, Mullens, & Moore, 2001) to show that significant improvements in achievement can be obtained through moderate increases in spending (Greenwald, Hedges, & Laine, 1996).

In addition to student characteristics and school resources, the "big five" personality factors of conscientiousness, openness, neuroticism, extraversion, and agreeableness have also been investigated as potential determinants of academic performance and problem-solving success (Marin, Infante, & Troyano, 2001). In general, the association between the last three factors and achievement has been seen as less consistently important than the effect of openness and conscientiousness (Barbaranelli, Caprara, Rabasca, & Pastorelli, 2003; Caprara, Vecchione, Alessandri, Gerbino, & Barbaranelli, 2011). Hence, openness and conscientiousness were the focus of the present study. PISA 2012 included two scales related to personality: "perseverance"[1] which we used to measure conscientiousness and "openness to problem solving" which we used to measure openness. Previous literature generally found that both these traits have a positive relationship to academic achievement (e.g., Asendorph & Van Aken, 2003; Caprara et al., 2011; De Raad & Schouwenburg, 1996; Paunonen & Ashton, 2001; Poropat, 2009).

There is also empirical support for the role of motivational factors in predicting student achievement. Based on self-determination theory (Deci & Ryan, 1985), several studies found that intrinsic motivation has a positive impact on educational outcomes (e.g., Baker, 2004; Deci, Vallerand, Pelletier, & Ryan, 1991). High intrinsic motivation is associated with task persistence (Bandura, 1989) and low academic procrastination (Brownlow & Reasinger, 2001). Extrinsic motivation was also shown to be positively associated with student achievement, although the strength of this relationship was weaker (e.g., Becker, McElvany, & Kortenbruck, 2010; Lee & Stankov, 2013). Similarly, students' attributions for success and failure have been shown to affect achievement, with internal attributions as the best predictors of achievement (Boyer, 2006; O'Sullivan & Howe, 1996; Vispoel & Austin, 1995; Watkins & Gutierrez, 2001), as attributing achievement or failure to others may result in a decreased sense of self-efficacy (Weiner, 1985, 2010) and thus lower achievement outcomes over time (Lane & Lane, 2001; Lane, Lane, & Kyprianou, 2004; Liu, Cheng, Chen, & Wu, 2009).

There are a limited number of prior studies relating various determinants of student achievement in Turkey. Yayan and Berberoglu (2004) used the

Turkish portion of the TIMMS 1999 dataset. Structural equation modeling (SEM) results showed a positive relationship between students' mathematics achievement and both parental education ($\beta = .22$) and the importance given to mathematics by parents and friends ($\beta = .17$). On the other hand, students' mathematics achievement was found to be negatively correlated to their perception of failure ($\beta = .39$). Berberoglu and Kalender (2005) were able to show that school types had a significant impact ($\eta^2 = .303$) on Turkish students' mathematics scores using the PISA 2003 dataset. For instance, the average standardized score for science high-school students was approximately equal to 700, which is two standard deviations above the OECD mean, while vocational high schools scored almost 1.5 standard deviations below the OECD mean. In a study investigating the factors affecting Turkish students' scores on the university entrance examination, Tansel and Bircan (2005) showed that students who received private tutoring in high school increased their test scores significantly (by .56–5.18 points). Moreover, girls performed worse compared with boys in mathematics (by .56–3.56 points), sciences (by 3.21 points), and social sciences (by .68–2.23 points) but better in Turkish (by 1.6–4.97 points). Parental education and previous academic achievement in high school were positively related to students' scores while household income was negatively related to them.

A more recent study by Alacaci and Erbas (2010) used results from PISA 2006 to show through Hierarchical Linear Modeling that 55% of the variance in students' mathematics scores was attributable to between-schools and the remaining 45% to student characteristics. Students from schools with high academic selectivity scored 33 points higher compared with those from general high schools. An additional hour per week spent in studying mathematics improved students' scores by 12 points, and being male was associated with a higher averaged score (by 16 points). Results also showed that students from Eastern and Southeastern Anatolia scored 48 and 44 points less, compared with those from Marmara Region. Finally, when Turkish students had the same economic, social, and cultural status (ESCS) as the average ESCS level in OECD countries, the Turkish average score was 39 points higher on the PISA mathematics scale. Also notable is a study by Dincer and Uysal (2010), which investigated factors affecting science scores, using results from the PISA 2006 dataset. These authors showed that school types and family characteristics significantly affected science scores such that students from Anatolian high schools performed better (by 43–63 points) and those from vocational high schools performed worse (by 26–43 points), compared with students from general high schools. In addition, students whose fathers were at least high-school graduates scored 10 to 14 points higher, and mother's employment and father's employment increased science literacy scores by 14 to 18 points.

As is clear from the preceding discussion, no prior studies investigated the impact of personality and motivation variables on Turkish students' academic achievement. Attempting to fill this gap, we proposed the following hypotheses:

Hypothesis 1: The following personal and family characteristics will be associated with higher mathematics scores: being male, greater age, higher family wealth, higher parental educational status, and higher parental occupational status.

Hypothesis 2: The following school characteristics will be associated with higher mathematics scores: greater academic selectivity, lower student-to-teacher ratio, ability grouping in mathematics classes, and higher quality of educational resources.

Hypothesis 3: The following personality and motivation variables will be associated with higher mathematics scores: more perseverance, more openness to problem solving, internal attributions to failure, higher intrinsic motivation, and higher instrumental motivation to learn mathematics.

Methods

The Data

The Turkish data were collected from a sample of 4,848 students from 170 different schools, attending 7th ($n = 21$), 8th ($n = 99$), 9th ($n = 1{,}317$), 10th ($n = 3{,}202$), 11th ($n = 194$), and 12th ($n = 15$) grades. The 12 school categories which were represented were as follows: primary school ($n = 120$), general high school ($n = 1{,}462$), Anatolian high school ($n = 1{,}050$), science high school ($n = 35$), social sciences high school ($n = 35$), Anatolian teacher training high school ($n = 207$), vocational high school ($n = 1{,}216$), Anatolian vocational high school ($n = 279$), technical high school ($n = 75$), Anatolian technical high school ($n = 123$), multi program high school ($n = 178$), and police high school ($n = 68$).

Variables

As our objective was to investigate factors associated with students' mathematics achievement, our dependent variable was students' mathematics scores. Mathematics questions in PISA test different skills in different content areas and contexts. The four content areas in 2012 included space and shape, change and relationships, uncertainty and data, and quantity (OECD, 2014a). The mathematics questions consisted of a mixture of multiple choice and open-ended questions that were based on a real-life situation in one of the four following contexts: personal, societal, occupational, and scientific (OECD, 2014a). There were a total of 390 minutes of test items but each student took a different combination of different tests. In other words, PISA uses a rotated design, in which students answer a different but overlapping set of mathematics questions selected from a large pool.

We used the following independent variables in our regressions.

Student and Family Variables. Gender, age, and socio-economic status were examined as potential factors related to students' mathematics achievement. Gender is a dummy variable which takes the value of 1 for female students and 0 for male students. Age is a continuous variable which denotes the age of the respondent in terms of years and months. It was calculated as the difference between the middle month of 2012 and the students' month and year of birth (OECD, 2014b).

Three variables were included to measure the socioeconomic status of students: The index of highest occupational status of parents (HISEI) was calculated by OECD using open-ended questions asking the students to indicate their parents' main jobs. The responses were coded into an index score according to methodology defined in Ganzeboom, De Graaf, and Treiman (1992; OECD, 2014b, p. 261). Higher scores on the HISEI index indicate higher levels of occupational status. For instance, farmers are scored 26, and skilled manual workers are scored 36, while higher service professionals are scored 68 (Ganzeboom & Treiman, 1996). To measure parental education, we employed the variable PARED calculated by OECD (2014b, p. 259), which is a continuous variable indicating the highest number of years of schooling attained by either parent. The third variable measuring socio-economic status was the index of family wealth (WEALTH). It is provided by OECD and was constructed based on the availability of 12 different items at the respondents' home. It is an index variable which has been standardized to have a mean value of zero and a standard deviation of one across all respondents from OECD countries (OECD, 2014b).

School-Related Variables. To control for the impact of school characteristics on achievement, we first considered school types. In Turkey, there are two main categories of high schools: those that admit students based on previous academic achievement and those that use nonacademic criteria (Dincer & Uysal, 2010). The institutions using academic criteria must base their selection on the results of a central exam administered by the Ministry of National Education at the end of eighth grade as a prerequisite for transition from primary education into certain specific types of schools. In 2012 when the PISA data were collected, the central exam was called the Level Determination Exam (SBS) and Anatolian high schools, science high schools, and social science high schools had to admit their students based on SBS scores. Given this specific feature of the Turkish educational system, the investigation of school types is especially important. We can assume that these three types of schools are more selective and that the students in these schools have higher previous academic achievement as they admit their students based on SBS scores while the other school types accept their students based on nonacademic criteria such as geographic proximity (Dincer & Uysal, 2010). To control for this, we created a dummy variable SELECT which takes the value of 1 for students from Anatolian high schools (including Regular Anatolian high schools, Anatolian vocational high schools, Anatolian teacher training high schools, and Anatolian technical high schools), science high schools, or social science high schools. All other students take the value of 0.

Some schools may group their students across classes according to their performance in order to create a more homogenous environment and better meet their needs. To investigate this practice, PISA asked school principals to indicate whether their school organizes mathematics instruction differently according to students' abilities. Based on principals' responses, we created a dummy variable, ABILITY, which takes the value of 1 if the school principal indicated that "mathematics classes study similar content but at different levels" or "different classes study different content or sets of mathematics topics that have different levels of difficulty" (OECD, 2013a, p. 139), otherwise the value is 0.

We also employed two variables to control for the school's resources. The index of quality of school educational resources (SCMATEDU) was derived from six items measuring the perception of school principals on the adequacy of resources such as instructional materials, computers, internet, software, library materials, or laboratory equipment. Higher values for the index indicate better quality of educational resources (OECD, 2013a). We also used the student-teacher ratio (STRATIO), which was calculated as the total number of students divided by the total number of teachers. When calculating this index, part-time teachers were assigned a weight of 0.5 (OECD, 2013a).

Personality and Motivation Variables. To account for the effects of students' personality and motivation on their mathematics scores, we used five indices calculated by OECD in the PISA 2012 dataset: *perseverance*, *openness to problem solving*, *perceived self-responsibility for failing in mathematics*, *intrinsic motivation to learn mathematics*, and *instrumental motivation to learn mathematics*.

To measure perseverance, students were asked to indicate the extent to which five statements described them on a 4-point Likert scale (e.g., I continue to work on tasks until everything is perfect; OECD, 2013b). Based on these responses the index of perseverance (PERSEV) was created with higher scores indicating more perseverence. Similarly, the index of openness to problem solving (OPENPS) was based on students' answers to questions asking them to indicate how much they are willing to engage with problems (e.g., I seek explanations for things;

OECD, 2013b). The responses were rated on a 4-point Likert scale with higher numbers indicating more openness.

To construct the index of perceived self-responsibility for failing in mathematics (FAILMAT), students were asked to consider a hypothetical scenario where they do badly on a mathematics quiz and to indicate on a 4-point Likert scale how likely they were to have six thoughts regarding the reasons of their bad performance (e.g., I'm not very good at solving mathematics problems). Students scoring higher on the FAILMAT index are more likely to attribute their failure in mathematics to themselves while students with lower scores attribute their failure to external factors (OECD, 2013b).

To measure intrinsic motivation to learn mathematics, students were asked to indicate the extent to which they agreed with four statements on a 4-point Likert scale (e.g., I do mathematics because I enjoy it; INTMAT; OECD, 2013b). Similarly, to measure instrumental or extrinsic motivation, students were asked to indicate their level of agreement with the four statements about their views on mathematics (e.g., learning mathematics is worthwhile for me because it will improve my career; INSTMOT; OECD, 2013b).

These indices are standardized scale scores with a mean of zero and a standard deviation of one for the entire OECD student population. A negative value for these indices indicates that a given student responded less positively than the average respondent in OECD countries while a positive value indicates that the student answered more favorably (OECD, 2013b).

Estimation

The rotated design employed by PISA allows the use of Item Response Theory to infer students' mathematics proficiencies based on their answers to a sample of items. To make this inference, PISA uses plausible values (PVs) which are random draws from an estimated distribution of mathematics proficiencies that the students might have achieved if they had answered the entire pool of questions (OECD, 2014a). PISA dataset provides five PVs of mathematics for each student. These values have been standardized so that the population weighted OECD average is 500 and the standard deviation is 100.

Another issue which arises when conducting statistical analysis with the PISA dataset is the variance structure of the statistics which results from the sampling design. Rather than using simple random sampling of students, PISA uses cluster sampling: In the first stage, schools are selected with probabilities proportional to their size. In the second stage, students are randomly selected within each school. As a result, the students participating in the PISA survey do not constitute a random sample. Accordingly, each student is assigned a weight to correct for sampling bias. However, these weights are not enough to account for the common error term shared by the students in a given school. To correct for the variance structure of the parameters and obtain unbiased and consistent estimates from PISA data, the method of balanced repeated replication (BRR) with Fay's method is employed by OECD (2014a, p. 187). According to this method, 80 sampling weights are provided and estimations are repeated 80 times to obtain a sampling distribution.

To handle the five PVs and to use the BRR methodology, we employed the STATA module developed by Macdonald (2008). The module runs five generalized least squares (GLS) regressions taking into account the heteroscedastic variance structure and then calculates the average of the statistics.

We considered three sets of regression models to investigate the factors associated with mathematics achievement. Following several studies in the education production function literature, our baseline model incorporated background characteristics of the students including age, gender, and variables related to family socio-economic status. The second model also included school characteristics to investigate whether they are significantly correlated with student scores even after controlling for background characteristics. As our objective was to investigate whether personality and motivational factors were significantly associated with achievement after student background and school characteristics were controlled for, the third and final model also included personality and motivation variables. Hence, the model we estimated can be written as follows:

$$\mathrm{T}_{ij} = \beta_0 + \beta_1 X_{ij} + \beta_2 S_j + \beta_3 P_{ij} + u_j + e_{ij} \tag{1}$$

where

T_{ij} is the test score of student i in school j,

X_{ij} is a vector of background characteristics for student i in school j,

S_j is a vector of school characteristics for school j,

P_{ij} is a vector of personality and motivation characteristics for student i in school j,

β_0, β_1, β_2, β_3 are vectors of coefficients to be estimated,

u_j is the residual for school j, and

e_{ij} is the residual for student i in school j.

Results

Descriptive Statistics

Descriptive statistics on our variables are presented in Table 1. Of the respondents in the Turkish PISA sample, 49% are female students. The average age is 15.81 years. The average score for the WEALTH index is −1.54, meaning that the average wealth of our sample was below the OECD average. On the other hand, HISEI index registers a mean value of 35.14, which approximately corresponds to the average index score of skilled manual workers (Ganzeboom & Treiman, 1996). The average of the highest number of years

Table 1. Descriptive Statistics.

Variable	*N*	Mean	*SD*	Min.	Max.
GENDER	4,848	0.49	0.50	0	1
AGE	4,848	15.81	0.28	15.33	16.25
HISEI	4,262	35.14	20.01	11.01	88.96
PARED	4,789	8.76	3.73	3	15
WEALTH	4,815	−1.54	0.98	−4.85	2.87
SELECT	4,848	0.36	0.48	0.00	1.00
ABILITY	4,689	0.66	0.47	0.00	1.00
STRATIO	4,243	17.28	7.71	3.65	38.49
SCMATEDU	4,773	−0.42	0.79	−2.29	1.98
PERSEV	4,774	0.43	1.07	−4.05	3.53
OPENPS	4,769	0.22	0.97	−3.63	2.45
FAILMAT	4,755	0.26	1.09	−3.77	3.91
INSTMOT	4,754	0.02	1.00	−2.30	1.59
INTMAT	4,763	0.42	1.07	−1.78	2.29

Note. GENDER is a dummy variable which equals 1 for female students. AGE denotes the age of the student in years and months. HISEI is index of highest occupational status of parents. PARED is the highest number of years of schooling attained by either parent. WEALTH is the index of family wealth. SELECT is a dummy variable which equals 1 for students from schools which recruit with the central placement exam. ABILITY is a dummy variable which equals 1 for students from schools which practice ability grouping in mathematics classes. STRATIO is the student–teacher ratio. SCMATEDU is the index of quality of school educational resources. PERSEV is the index of perseverance. OPENPS is the index of openness to problem solving. FAILMAT is the index of perceived self-responsibility for failing in mathematics. INTMAT is the index of intrinsic motivation to learn mathematics. INSTMOT is the index of instrumental motivation to learn mathematics.

of education attained by either parent was 8.76 years. Of the schools participating in the PISA study, 36% were classified as "selective" as they recruit their students through the central exam and 66% practice ability grouping for their math classes. The average student-to-teacher ratio is 17, while the SCMATEDU index measuring the school's educational resources has a mean value of −0.42, which means that principals in Turkish high schools consider their educational resources to be worse than the OECD mean. Of the indices related to students' personality and motivation, PERSEV and OPENPS had mean values of 0.43 and 0.22, respectively. FAILMAT, INSTMOT, and INTMAT indices on the other hand, had mean values of 0.26, 0.02, and 0.42, respectively. All these values were slightly above OECD averages meaning that Turkish students display more perseverance and more openness to problem solving compared with an average student in the OECD countries. Similarly, Turkish students were more likely to attribute their failure in mathematics to themselves and have more intrinsic and instrumental motivation to learn mathematics compared with students in other OECD countries.

Regression Results

The estimation results are presented in Table 2. The percentage of total variance in mathematics scores explained by the model was 14% when only student and family characteristics were considered. When school characteristics were

Table 2. GLS Estimation Results.

Variable	Model 1	Model 2	Model 3
CONSTANT	111.85 (1.39)	254.21 (4.13)***	240.34 (3.78)***
GENDER	−9.77 (−2.39)**	−17.66 (−5.23)***	−18.08 (−5.54)***
AGE	20.11 (3.99)***	10.02 (2.64)***	10.81 (2.78)***
HISEI	0.56 (5.29)***	0.30 (3.84)***	0.30 (3.74)***
PARED	3.75 (6.19)***	1.26 (2.46)**	1.27 (2.43)**
WEALTH	17.26 (7.82)***	7.27 (3.43)***	7.29 (3.42)***
SELECT		116.31 (16.73)***	114.91 (16.87)***
ABILITY		5.58 (0.69)	5.69 (0.72)
STRATIO		−0.27 (−0.64)	−0.29 (−0.68)
SCMATEDU		10.51 (1.85)*	10.14 (1.76)*
PERSEV			2.15 (1.48)
OPENPS			3.96 (2.55)***
FAILMAT			−3.45 (−2.80)***
INSTMOT			0.60 (0.35)
INTMAT			3.81 (1.97)*
Average Adj. R^2	.14	.49	.50
N	4,226	3,630	3,555

Note. This table shows the results from estimating the specification in equation (1). The dependent variable is the mathematics score, presented as five plausible values. GENDER is a dummy variable which equals 1 for female students. AGE denotes the age of the student in years and months. HISEI is index of highest occupational status of parents. PARED is the highest number of years of schooling attained by either parent. WEALTH is the index of family wealth. SELECT is a dummy variable which equals 1 for students from schools which recruit with the central placement exam. ABILITY is a dummy variable which equals 1 for students from schools which practice ability grouping in mathematics classes. STRATIO is the student–teacher ratio. SCMATEDU is the index of quality of school educational resources. PERSEV is the index of perseverance. OPENPS is the index of openness to problem solving. FAILMAT is the index of perceived self-responsibility for failing in mathematics. INTMAT is the index of intrinsic motivation to learn mathematics. INSTMOT is the index of instrumental motivation to learn mathematics. The *t* statistics are reported within parentheses. ***, **, and * denote significance at 1%, 5%, and 10%, respectively. GLS = generalized least squares.

considered, there was a 35% increase in variance explained. The final model including personality and motivation variables explains 50% of the variance in students' mathematics scores.

In the baseline model, we included gender, age, and variables related to socio-economic status as independent variables. Consistent with Hypothesis 1, these variables were found to be significantly associated with mathematics scores. According to our results, male students scored higher than female students by 10 to 18 points. In addition, older students obtained higher scores. Family socio-economic status was also positively associated with mathematics achievement. All three indicators of socio-economic status had positive and statistically significant coefficients. Students whose parents had higher occupational status and received more years of formal education achieved higher scores. Wealth also had a positive relation with mathematics achievement.

In the second model, we also added school characteristics as potential factors related to mathematics achievement. First of all, the signs and significance of student and family variables were robust to the inclusion of school-related variables in the model. According to the empirical results of the second model, school selectivity was the factor most strongly related to mathematics achievement. Students from schools which admit their students through a central exam scored on average 116 points higher compared with students from other types of schools which do not require their students to take the national exam to be admitted (i.e., general, vocational, technical, multiprogram, or police high schools). The quality of schools' educational resources also had a positive association with student achievement, as indicated by the positive and statistically significant coefficient of the variable SCMATEDU. On the other hand, the schools' student-to-teacher ratio was not significantly associated with achievement. Our results also indicated that there was no difference between the scores of students from schools practicing ability grouping and those that do not. In other words, grouping students based on their ability across mathematics classes did not seem to contribute to higher mathematics scores in PISA. These results provide partial support for Hypothesis 2.

In the third model, we also added personality and motivational factors. First, the signs and significance of student variables and school variables were robust to the inclusion of personality and motivation variables. Consistent with Hypothesis 3, students who were more open to problem solving achieved higher scores in mathematics. Intrinsic motivation also had a positive relationship to mathematics scores. However, contrary to Hypothesis 3, those students who attributed their failure in mathematics to internal factors displayed lower mathematics achievement, as indicated by the negative coefficient of the variable FAILMAT. The coefficient of the variable INSTMOT was not statistically significant, meaning that instrumental motivation to learn mathematics was not significantly related to students' achievement. Perseverance was not associated with academic achievement in mathematics either.

Discussion

Using data from the PISA 2012 survey, we showed that gender, age, socio-economic status, school resources, as well as personality and motivational variables were significantly associated with Turkish students' achievement in mathematics. The factor which was most strongly associated with student achievement was the academic selectivity of the school in which the student was enrolled. The same finding was obtained on several past Turkish studies, including those by Alacaci and Erbas (2010), Berberoglu and Kalender (2005), and Dincer and Uysal (2010). Students from Anatolian high schools, science high schools, and social science high schools scored significantly higher compared with students from general, vocational, technical, multiprogram, or police high schools. The school's educational materials also had a positive relation with mathematics scores.

Second, students' socio-economic background played a significant role in explaining differences in mathematics achievement. Students whose parents received more years of formal education performed significantly better. This result is consistent with several other Turkish studies (Dincer & Uysal, 2010; Tansel & Bircan, 2005; Yayan & Berberoglu, 2004). Other variables related to socio-economic status including parental occupational status and wealth had a positive relation with mathematics scores. These findings are consistent with Alacaci and Erbas (2010) and Dincer and Uysal (2010). The gender gap in mathematics achievement was also notable and the reasons behind girls' lower scores should be investigated to design appropriate policies. The finding that girls performed worse than boys is consistent with Tansel and Bircan (2005) for mathematics but contradicts the results obtained for the Turkish test.

Finally, personality and motivation played a significant role in explaining Turkish students' mathematics achievement. Students who were more open to problem solving performed significantly better. This result is to be expected as succeeding in mathematics requires engaging in new material (OECD, 2013b). In addition, students who were intrinsically motivated performed better. These students learn mathematics because they have a personal interest in and get joy from mathematics. On the other hand, extrinsically motivated students who learn mathematics just because "they have to" for their career did not perform any better than students with lower extrinsic motivation. These results suggest that teachers and families should foster an environment where students are encouraged to try new things and also to develop a real interest in mathematics rather than just telling them that mathematics is useful and necessary for their future. A final finding that emerges from our analysis is that students who attributed their failure in solving mathematics problems to themselves performed worse than those who attributed their failure to the teacher, the material, or luck. It might be the case that successful students had more self-esteem (Ross & Broh, 2000) and thus considered external, uncontrollable factors as responsible for their failure (Weiner, 1980). However, more research is needed to tease out those issues.

The present study has the following limitations to be addressed by future research. First, due to the cross-sectional nature of the study, no causal relationships can be assumed. Future studies can address this limitation by employing longitudinal designs. Second, our sample consisted of 15-year–old students who were currently enrolled in school and thus excluded those who had to quit school due to low achievement or economic considerations. Future research can use a more representative sample to derive more generalizable results. Finally, the study was subject to the limitations of the PISA dataset. Several potential factors such as teacher quality, family structure, scholastic activities, and support associated with academic achievement from previous literature could not be tested because these variables were not available in the dataset.

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Note

1. Perseverance is considered a facet of conscientiousness dimension (Caprara, Barbaranelli, Consiglio, Picconi, & Zimbardo, 2003)

References

Alacaci, C., & Erbas, A. K. (2010). Unpacking the inequality among Turkish schools: Findings from PISA 2006. *International Journal of Educational Development*, *30*(2), 182–192.

Asendorph, J. B., & Van Aken, M. A. G. (2003). Personality-relationship transaction in adolescence: Core versus surface personality characteristics. *Journal of Personality*, *71*(4), 629–662.

Baker, S. R. (2004). Intrinsic, extrinsic, and amotivational orientations: Their role in university adjustment, stress, well-being, and subsequent academic performance. *Current Psychology*, *23*(3), 189–202.

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist*, *44*(9), 1175–1184.

Barbaranelli, C., Caprara, G. V., Rabasca, A., & Pastorelli, C. (2003). A questionnaire for measuring the Big Five in late childhood. *Personality and Individual Differences*, *34*(4), 645–664.

Becker, M., McElvany, N., & Kortenbruck, M. (2010). Intrinsic and extrinsic reading motivation as predictors of reading literacy: A longitudinal study. *Journal of Educational Psychology*, *102*(4), 773–785.

Berberoglu, G., & Kalender, I. (2005). Öğrenci başarısının yıllara, okul türlerine, bölgelere göre incelenmesi: OSS ve PISA analizi. *Egitim Bilimleri ve Uygulama*, *4*(7), 21–35.

Boyer, W. (2006). Accentuate the positive: The relationship between positive explanatory style and academic achievement of prospective elementary teachers. *Journal of Research in Childhood Education*, *21*(1), 53–63.

Brownlow, S., & Reasinger, R. D. (2001). Putting off until tomorrow what is better than today: Academic procrastination as a function of motivation toward college work. *Journal of Social Behavior and Personality*, *15*(5), 15–34.

Caprara, G. V., Barbaranelli, C., Consiglio, C., Picconi, L., & Zimbardo, P. G. (2003). Personalities of politicians and voters: Unique and synergistic relationships. *Journal of Personality and Social Psychology*, *84*(4), 849.

Caprara, G. V., Vecchione, M., Alessandri, G., Gerbino, M., & Barbaranelli, C. (2011). The contribution of personality traits and self-efficacy beliefs to academic achievement: A longitudinal study. *British Journal of Educational Psychology*, *81*(1), 78–96.

Coleman, J. S. (1966). *Equality of educational opportunity (COLEMAN) study (EEOS)*. Ann Arbor, MI: Inter-university Consortium for Political and Social Research (distributor). doi.org/10.3886/ICPSR06389.v3

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum Publishing Co.

Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. *Educational Psychologist*, *26*(3–4), 325–346.

De Raad, B., & Schouwenburg, H. C. (1996). Personality in learning and education: A review. *European Journal of Personality*, *10*(5), 303–336.

Dincer, M. A., & Uysal, G. (2010). The determinants of student achievement in Turkey. *International Journal of Educational Development*, *30*(6), 592–598.

Ehmke, T., Drechsel, B., & Carstensen, C. H. (2008). Klassenwiederholen in PISA-I-Plus: Was lernen Sitzenbleiber in Mathematik dazu? [Grade retention in PISA-I-Plus: What do retained students learn in mathematics?]. *Zeitschrift für Erziehungswissenschaft*, *11*(3), 368–387.

Fischbach, A., Keller, U., Preckel, F., & Brunner, M. (2013). PISA proficiency scores predict educational outcomes. *Learning and Individual Differences*, *24*, 63–72.

Ganzeboom, H. B. G., De Graaf, P. M., & Treiman, D. J. (1992). A standard international socio-economic index of occupational status. *Social Science Research*, *21*(1), 1–56.

Ganzeboom, H. B. G., & Treiman, D. J. (1996). Internationally comparable measures of occupational status for the 1988 International Standard Classification of Occupations. *Social Science Research*, *25*(3), 201–239.

Greenwald, R., Hedges, L. V., & Laine, R. D. (1996). The effect of school resources on student achievement. *Review of Educational Research*, *66*(3), 361–396.

Hanushek, E. A. (2008). Education production functions. In S. N. Durlauf, & L. E. Blume (Eds.), *The New Palgrave dictionary of economics* (2nd ed., pp. 1–6). Basingstoke: Palgrave Macmillan. doi:10.1057/9780230226203.0448

Lane, J., & Lane, A. (2001). Self-efficacy and academic performance. *Social Behavior and Personality: An International Journal*, *29*(7), 687–694.

Lane, J., Lane, A. M., & Kyprianou, A. (2004). Self-efficacy, self-esteem and their impact on academic performance. *Social Behavior and Personality: An International Journal*, *32*(3), 247–256.

Lee, J., & Stankov, L. (2013). Higher-order structure of non-cognitive constructs and prediction of PISA 2003 mathematics achievement. *Learning and Individual Differences*, *26*, 119–130.

Liu, K. S., Cheng, Y. Y., Chen, Y. L., & Wu, Y. Y. (2009). Longitudinal effects of educational expectations and achievement attributions on adolescents' academic achievements. *Adolescence*, *44*(176), 911–924.

Macdonald, K. (2008). PV: Stata module to perform estimation with plausible values [Software]. Retrieved from http://ideas.repec.org/c/boc/bocode/s456951.html

Marín, M., Infante, E., & Troyano, Y. (2001). Personality and academic productivity in the university student. *Social Behavior and Personality: An International Journal*, *3*(29), 299–306.

Mayer, D. P., Mullens, J. E., & Moore, M. T. (2001). Monitoring school quality: An indicators report. *Education Statistics Quarterly*, *3*(1), 38–44.

Meisenberg, G., & Woodley, M. A. (2013). Are cognitive differences between countries diminishing? Evidence from TIMSS and PISA. *Intelligence*, *41*(6), 808–816.

Organisation for Economic Co-operation and Development. (2013a). *PISA 2012 results: Excellence through equity: Giving every student the chance to succeed* (Vol. II). Paris: PISA, OECD Publishing. Retrieved from http://dx.doi.org/10.1787/9789264201132-en

Organisation for Economic Co-operation and Development. (2013b). *PISA 2012 results: Ready to learn – students' engagement, drive and self- beliefs* (Volume III). Paris: PISA, OECD Publishing. Retrieved from http://dx.doi.org/10.1787/9789264201170-en

OECD. (2014a). *PISA 2012 technical report*. Paris: PISA, OECD Publishing. Retrieved from https://www.oecd.org/pisa/pisaproducts/PISA-2012-technical-report-final.pdf

OECD. (2014b). *PISA 2012 results: What students know and can do – Student performance in mathematics, reading and science* (Vol. I, Rev. ed., February 2014). Paris: PISA, OECD Publishing. Retrieved from http://dx.doi.org/10.1787/9789264201118-en

O'Sullivan, J. T., & Howe, M. L. (1996). Causal attributions and reading achievement: Individual differences in low-income families. *Contemporary Educational Psychology*, *21*(4), 363–387.

Paunonen, S. V., & Ashton, M. C. (2001). Big five predictors of academic achievement. *Journal of Research in Personality*, *35*(1), 78–90.

Poropat, A. E. (2009). A meta-analysis of the five-factor model of personality and academic performance. *Psychological Bulletin*, *135*(2), 322–338.

Schleicher, A. (2007). Can competencies assessed by PISA be considered the fundamental school knowledge 15-year-olds should possess? *Journal of Educational Change*, *8*(4), 349–357.

Schleicher, A. (2010). Assessing literacy across a changing world. *Science*, *328*(5977), 433–434.

Ross, C. E., & Broh, B. A. (2000). The roles of self-esteem and the sense of personal control in the academic achievement process. *Sociology of Education*, *73*(4), 270–284.

Tansel, A., & Bircan, F. (2005). Effect of private tutoring on University entrance examination performance in Turkey. IZA Discussion Paper No. 1609. Available at SSRN. Retrieved from http://ssrn.com/abstract=721925

Vispoel, W. P., & Austin, J. R. (1995). Success and failure in junior high school: A critical incident approach to understanding students' attributional beliefs. *American Educational Research Journal*, *32*(2), 377–412.

Watkins, D., & Gutierrez, M. (2001). Causal relationships among self-concept, attributions, and achievement in Filipino students. *The Journal of Social Psychology*, *130*(5), 625–631.

Weiner, B. (1980). *Human motivation*. New York: Holt, Rinehart & Winston.

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review*, *92*(4), 548–573.

Weiner, B. (2010). The development of an attribution-based theory of motivation: A history of ideas. *Educational Psychologist*, *45*(1), 28–36.

Wu, M. (2010). Comparing the similarities and differences of PISA 2003 and TIMSS. OECD Education Working Papers, No. 32. OECD Publishing (NJ1). [Online]. Retrieved from http://dx.doi.org/10.1787/5km4psnm13nx-en

Yayan, B., & Berberoglu, G. (2004). A re-analysis of the TIMSS 1999 mathematics assessment data of the Turkish students. *Studies in Educational Evaluation*, *30*(1), 87–104.

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