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Investigation of Student and Teacher Characteristics Associated with Mathematics Achievement in the Transition to Secondary Education Exam

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Abstract

The purpose of this study is to examine student and teacher characteristics related to students' mathematics achievement. The study group for this research was composed of 1533 students who participated in the mathematics subtest of the transition from basic education to secondary education applied in 2016 and 36 mathematics teachers who teach these students. The data for the research are collected with the prepared student and teacher questionnaires. In the analysis of the data, two-level hierarchical linear models are used. According to the results, the most important teacher characteristic related to students' mathematics achievement is the level of professional satisfaction of the teacher. In addition, teachers' seniority, main field education, and classroom management skills have a significant and positive effect on mathematics achievement. Also, teachers' participation in professional development activities has a significant and negative effect on mathematics achievement, but this effect is small in practice. At the student level, the student's self-confidence in mathematics has the most important effect on the subject's achievement. The variables of students' liking mathematics and their anxiety towards mathematics have negative and significant effects on mathematics achievement, but these effects are small in practice.

Keywords: Mathematics achievement, Secondary education transition exams, HLM, Teacher characteristics, Student characteristics

Introduction

The general purposes of education systems are improved according to the needs of individuals and society. Although there are differences among countries, the general purposes are to raise productive and well-equipped individuals who can adapt to developing and changing situations, are researchers, have a healthy character that can make both themselves and the society happy, and are respectful of the beliefs, thoughts, and differences of others.

Education systems are composed of stages. These stages are broadly classified as pre-school, basic, secondary, and higher education. Each country prefers different policies for the transition from basic education to secondary education. For example, in countries such as China, South Korea, the Netherlands, and the USA, transitions to secondary education institutions are based on central examinations, while in countries such as Germany and Finland, teacher evaluations or student grades are taken as the basis for the transition to secondary education (Gür, Çelik, & Coşkun, 2013).

In Turkey, the transition to secondary education examination has been administered for years. The scope of these exams varies within the framework of different policies. MEB stated that the general purpose of the changes is to reduce stress in students and parents and to increase the importance given to school education (MEB, 2007; MEB, 2013). The fact that the schools that choose their students with high scores in the transition exams have a high rate of university transition increased the importance given to these exams and caused these exams to be seen as the key to a good future.

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Secondary Education Transition Exams in Turkey

With the institution of the colleges in Turkey in 1955, some secondary education institutions started to admit students by examination (Gür et al., 2013). After this date, central examination systems are needed due to the increasing interest in secondary education institutions providing quality education and the limited quotas of these schools. With the eight-year compulsory education law on August 18, 1997, basic and secondary schools were merged and renamed as primary education. After this date, the High School Entrance Examination was started to be administered for students who wanted to transfer from primary education to secondary education institutions such as Anatolian and Science High Schools. There were also different exams, such as private high school exams and police college exams.

LGS, which was applied between 1998 and 2004, was abolished in order to combine all exams under a single exam, and the Secondary Education Institutions Selection and Placement Exam (OKS) began to be applied instead of this exam (Gür et al., 2013). OKS, which was applied between 2004 and 2007, was abolished on the grounds that students were under great stress and the scope of the exam was not sufficient. In 2008, SBS (Level Determination Exams) started to be implemented within the scope of the Transition System for Secondary Education Institutions (OGES). OGES was put into practice as a student-focused system consisting of three main elements by combining the scores of the students in the SBS applied at the end of the 6th, 7th, and 8th grades, the school achievement scores of the students, and the behavioral scores of the students (MEB, 2007). However, in this system, the 6th and 7th grade SBS applications were abolished in 2010 due to the fact that it was harmful for students to meet the central exam at a young age, and the 8th grade SBS application was continued (MEB, 2010).

After the single-stage SBS between 2010 and 2013, Transition System from Basic Education to Secondary Education (TEOG) started to be administered. It had been stated that the purpose of this exam was to reduce the stress of the students by spreading the exams throughout the process and to provide the students with the opportunity to make up for the exams they could not take (MEB, 2013). TEOG exams were also not very long-term, and they were abolished in 2018 and replaced by the LGS (High School Entrance System). In this new system, which is still applied today, the number of secondary education institutions that take their students via exams has decreased, and schools selected from every type of school (Science, Anatolian, Social sciences, Vocational high schools, and project schools, etc.) in every province started to admit students with this exam (MEB, 2018).

There is a need for central examination systems in our country due to the high population of young people and the low number of high schools providing quality education. As mentioned above, many different exam systems have been administered since 1997. Especially in the last two decades, the content and scope of the centrally administered examination systems have undergone many changes within the framework of different reasons and policies, and stability has not been achieved.

Yavuz, Odabaş, and Özdemir (2016) investigated the relationship between students' socioeconomic levels and TEOG mathematics achievement using the Hierarchical Linear Model. It has been found that schools vary significantly from each other in terms of mathematics achievement, and SES does not have a significant effect on students' mathematics achievement. Yıldız (2015) examined the relationship between students' metacognitive awareness, academic self-efficacy levels, motivational beliefs, and TEOG Turkish scores using a structural equation model. According to the results of the research, it has been found that the most important variable affecting the TEOG Turkish score is academic self-efficacy. Süer (2014) examined the relationship between TEOG score and students' self-regulation skills, gender, going to a private teaching school, and socioeconomic levels. It has been concluded that students who go to private teaching institutions and who have a high socioeconomic level are more successful. The variables of self-efficacy and anxiety level are related to the TEOG score, while the variables of self-regulation and intrinsic value are not related to the TEOG score of the students. Genç (2020) examined the effect of non-routine problem-solving education on strategic flexibility and LGS success. There is a positive and moderately significant relationship between the strategic flexibility score and LGS mathematics achievement. However, although the given training made a difference in the LGS math scores of the experimental group students compared to the control group, there is no significant difference between the two groups. Yıldız (2021) investigated the effect of panic levels on academic achievement when students' communication with smart phones was cut off. According to the results obtained, the nomophobia sub-factor scores differed according to the LGS scores. Kılıç (2022) found that students who take private lessons and think that they have enough family support are more successful in LGS. While it is seen that there is a positive and moderately significant relationship between attitudes towards mathematics and LGS scores, there is no relationship between motivation level and LGS scores.

Mathematics Achievement

Increasing the mathematics achievement of a society is very important for individuals to have stronger foundations in lifelong learning skills and to gain analytical thinking ability (Bloom, 1998). Therefore, great efforts are made to improve and develop students' mathematics achievement at all levels of education. Man is a social being and interacts with his environment. Therefore, the focus of researchers should be to examine the factors associated with mathematics achievement and to understand how these factors can be used to improve achievement (Miller, 1991). Variables associated with mathematics achievement may be related to individual characteristics as well as family, peer group, teacher, and school characteristics (Petty, Wang, & Harbaugh, 2013). The purpose of this study is to examine the student and teacher characteristics associated with mathematics achievement; therefore, the characteristics associated with mathematics achievement are examined under the title of teacher and student characteristics.

Teacher Characteristics

Teachers have a great responsibility in the realization of education and training purposes (Büyükkaragöz, 1998). Therefore, it is extremely important to investigate the qualifications and competencies that effective teachers should have and to carry out the necessary studies to develop these characteristics (Goe, 2007). According to Rogers (1979), the characteristics that effective teachers should have are accepting students, reinforcing students' positive behaviors, having an empathetic understanding, and having self-confidence. According to Perrot (1984), effective teachers plan the lesson well, explain the lesson effectively and efficiently, involve the students in the lesson by asking questions, and ensure the classroom organization and communication in a healthy way. On the other hand, Liu and Meng (2009) classified the characteristics of effective teachers as teacher ethics, student achievement scores, professional development, and professional skills.

In the learning process, the student and the teacher are in one-to-one interaction. That's why one of the most important variables affecting success is teacher characteristics. In the studies examining the teacher characteristics related to the success of the students, it is seen that the variables examined were the teacher's main field of education, seniority, gender, participation in professional development activities, classroom management skills, and professional satisfaction (Ashton & Crocker, 1987; Cohen & Hill, 1977; Greenwald, Hedges & Laine, 1996; Lamb & Fullarton, 2002; Murnane & Phillips, 1981; Opdenakker & Damme, 2006; Wiley & Yoon, 1995; Zuzovsky, 2009;).

Student Characteristics

There are many variables that affect mathematics achievement. Some of these variables are related to the student's characteristics. Variables such as the student's attitude towards mathematics, anxiety level, desire to learn mathematics, value of mathematics, gender, socioeconomic level, etc. affect the student's mathematics achievement.

According to Hart (1989), mathematics attitude is the tendency to respond to mathematics in a positive or negative way. According to Kay (1993), mathematics attitude includes cognitive, affective, and behavioral domains, and these domains can be exemplified by variables such as self-confidence in mathematics, liking learning mathematics, valuing mathematics, and the usefulness of the mathematics. Reyes (1984) stated that the main variables associated with mathematics achievement are attitude towards mathematics, self-confidence in mathematics learning, and the usefulness of mathematics. Ma and Kishor (1997) stated that there is a significant positive relationship between mathematical attitude and mathematical achievement. Azina and Halimah (2012), Aydın (2015), Akyüz (2014), Kadijevich (2008) found in their studies that there is a significant and positive relationship between mathematics achievement and self-confidence.

Sheffield and Hunt (2006) define math anxiety as the fear and anxiety that occur in students when faced with mathematical problems. Şentürk (2010), Yenilmez and Özabacı (2003), Miller (1991), Ma and Xu (2004), found that there is a negative and significant relationship between anxiety level and mathematics achievement. In addition to the affective characteristics of the students, it has been investigated in the studies that variables such as the time allocated to learning, gender, taking private lessons, and the education level aimed at by the student are associated with mathematics achievement (Gainer, 1962; Özer & Anıl, 2011; Petty et al., 2013; Yılmaz & Hanci, 2016).
Factors affecting mathematics achievement may arise from the student himself as well as from the characteristics of the teacher and school. Analyzing the variables affecting achievement according to these

levels will provide a more effective explanation of the factors affecting success. Classical regression analyses consider the variables as a whole and do not allow analysis according to their levels. Hierarchical Linear Models, on the other hand, provide the opportunity to analyze the variables according to their levels by eliminating this deficiency of classical regression analysis. Therefore, in this study, variables affecting mathematics achievement are analyzed with Hierarchical Linear Models.

Hierarchical Linear Models

As a social being, the human interacts with his environment and tends to be in groups with similar characteristics. For this reason, research data obtained in the fields of social sciences is generally organized in a hierarchical structure. That is, the data subject to the research can be classified within groups with the same characteristics. Hierarchical linear models, which are expressed in different terms in the literature such as Nested Model, Multilevel Model, Covariance Component Model, Mixed Linear Modeling or Progressive Linear Model, are widely used in many different fields such as education, social sciences, health, and economy. With these models, analyses can be carried out at the individual level, and intergroup relations and differences can be examined flexibly (Raudenbush & Bryk, 2002).

Behaviors and characteristics of individuals are affected by the group characteristics of individuals as well as inherited. Therefore, in studies conducted on individuals, the group characteristics of individuals should also be taken into account. Although it is assumed that the data are independent from each other in classical analysis techniques, analysis should be carried out considering that the group characteristics of the data belonging to the same group are similar and the data are not independent from each other (Raudenbush & Bryk, 2002). For example, the classroom climate, teacher characteristics, and school characteristics are the same for two students in the same class. Therefore, class, teacher, and school characteristics should be included in the student-level analysis.

There are many studies in the literature using hierarchical linear models. In these studies, variables related to achievement are modeled at multiple levels, the characteristics of students, teachers, schools, and regions are included in the models in a flexible way, and comparisons are made across countries (Atar, 2014; Chiu, 2010; Demir & Kılıç, 2010; Kanyongo, Schreiber & Brown, 2007; Karabay, Yıldırım & Güler, 2015; Lamb and Fullarton, 2002; Mohammadpour & Shekarchizadeh, 2013; Petty et al, 2013; Yıldırım, 2012; Yılmaz & Hanci, 2016). In the study, student and teacher characteristics related to mathematics achievement are examined. Students are nested within teachers. That is, the data set of the study has a hierarchical structure. For this reason, Hierarchical Linear Models, which are one of the multi-level analysis methods suitable for the data structure of the research, are used in the study.

Purpose of the Study

The purpose of this study is to investigate student and teacher characteristics related to mathematics achievement. For this purpose, the mathematics scores of the Transition System from Basic Education to Secondary Education (TEOG) are used. A great deal of effort and time is spent on teaching mathematics from preschool to the last step of the education level. However, when the results of the international and national exams are examined, it is seen that the mathematics achievement of the students is very low, and the deficiency cannot be eliminated (MEB, 2015; MEB, 2016; MEB, 2016b). The reasons why students fail in mathematics may be due to student or environmental characteristics. When the literature is examined, it is seen that the data from international exams (such as PISA and TIMSS) are generally used in studies examining the effects of student and teacher characteristics on achievement, and there is not much study about the transition exams from basic education to secondary education, which are administered in our country and affect the future of students. It is thought that this study will contribute to the determination of the characteristics that affect achievement in the transition exams from basic education to secondary education, which are applied in our country and where important decisions are taken with their results. Investigating the variables that are affecting mathematics achievement with the Hierarchical Linear Model at the student and teacher level will provide more detailed information about the effects of these variables. For this purpose, answers to the following questions are investigated in the study:

1- Is there a difference among teachers in terms of mathematics achievement in the secondary education transition exam?

2- What are the teacher characteristics that affect the mathematics achievement in the secondary education transition exam?

3- What are the affective characteristics of the students that affect their mathematics achievement in the secondary education transition exam?

Method

Research Model

The purpose of this research is to examine the relationship between students' mathematics achievement and student and teacher characteristics. Therefore, this study is a correlational one. These studies examine the size and direction of the relationship among variables (Lodico, Spaulding & Voegtle, 2006).

Working Group

The study group for the research consisted of 1533 student (796 boys (50.2%) and 764 girls (49.8%)) 8th grade who participated in the TEOG mathematics subtest administered in November 2016 and 36 mathematics teachers. There are 36 mathematics teachers (14 men (38.9%) and 22 women (61.1%)) who participated in the research.

Data Collection Tools

The data for the study were collected with student and teacher questionnaires prepared by the researchers. The scales of self-confidence in mathematics, mathematics anxiety, engagement in learning mathematics, and valuing mathematics were taken from the TIMSS 2011 student questionnaire, and the teachers' professional satisfaction scale was taken from the TIMSS 2011 teacher questionnaire. TIMSS questionnaires, a project of the IEA, are developed by experts, and necessary scale development, pilot applications, and item analyses are carried out in detail (Martin & Mullis, 2012).

The affective characteristics of the students were obtained from the student questionnaire. These variables are the student's level of anxiety towards mathematics, self-confidence toward mathematics, desire to learn mathematics, engagement in learning mathematics, and value of mathematics.

The prepared teacher questionnaires were applied to the mathematics teachers who teach the students in the study group. The teacher's seniority year, participation in professional development activities, professional satisfaction level, main field education, and classroom management skills were obtained from teacher questionnaires.

In this study, mathematics achievement scores obtained from the 1st session of the Transition Exam from Basic Education to Secondary Education (TEOG) were used as the dependent variable. TEOG exams were administered twice a year, in November for the first semester and for April in the second semester and consisted of six subtests. These were Mathematics, Turkish, Science, Foreign Language, Religious Culture and Moral Knowledge, T.C. History of Revolution and Kemalism domains. There were 20 questions in each subtest (MEB, 2016a). Mathematics scores were calculated by multiplying the number of correct answers in the tests by 5.

Table 1. Descriptive findings of student and teacher level variables

Level 1 Variables	N	Mean	S.D	Max.	Min	Cronbach Alfa
Anxiety	1533	12.76	4.96	5	25	0.84
Self-confidence	1533	26.23	7.34	8	40	0.86
Like Learning	1533	18.32	5.06	5	25	0.82
Engagement	1533	18.42	3.58	5	25	0.60
Value	1533	22.72	5.36	6	30	0.81
Level 2 Variable						
Professional Satisfaction	36	25.33	2.20	20	30	0.73

Analysis of Data

Many social studies show hierarchical data structures, and the levels across hierarchies are interrelated. Classical statistical techniques assume that the data are independent. School, classroom, and teacher characteristics are assumed to be independent and analyzed according to this assumption. However, it is obvious that the characteristics of the class belong to every student in the class and that these data are not independent. Therefore, it is recommended to use hierarchical linear models in the analysis of nested data (Raudenbush & Bryk, 2002).

In the study, student and teacher characteristics related to mathematics achievement are examined. Students are nested within teachers. That is, the data set of the study has a hierarchical structure. For this reason, Hierarchical Linear Models, which are one of the multi-level analysis methods suitable for the data structure of the research, are used in the study. Random Effects One Way ANOVA Model, Random Coefficients Regression Model and Mean-as-Outcomes Model are used in the analysis of the data.

Random Effects One Way ANOVA Model

The Random Effects ANOVA Model is the simplest model among the Hierarchical Linear Models. This model is also known as the empty model. It does not contain any independent variables at levels 1 or 2. Hierarchical Linear Models begin with the Random Effects ANOVA Model. The purpose of this model is to separate the variance in the dependent variable according to different levels of the hierarchy (Raudenbush & Bryk, 2002).

Random Coefficients Regression Model

Random Coefficients Regression Model is used when the dependent variable is estimated by level 1 independent variables. That is, it is used to determine which level 1 variables are thought to have an effect on the dependent variable (Raudenbush & Bryk, 2002). With this model, student characteristics related to mathematics achievement are examined. In the Random Coefficients Regression Model, which includes student characteristics at level 1, none of the independent variables are included at level 2 (Raudenbush & Bryk, 2002).

Means-as-Outcomes Models

Means-as-Outcomes Models are used when the dependent variable is estimated by level 2 independent variables. That is, it is used to determine what level 2 variables are thought to have an effect on the dependent variable. While the level 1 equation of this model is set up as in the Random Effects ANOVA Model, the level 2 equation is formed by adding the variables that are thought to have an effect on the dependent variable (Raudenbush & Bryk, 2002). With this model, teacher characteristics associated with students' mathematics achievement are examined. While no student characteristics are added in level 1, teacher characteristics are added in level 2 (Raudenbush & Bryk, 2002).

Because of the large sample size, although independent variables have small effects on dependent variables, they can still produce statistically significant results (Fishman & Galguera, 2003). Therefore, the sizes of the effects of the independent variables are also calculated in the study. Effect sizes are allowing comparisons between different metrics. Effect sizes are calculated by dividing the gamma coefficients of the independent variables by the standard deviation among or within the unconditional model (Von Secker & Lissitz, 1999). If the effect sizes of the variables are 0.5 and more, they are interpreted as large; between 0.5 and 0.3 as moderate; between 0.3 and 0.1 as small; and less than 0.1 as trivial (Rosenthal & Rosnow, 1984).

After the analysis, HLM assumptions are checked. Independence of errors, homogeneity of variances, and normality assumptions are met. In order to correctly interpret the slope and intersegments coefficients estimated by the HLM models, the variables whose zero value is not significant should be centered (Raudenbush & Bryk, 2002). In this study, level 1 variables with non-significant zero values are centered around the group mean, and level 2 variables are centered around the general mean. Analyses are carried out using the HLM 7 program (Raudenbush & Bryk, 2002). SPSS package programs are used to organize the data.

Results

Results for the 1st Sub-problem

A Random Effect ANOVA Model is used to answer the question "Is there a difference among teachers in terms of mathematics achievement in secondary education transition exam?" Table 2 shows the results.

Table 2. Results of Random Effect ANOVA Model

Fixed Effect	*Coefficient*	*S.E*	*t-ratio*
Average mathematics Achievement γ_{00}	51.03	1.99	25.95***
Random Effect	*Sd*	*Variance*	χ^2
Teacher Level u_{ij}	11.03	121.59	363.60***
Student Level r_{ij}	22.63	512.30	

* p < .05; ** p < .01; *** p < .001

The general mathematics achievement mean of the students is ranged from 47.18 to 54.87 (51.03±1.96(1.99)) with 95% probability. In addition, the general mathematics achievement average among teachers is ranged from 29.43 to 72.62 (51.03±1.96(11.03)1/2) with 95% probability. This value shows that the average mathematics achievement among teachers is in a wide range. Also, students' overall mathematics achievement has been found to significantly vary among teachers (p < .001). That is, there are significant differences among teachers in terms of students' mathematics achievement. Interclass correlation is calculated as 0.19 (ρ=121.59/(512.30+121.59)). That is, 19% of the differences in mathematics achievement are due to differences among teachers and 81% to individual differences among students.

Results for the 2nd Sub-problem

The Means-as-Outcomes Regression Model is used to answer the question, "What are the teacher characteristics that affect the mathematics achievement in the secondary education transition exam?" For this purpose, the year of seniority (seniority), the teacher's main field of education (education), participation in professional development activities (professional development), the level of professional satisfaction (professional satisfaction), and classroom management skills (classroom management) are added to the analysis. Table 3 shows the results.

Table 3. Results of Means-as-Outcomes Regression Model

Fixed Effect	Coefficient	S.E	t-ratio	Effect Size
Average Mathematics γ_{00}	50.54	1.22	41.53***	
Seniority γ_{01}	5.39	1.63	3.32***	0.49
Education γ_{02}	4.13	1.74	2.37*	0.37
Professional Development γ_{03}	-1.74	0.76	-2.30*	-0.16
Classroom Management γ_{04}	5.11	2.12	2.42*	0.46
Professional Satisfaction γ_{05}	6.50	1.39	4.68***	0.59
Random Effect	Sd.	Variance	χ^2	
Teacher Level u_{ij}	6.00	36.02	116.94***	
Student Level r_{ij}	22.63	512.16		

* p < .05; ** p < .01; *** p < .001

Table 4 shows that the teacher's seniority, main field education, classroom management, and professional satisfaction level have a significant and positive effect on mathematics achievement. Students of teachers who have high seniority, graduated from education faculties, are good at classroom management, and have high professional satisfaction are more successful in mathematics. In addition, it can be stated that the most important teacher characteristic related to mathematics achievement is the satisfaction level of the teacher. There is a negative and significant relationship between the number of teachers participating in professional development activities in the last two years and the mathematics achievement of the students.

When the effect sizes of teacher characteristics are examined, an increase of 1 standard deviation in a teacher's seniority, education, classroom management, and professional satisfaction will provide an increase of 0.49, 0.37, 0.46 and 0.59 standard deviations in mathematics achievement, respectively. The effect sizes of these variables are moderate. An increase of 1 standard deviation in participation in professional development activities will cause a 0.16 standard deviation decrease in mathematics achievement. However, this effect has been found to be insignificant in practice. Adding teacher characteristics to the Means-as-Outcomes Regression Model decreased the among-teacher variability variance from 121.59 to 36.01. It is established that the level 2 variables explain 71% of the variance among teachers in mathematics achievement.

Results for the 3rd Sub-problem

Random Coefficients Regression Model is used to answer the question "What are the affective characteristics of the students that affect the mathematics achievement in the secondary education transition exam?". For this purpose, anxiety in mathematics, self-confidence in mathematics, liking learning mathematics (like learning), engagement in learning mathematics (interest), and valuing mathematics (value) variables are added to the Random Coefficients Regression Model as level 1 predictors.

Table 4. Results of Random Coefficients Regression Model

Fixed Effect	Coefficient	S.E	t-ratio	Effect Size
Average Mathematics γ_{00}	47.44	2.32	20.44***	
Valuing Mathematic γ_{10}	0.16	0.79	0.20	
Anxiety in mathematics γ_{20}	-3.34	0.62	-5.38***	-0.15
Self-confidence in mathematics γ_{30}	13.40	1.03	12.97***	0.60
Like Learning Mathematics γ_{40}	-2.89	0.80	-3.60***	-0.12
Engagement in Mathematics γ_{50}	1.11	0.91	1.22	
Random Effect	**Sd.**	**Variance**	**χ^2**	
Teacher Level u_{ij}	10.70	114.55	750.82***	
Self-confidence u_{3j}	1.40	1.96	36.08*	
Student Level r_{ij}	17.07	291.38		

* p < .05; ** p < .01; *** p < .001

According to the results of the analysis, the relationship between the value given to mathematics and the interest in mathematics variables and mathematics achievement was not found to be significant. In other words, there is no significant relationship between the student's value and interest in mathematics and his or her mathematics achievement.

It has been found that there is a negative and significant relationship between the student's anxiety level and their likeliness to learn mathematics and mathematics achievement. When other variables are fixed, a one standard deviation increase in the student's anxiety level and the variables like learning mathematics will decrease the mathematics achievement by 0.15 and 0.12 standard deviations, respectively. However, the size of the effect of both variables is found to be minimal in practice.

It is found that there is a significant and positive relationship between student's level of self-confidence in the mathematics and mathematics achievement. When other student affective characteristics added to the model are fixed, a one standard deviation increase in students' self-confidence will increase their mathematics scores by 0.6 standard deviations, and this effect size is important in practice. In addition, the most important variable affecting mathematics achievement at the student level is self-confidence. In addition, when the random effect values are examined, the random effect on the slope of the self-confidence variable is significant (p<.05). In other words, effect of the self-confidence on mathematics achievement varies across the population of teachers. Adding student characteristics to the Random Coefficients Regression Model decreased the teacher variability variance from 512.30 to 291.38. It is established that the level 1 variables explain 43percent of the variance in students' mathematics achievement.

Conclusion and Discussion

According to the results of the research, 19% of the variances in mathematics achievement are due to the differences among teachers, and this difference is found to be statistically significant. The year of seniority, main field education, participation in professional development activities, the level of professional satisfaction, and classroom management skills variables explain 71% of the variance among teachers in mathematics achievement. At the student level, approximately 43% of the variance in students' mathematics achievement is explained by the variables of the student's level of anxiety towards the mathematics, the level of self-confidence in the mathematics, like learning mathematics, the valuing mathematics and the student's engagement in learning mathematics.

Teacher Characteristics

An outcome of the research is that the seniority of the teacher has a significant and positive effect on mathematics achievement, and the size of this effect is moderate. There are many studies investigating the relationship between a teacher's seniority and achievement. Murnane and Philips (1981), Greenwald et al. (1996), found in their studies that there is a significant and positive relationship between achievement and teachers' seniority. While there may be a positive relationship between seniority and achievement, there are studies that determine that there is no or a negative relationship (Akyüz, 2006; Lamb & Fullarton, 2002; Zuzovsky, 2009). In addition, in some studies, it has been stated that the relationship between seniority and success disappeared within three or four years (Rivkin, Hanushek, & Kain, 2005).

An outcome of the research is that teachers' main field education has a significant and positive effect on mathematics achievement, and the size of this effect is moderate. Accordingly, the more the main field of education of teachers is related to mathematics and educational sciences, the higher the mathematics achievement of the students. There are studies showing that there are strong positive relationships between education programs and teacher effectiveness (Ashton & Crocker, 1987; Evertson, Hawley & Zlotnik, 1985; Ferguson & Womack, 1993; Guyton & Farokhi, 1987). Monk (1994) found that there is a positive correlation between students' science and mathematics achievements and teachers' pedagogical education. Begle (1979) found that there is a strong relationship between students' mathematics performance and teachers' mathematics education. There are also studies that show that there is no relationship between main field education and achievement (Goldhaber & Brewer, 2000; Perkes, 1967-1968) or that there is a negative relationship (Zuzovsky, 2009).

According to the results of the study, there is a negative and significant relationship between the number of teachers participating in professional development activities in the last two years and students' mathematics achievement, but the size of this effect is small in practice. Professional development activities can help teachers update their field knowledge and learn new techniques in the field of education and training. Some of the professional development activities are mandatory for candidate teachers (MEB, 2017). This result may be due to the compulsory participation of newly appointed teachers. The relationship between participation in professional development activities and success is not fixed. Jacob & Lefgren (2004) have stated that there isn't a significant relationship between student achievement and teachers' participation in professional development activities. Contrary to this study, Cohen and Hill (1977), Wiley and Yoon (1995), and Brown, Smith and Stein (1995) determined that there is a significant and positive relationship between students' mathematics achievement and teachers' participation in professional development activities.

An outcome of the research is that teacher's classroom management skills have a significant and positive effect on mathematics achievement, and the size of this effect is moderate. Classroom management skills are a property that varies from teacher to teacher. Classes that do not have an effective teaching-learning environment distract students and teachers, which can lead to inefficient teaching. The fact that the teacher's classroom management skills are high indicates that the teacher creates a quiet and orderly working environment in their classrooms; there is no problem maintaining order and keeping students under control (Opdenakker & Damme, 2006). Therefore, it is extremely important for teachers to have classroom management skills. Studies in the literature have found that there is a significant relationship between class management skill and achievement (Akyüz, 2006; Opdenakker & Damme, 2006) or that there is no relationship (Akyüz, 2006).

According to the outcomes of the research, teachers' professional satisfaction levels have a significant and positive effect on mathematics achievement. In addition, when the effect size of this variable is examined, the most important teacher characteristic affecting the average mathematics achievement is the level of professional satisfaction of the teacher. Şahin (2013) stated that teachers experience job dissatisfaction in terms of management and wages. On the other hand, it can be said that the professional satisfaction levels of teachers have decreased due to reasons such as decreased respect for the teaching profession, increased daily lesson hours, and frequent school discipline problems. There are many studies examining the relationship between the level of professional satisfaction and success. Opdanakker and Damme (2006) and Aktaş (2011) have stated that there is a significant and positive relationship between teachers' levels of professional satisfaction and success, while Atar (2014) stated that there is practically no significant relationship between the level of professional satisfaction and achievement.

Student Characteristics

According to the results of the study, the student's engagement in learning mathematics and valuing mathematics doesn't have a significant effect on mathematics achievement. Valuing mathematics refers to students' attitudes towards the importance of mathematics and its usefulness in various periods of their lives (Wigfield & Eccles, 2000). Kim et al. (2013) found that there is no significant relationship between valuing mathematics and student achievement in Finland, while there is a significant relationship in Singapore and Korea. Arıkan, van de Vijver & Yağmur (2016) conducted a study using TIMSS 2007 and 2011 data and found that there is no significant relationship between the value given to mathematics and success. This result can be interpreted as the students' value of mathematics regardless of whether they are successful or unsuccessful, but this is not related to mathematics achievement.

Student engagement is a factor defined as intrinsic interest and the level of student involvement in school. It consists of behaviors such as motivation, persistence, positive learning values, enthusiasm, effort, and interest (Gibbs & Poskitt, 2010). Shernoff & Schmidt (2008) found that student engagement increases achievement. Akyüz (2014) stated that there is a significant positive relationship between engagement in mathematics and success in Turkey and America, and a negative significant relationship in Singapore and Finland. The view of Simmich-Dudgeon (1996) that students' interest in mathematics is not a self-assessment tool that reflects how good they will be in mathematics is in line with the result of our research.

According to the results of the study, it has been found that there is a negative and significant relationship between the level of student anxiety about the mathematics lesson and mathematics achievement, and the effect size of this variable is small in practice. There are many studies in the literature examining the relationship between students' anxiety levels and academic achievement. Miller (1991), Yenilmez and Özabacı (2003), Ma and Xu (2004), and Şentürk (2010) have found in their studies that there is a negative and significant relationship between students' anxiety level and achievement.

According to the results of the study, there is a negative and significant relationship between the students' likeliness to learn mathematics and their mathematics achievement, but the size of this effect is quite small. Although students do not like mathematics, they can be successful in it to prove themselves to their families, friends, and teachers and to gain an appreciation for the environment. Although they like mathematics, have fun with it, and believe in its necessity, they may fail because they do not make much effort (Öztürk & Şahin, 2015). Kadijevich (2008), using TIMSS 2003 data, found that there is a negative relationship between like learning mathematics and mathematics achievement in 30 countries; Şentürk (2010) found that there is no significant relationship between like learning mathematics and mathematics achievement. Akyüz (2014), using TIMSS 2014 data, found that there is a significant relationship between the variable of liking learning mathematics and success in mathematics in Singapore and the United States, but this relationship is not significant in Turkey and Finland.

Among all affective characteristics included in the analysis, it is seen that the most important variable associated with mathematics achievement is students' self-confidence in mathematics, and the effect size of this variable is quite high. Self-confidence in mathematics is expressed as students' perceptions of difficulty or ease in learning mathematics (Akyüz, 2014). The more students feel that they can learn mathematics and be successful, the more time and effort they will spend to be successful, which will lead the student to success. There are many studies that have found that there are significant relationships between self-confidence and mathematics achievement. Azina and Halimah (2012), Kadijevich (2008), Aydın (2015), Akyüz (2014) found in their studies that there is a significant and positive relationship between mathematics achievement and self-confidence.

Recommendations

This study has some limitations. In the study, the mathematics subtest of the secondary education entrance exam was examined as a dependent variable. Different subtests can be used as dependent variables in further studies. In addition, the variables used in the research are limited to student and teacher characteristics. In future studies, it can be examined in more detail by adding family and peer characteristics related to student achievement. Two-level hierarchical linear models were used in the analysis of the research. For further research, analyses can be made with different methods suitable for the structure of the data; differences or similarities between the methods can be examined in detail; or three-level hierarchical models can be established. Another limitation of the study is that the research group is small. In future studies, analyses can be carried out on larger samples.

In this study, the students with a high anxiety level and low self-confidence in mathematics had lower mathematics achievement. It is recommended to carry out collaborative work with student, teachers, schools, parents, and the ministry in order to decrease the anxiety levels of students towards mathematics and to raise more confident students in the subject. In addition, as in the PISA and TIMSS exams, student, teacher, and school questionnaires can be applied in national exams to determine the affective and characteristic features of students, to have a large data set, and to determine what changes have occurred in these characteristics of students over the years.

The content of professional development activities for teachers should be reviewed, activities that will increase teachers' classroom management skills should be emphasized, and trainings should be organized to meet the needs and contribute positively to teaching. In addition, teachers with high seniority should be encouraged to participate in professional development activities. According to the results, it was seen that the classes of the teachers from the mathematics department of the faculty of education are more successful. Teachers should be given opportunities to update and improve themselves in the fields of pedagogy and mathematics, as well as the necessary permission and support. In this study, the most important teacher characteristic related to mathematics achievement is the level of professional satisfaction of the teacher. It is recommended to give the necessary importance to the teaching profession and teachers and to carry out the necessary studies for teachers to have better living and working conditions.

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Author (s) Contribution Rate
The authors contributed equally to the study.

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