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The relative effect of student, family and school-related factors on math achievement by location of the school

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Abstract

This study aims to examine the relative effects of student, family and school-related characteristics on 4th grade students' math achievement according to location of the school in Turkey. The data of 6435 students studying at 260 primary schools were analyzed using TIMSS-2015 database. The dependent variable of the study was students' math scores and 19 factors constituting the student, family and school-related characteristics were the independent variables. The location of the school was classified as urban, suburban, medium-size city and village. The data was analyzed via single level multiple linear regression. The results revealed that the entire models explained the largest amount of variance (52%) in the schools located in the villages and the least amount of variance (44%) in those located in the urban area. Although all of the student, family and school-related characteristic sets were found to be significantly related with the achievement, the student-related characteristics explained the largest amount of variance in achievement. Students' confidence in math contributed almost the highest amount of variance, and the early numeracy tasks, absenteeism in school, parents' highest education level, parents' highest occupation level, early numeric activities before school explained small amounts of variance in students' math achievement in the schools of all locations.

Keywords: Math achievement, Student-related factor, Family-related factor, School-related factor, TIMSS

Introduction

Numeracy, mathematical competences and understanding of science are vital for the participation in the knowledge society and the competitiveness of modern economies. Math constitutes one of the key competences for personal fulfillment and participation in school, society and the labor market of the twenty-first century (European Commission, 2011). It is a critical academic filter for students' educational pathways (Chiu & Klassen, 2010; Pitsia et al., 2017).

Students' achievement in math can be assessed by international large-scale surveys called Trends in International Mathematics and Science Study (TIMSS) in the world. TIMSS is an international assessments of the math and science knowledge of 4th and

8th grade students in all around the world. The participants come from a diverse set of educational systems in terms of geographical location, economic development and population size. The schools and classes that participate in TIMSS are randomly selected to reflect the country-wide data. Since TIMSS focuses on the curriculum, it collects a wider range of background information about student learning environments (TIMSS, 2015). The vital information of TIMSS allows researchers to get profound insights into students' learning, the relationship between their achievement and various factors.

Understanding the factors affecting students' math achievement is extremely important. The related literature indicates that previous studies primarily focused on the influences of many individual factors (Lee et al., 2014; Lu et al., 2011; Semeraro et al., 2020). But, the latest research has expanded the focus beyond the individual level such as student, family, school context and the complexity of the interaction between them. The studies report that there is general agreement about the impact of the student, family and school-related factors on achievement (Ataç, 2019; Engin-Demir, 2009; Farooq et al., 2011; Ker, 2016; Kraft & Dougherty, 2013; Mohammadpour, 2013; Özer & Anıl, 2011; Takashiro, 2017). It is also claimed that the variables predicting achievement and strength of the relationship can differ according to both the countries at the macro level (Holzberger et al., 2020) and the characteristics of the locations of the school within the country at the micro-level (Ministry of Education [MEB], 2005; OECD, 2009a). If strong predictors of later math success are found and successfully targeted by practitioners early in school, then perhaps the education system can prevent at-risk children from falling further behind (Gersten et al., 2005). Hence, it is emphasized that the aforementioned factors should be examined both separately and collectively to predict math achievement (Semeraro et al., 2020).

Theoretical Background

Student-related factors and achievement

Research results indicate that the student-related features were the most influential factors in terms of student achievement (Ker, 2016; Nartgün & Çakır, 2014). According to Hattie (2009) the potential predictors of achievement reside in students themselves. Student's gender, school absenteeism, early numerical and reading skills, preschool education, perceptions, attitudes and the frequency of speaking test language at home are some of the fundamental student-related factors presented in the literatüre (Chowa et al., 2015; Gottfried, 2014; Harju-Luukkainen et al., 2020; Mohammadpour, 2013; Papanastasiou, 2000; Sarouphim & Chartouny, 2017; Yayan & Berberoglu, 2004; Zippert & Rittle-Johnson, 2020).

Gender is a critical variable whose relationship with math achievement has been studied extensively (Bassey et al., 2011; Sarouphim & Chartouny, 2017). Although research results draw attention to the relationship between gender and academic achievement, there are contradictory findings in the literature. For example, some studies (Bassey et al., 2011; Butt & Dogar, 2014; Mohammadpour, 2013; Ross et al., 2012; Yayan & Berberoglu, 2004) report that males are more successful than females, the other (Farkas et al., 1990) presents opposite finding. However, some of the other studies (Lee & Kung, 2018; Sarouphim & Chartouny, 2017) report either a non-existent or declining gender gap in performance, with gender patterns differing between countries. Besides,

cross-national studies suggest that the gender gap in math performance narrows or even reverses in societies with more gender equality, but not in those with more gender inequality (Lee & Kung, 2018).

Recently, a growing number of studies find a strong association between early math skills and later academic achievement (Bailey et al., 2014; Geary et al., 2013; Watts et al., 2014). In previous studies (Harju-Luukkainen et al., 2020; Ribner et al., 2017), the analysis of six large longitudinal data sets uncovered a strong association between school entry math skills and math achievement in third grade while accounting for a substantial number of control variables including IQ, reading achievement, attentional control and socioemotional skills, in five of the six studies. Similar longitudinal relations have also been found by Byrnes and Wasik (2009) and extended to fifth-grade math achievement.

Research results emphasize that the positive attitude towards the course (Chowa et al., 2015), motivation level (Nartgün & Çakır, 2014), affective characteristics such as fear, stress, anxiety, belonging (Papanastasiou, 2000) were reported as related to achievement. According to Chowa et al. (2015), between 12 and 20% of the total variability in achievement was explained by differences in attitudes towards the course. In their study, Wang et al. (2012) investigated factors associated with 8th graders' math achievement in four countries using TIMSS-2003 data. They reported that confidence in learning math was found to have the strongest significant effect on math achievement in the USA, Russia, Singapore and South Africa. Similarly, the study of Ker (2016) indicated that self-confidence is the most influential aspect of math performance for Singapur and the USA. In line with self-confidence, motivation is another crucial factor explaining students' achievement (Nartgün & Çakır, 2014). Motivation variables considering math measure how students feel about maths, their value of maths and the perception of learning it (Mullis et al., 2012; Wigfield & Eccles, 2000). Absenteeism is another significant factor and has a negative relationship with academic achievement (Gottfried, 2014). According to Gershenson et al. (2014) the chronic absentees tend to have 0.05σ to 0.11σ lower test scores compared with average absentees. Like the absenteeism, the sense of belonging at school is other factor affecting math achievement. It is the extent to which students feel accepted by and connected to their peers and part of the school community. Sense of belonging gives students' feeling of security, identity and community which, in turn, supports academic, psychological and social development (OECD, 2018). It is underlined that lack of connectedness can adversely influence students' perceptions of themselves, their satisfaction with life and their willingness to learn and put effort into their studies. Additionally, bullying at school also affects student success at schools. Primary students who have been bullied at school show significantly poorer math and reading achievement than those who have not, and both being bullied and witnessing the bullying of a classmate have a negative impact on achievement levels (Murillo & Román, 2011). The language of education is another factor investigated in educational research. Whether the education language and spoken language at home are same or not, may create differences in math achievement. In the study of Mohammadpoure (2013), students who spoke English at home more frequently achieved 10.33 points higher than those who did less frequently, when the other factors in the model were taken into account.

Finally, previous research (ERG, 2017; Oral et al., 2016; Ribner et al., 2017; World Bank, 2012; Zippert & Rittle-Johnson, 2020) highlight the relationship between preschool

education and academic success. However, in these studies, the relationship between preschool education and academic achievement was not evaluated in the contexts of the socio-economic structure of the family and the location of the school.

Family-related factors and achievement

The literature presents that characteristics of the family where the students grow up in are also associated with academic achievement. According to Hurn (1993) family is one of the main factors that makes a difference in achievement. It is reported that family socioeconomic and cultural status (Yamamoto & Holloway, 2010), how parents are involved in their child's education (Christenson, 2004; Fantuzzo et al., 2000; Şad, 2012) and what type of expectations the families have towards their child (Marchesi & Martin, 2002; Siraj-Blatchford, 2010) are some of the significant family-related factors affecting students' math achievement in the literature. Family socioeconomic status is a collective terminology comprising of social class/status, economic status, family size, family structure, parental education level, occupation and other factors pertaining to family life (Muola, 2010). According to OECD (2019), the parents of the students with low academic success are more likely to have low educational levels, work in less prestigious jobs with low wages, migrate, speak a different language at home rather than educational language and have a rural origin.

The explanatory power of Socioeconomic Status (SES) factors for student achievement varies in different countries (Harju-Luukkainen et al., 2020). According to Şirin (2005), the SES in which the student grew up are not only directly related to academic achievement, but also indirectly related with multiple interaction systems including students' racial and ethnic origins, grade levels and school/neighborhood locations. For instance, the family SES, which will largely determine the location of the child's neighborhood and school, not only directly provides home resources, but indirectly creates supportive relationships between structural forces and individuals (e.g., parent-school) through social capital. The SES promotes sharing of social norms and values required for students to succeed in schools through social capital. It is suggested that socioeconomic indicators such as parents' highest education level, parents' highest occupation level, family income and size are important determinants of achievement (Chevalier & Lanot, 2002; Juma et al., 2012; Şirin, 2005; Tomul & Savasci, 2012).

There is high probability of families with a high level of the SES to offer their children a better quality of academic support availability (Alokan et al., 2013; Kudari, 2016; McNeal, 1999). Parents' highest education level and family income are suggested to be the long-term determinants of achievement and specifically the parental education level is the most important reason for the difference in student achievement (Chevalier & Lanot, 2002). It is remarked that the increase in family income leads to school achievement at every level of education (Juma et al., 2012) and generally the children of poor family have lower achievement (Chevalier & Lanot, 2002). According to Kyriakides et al. (2019), the low family income, on the one hand, prevents students from living in a more developed settlement area, possessing a good peer group and accessing a school that provides a good education. It limits the level of family meeting the cost of education. In addition to these, family characteristics such as family size, number of siblings, and birth order, the environment in which the family lives and parents' highest occupation level

also appear to affect student achievement. It is reported that as the number of individuals in the family increases, the achievement decreases (Juma et al., 2012). In developing countries, the older children are less likely to succeed and access higher education levels compared to younger siblings (Smits, 2007).

Harju-Luukkainen et al. (2020) present that the family-related factors, like parent's educational level, their values and expectations have a significant impact on child's early skills and later educational outcomes. Especially the early years math knowledge is significantly correlated with later math and reading skills (Harju-Luukkainen et al., 2020; Watts et al., 2014). Hence parents tend to provide their child with a broad math and early literacy input. According to recent longitudinal study (Lehrl et al., 2020), book exposure and the quality of verbal interaction regarding math predicted 554 3-year-old children's math outcomes in secondary school and those effects were mediated through early language and arithmetic skills. Chohan and Khan (2010) investigated the impact of family support on the academic performance and self-concept of 4th grade public school students. The findings revealed that family support had consistent and positive effect on academic achievement and self–concept of learners. Similarly, Schmitt and Kleine (2010) studied the influence of family–school relations on achievement. They have found that family relationship affects student's achievement. On the other hand, Zippert and Rittle-Johnson (2020) report barely any links between parent support and children's broad math skills. And the impact of early academic skills on students' educational outcomes can vary depending on gender, the SES and language proficiency (Hannover Research, 2016).

School-related factors and achievement

Mohammadpour (2013) states that school plays a vital role in students' learning process. Since students gain part of their knowledge in schools, the school-related factors are crucial to consider as well as student and family-related factors. The previous research (Mullis et al., 2012; Wigfield & Eccles, 2000) underline that the availability of school/instructional resources may have significant effects on learning. Hence, Holzberger et al. (2020) suggest determining the relationship between students' math achievement and school-related variables due to the school-related factors can be manipulated actively and developed. Research results indicate that the relationship between the school-related factors and student outcomes varies depending on the specific school variables (Furtak et al., 2012; Hedges et al., 2016; Mickelson et al., 2013; Quin, 2017; Thapa et al., 2013). In the study of Bosker and Witziers (1996), 18% of the variance in students' achievements was explained by school factors. Likewise, 9% and between 4.4 and 5.3% of the variance in achievements was explained by school factors in the related studies conducted by Yavuz et al. (2016) and Bacolod and Tobias (2005) respectively. According to the MEB (2005), the percentage of explained achievement difference resulting from school characteristics can vary between 29 and 49%, when the socioeconomic characteristics of the school locations are considered together. Likewise, Chiu and Klassen (2010) indicate that the school-level differences accounted for approximately one-fourth of the total variance in science performance. On the other hand, it is also claimed that impact of the school characteristics on academic achievement can vary according to the countries, the socioeconomic characteristics of the student and the level of education. In

countries such as Greece, Norway and Turkey, the school-related characteristics seem to have higher effects on achievement (MEB, 2005).

The study conducted by Holzberger et al. (2020) revealed that there are strong relationships between schools' SES composition, out-of-school activities, schools' academic pressure, instructional practices, classroom climate and student' achievement. The researchers reported that predictor of school composition by student background has strong positive relationship with the means of math achievement for Singapur and USA. Ker (2016) found the socioeconomic background, home and school resources as influential elements on American students' math achievement. Besides, Akyüz (2014) claims that academic emphasis of the school is key variable in explaining student math achievement at all levels of education in Turkey, Singapore and Finland. Likewise, the previous research (Mullis et al., 2012; Wigfield & Eccles, 2000) support that the school emphasis on academic success can promote student attainment and in turn the achievement. Positive school climate and motivation are linked to academic outcomes as school climate particularly relates to instructional quality and student achievement (Rohatgi & Scherer, 2020). In addition, the discipline and safety characteristics of a school also explain some of the variance in achievement among schools. Students perform better both behaviourally and academically in schools where the disciplinary climate is strong (Akyüz, 2014; OECD, 2009a).

The related literature presents that the effect of school characteristics is higher on the academic achievements of elementary school-level students from the lower social strata (Mancebon and Mar Molinero, 2000). In some studies, class size (Hoxby, 2000; Rivkin et al., 2005), student–teacher ratio (Fredriksson & Öckert, 2008) and a good school physical structure (Earthman, 2002) have been found to affect academic success positively. It is expressed that having a school equipped with a library, computer room and laboratory or other learning materials such as textbooks and projectors are important for academic achievement.

Location of the school and achievement

An important factor behind limited academic achievement is location of the school, whereby wealth and poverty are concentrated in particular geographic settlemets and neighbourhoods. Location of the school segregation is often accompanied by school segregation, where students from less advantaged households are more likely both to attend lower-quality schools and be grouped with similarly disadvantaged peers. Schools in poorer neighbourhoods generally suffer from limited resources, larger classes, inexperienced teachers and inability to retain staff—all of which create fewer opportunities for students to excel (OECD, 2018).

Many studies reveal that there is a linear relationship between the location of the school and academic achievement (Dinçer & Uysal Kolaşin, 2009; Giambona & Porcu, 2015; Goddard et al., 2000; Güvendir, 2014; Ramos et al., 2016). According to Ferreira et al. (2010), the spatial change of schools explains more than a quarter of the total inequality within achievement in Turkey. The school in a rural area has a significant relationship with test scores which creates a significant difference in math scores especially. It is reported that the students studying in schools of residential areas with a population

of 15,000 or less have lower science, math and reading scores (Dinçer & Uysal Kolaşin, 2009).

Studies show that the socio-cultural and economic characteristics of the residential area where the school is located and the differences in the quality of educational opportunities were considered as the potential sources of academic achievement (OECD, 2009b; World Bank, 2011). In Turkey, the composition of the household differs according to the location of residence as in the case of other countries. The families are divided into two main groups such as rural and urban families. They differ in some aspects such as family size, income distribution, socioeconomic and cultural structure, education level, authority pattern and the position of individuals within the family (Canatan & Yıldırım, 2009). There also exists slum family type that generally lives in the outskirts of cities and bears characteristics of both urban and rural families (Adak, 2017). According to TUIK (2014), rural areas and outskirts of cities increase the risk of poverty and the educational levels of the parents in these regions are lower (TUIK, 2013). In this context, it can be said that the families with low socioeconomic level generally live in rural areas and outside of the cities which are more disadvantaged settlements. Also, the same extent of family characteristics are reflected in schools (Karip, 2007; Marks, 2006; OECD, 2009b). Because, the students are automatically enrolled in schools closest to their homes, based on the residence address (MEB, 2019).

Quality of the educational opportunities offered by schools in different settlements determines the relationship between the location of the school and academic achievement as well as the socio-cultural and economic opportunities as mentioned above. The results of many studies have revealed that academic achievement can vary depending on the availability, use and management of school-based resources (Adeogun & Osifila, 2008; Bacolod & Tobias, 2005; OECD, 2009b; Önder, 2016). However, in Turkey, it can be said that there are no significant differences between schools in terms of physical and technical equipment in different locations, but they may differ both quantitatively and qualitatively in terms of human resources. Namely, the rate of teacher mobility is very high in schools within disadvantaged residential areas. Despite taking serious precautions, the shortage of teachers in schools within these regions could not be closed. Educational activities are sometimes carried out by less experienced teachers (Önder, 2016) and substitude teachers who are employed on a semester or yearly basis in return for tuition fees. Therefore, Turkish education system is occasionally subjected to criticism that the students, who are disadvantaged in different aspects, are faced with other disadvantages within the system (Karip, 2007).

Purpose of the research

The number of studies investigating the individual and collective effects of the student, family and school-related factors on achievement is limited (Engin-Demir, 2009; Güvendir, 2014; Ölçüoğlu & Çetin, 2016; Önder & Uyar, 2018; Sarı et al., 2017; Taslidere, 2020) and none of them have studied the collective effects of aforementioned factors on math achievement according to the location of the school in Turkey. Hence, this study aimed to determine how well each set of the student, family and school-related factors predict 4th grade students' math achievement over and above the other(s) in schools located within different regions in Turkey. It is expected that the findings can provide

tips on how to support the student groups studying in different school locations. It can contribute to taking the necessary measures in various locations of the schools and making attempts to reduce the differences in success between schools. Results can also shed light on the development of education policies targeting the right groups. For these reasons, it is thought that the current research is important in terms of creating a resource for educational reform and developments.

Research questions

In the light of previously mentioned aspects, this study aims to answer the following questions;

1. How well each set of the student, family and school-related factors predict 4th grade students' math achievement when they are added over and above the other(s) by location of the school in Turkey?
2. Which of the student-related factors significantly explain 4th grade students' math achievement when the student, family and school-related factor sets were added over and above the other(s) by location of the school in Turkey?
3. Which of the family-related factors significantly explain 4th grade students' math achievement when the student, family and school-related factor sets were added over and above the other(s) by location of the school in Turkey?
4. Which of the school-related factors significantly explain 4th grade students' math achievement when the student, family and school-related factor sets were added over and above the other(s) by location of the school in Turkey?

Method

Participants

The data concerning the participants was taken from TIMSS (2015). TIMSS-2015 application collected data from total of 6456 4th graders studying in schools located within different residential areas in Turkey. The location of the school in the data set (variable ACBG05B) was originally divided into five categories including urban (densely populated), suburban (on fringe or outskirts of urban area), medium-size city (medium size city or large town), village (small town or village) and remote rural (remote rural) (TIMSS, 2015). Preliminary analysis indicated that there was only 45 participants studying in the shools located within remote rural area. It seems that the number of data concerning them was insufficient for the analyses. So it was decided to combine the data of the participants in this region under village data due to the fact that the chacteristic properties of their schools and settlements are almost similar. Also, the data concerning 21 participants' was excluded from all analyses completely based on missing data analysis. Hence, 6435 4th grade students attending 260 primary schools located in different residential areas of Turkey constituted the participants of the research. The number of participants and their gender, studying in the schools of different settlements are given in Table 1. As seen from Table 1, most of the participants (43%) are studying in the schools of urban area and the least number of them (13%) are studying in those of the village area. Almost 49% of the participants are female and remaining are male students.

Table 1 The number of participants by location of the school

Settlement	Gender		Total
	Female	Male	
Urban	1370	1391	2761
Suburban	508	507	1015
Medium-size city	897	988	1885
Village	389	385	774
Total	3164	3271	6435

Variables

The dependent variable of the research is math scores of the 4th grade students who participated in TIMSS-2015 application from different residential areas in Turkey. TIMSS-2015 collected extensive data, but the current study used only 19 of them grouped under three main sets such as the student, family and school-related factors. The independent variables were selected based on theoretical and empirical findings from previous research. Besides, the data availability, comparability, criticality and whether or not it will enable comprehensive evaluation were also taken into consideration (Ataç, 2019; Engin-Demir, 2009; Farooq et al., 2011; Ker, 2016; Kraft & Dougherty, 2013; Mohammadpour, 2013; OECD, 2019; Özer & Anıl, 2011; Semeraro et al., 2020; Şirin, 2005; Takashiro, 2017; Taslidere, 2020). The data concerning the student and family-related variables were derived from the student's questionnaire and those of the school-related variables were obtained from school principal's questionnaire. The student-related factor set includes gender, often speak language of test at home, about how often absent from school, student attended preschool, early numeracy tasks, students sense of school belonging, student bullying, students like learning math, engaging teaching in math lessons and students confident in math. The family-related factor set includes parents' highest education level, parents' highest occupation level, early numeric activities before school, parents' perceptions of school performance, parent attitude towards math and science. The school-related factor set includes school composition by student background, instruction affluent by math resource shortage, school emphasis on academic success and school discipline problems. Definitions of the variables with their codes and descriptive statistics results concerning them are presented in Table 2. Among all, only the gender (1—Female; 2—Male) was categorical and the remaining are ordinal variables.

Data considerations and data analyses

Missing data is a challenging issue in analysis, especially at the group or upper levels (McCoach, 2010), because any group-level unit with missing data excludes all individual units nested within the group-level unit from the analyses. The outcome variable was without missing data, but there were some missing data among the predictors in the student-related factors ranging from 0.6% (for the "engaging teaching in math lessons") to 5.0% (for the "often speak the language of test at home"). At the family-related factors, the total missing data ranged from 2.4% (for the "parents' perceptions

Table 2 Codes, definitions and average values of the dependent and independent variables of the research in TIMSS, 2015 dataset

Data code/variables	Urban			Suburban			Medium-size city			Village		
Student-related factors	**N**	**%**	**Math x̄**	**N**	**%**	**Math x̄**	**N**	**%**	**Math x̄**	**N**	**%**	**Math x̄**
ASBG01												
Gender												
1-Girl	1370	49.3	502	508	48.9	473	897	48.0	492	389	49.8	428.4
2-Boy	1391	50.8	503	507	51.1	477	988	52.1	501	385	50.2	415.4
ASBG03												
Often speak language of test at home												
1. Sometimes or never	301	11.0	506	202	20.6	447	299	15.0	474	223	26.2	351
2. Almost always	239	9.0	527	70	7.1	506	132	7.5	523	54	7.0	415
3. Always	2106	80.0	504	679	72.2	489	1347	77.5	506	460	66.9	456
ASBG08												
About how often absent from school												
1-Never or almost never	1807	65.8	517	566	57.3	501	1259	67.1	510	421	54.7	439
2-Once a month	553	20.5	493	221	21.7	473	350	19.7	484	176	24.1	424
3-Once every 2 weeks	171	6.4	463	88	7.9	422	137	7.0	462	60	8.0	394
4-Once a week or more	210	7.3	443	127	13.1	408	116	6.3	444	100	13.2	375
ASDHAPS												
Student attended preschool												
1-Did not attend	762	28.1	468	315	30.8	447	461	24.2	453	273	35.5	392
2-1 year or less	1266	46.8	510	463	49.5	491	896	49.6	506	377	51.7	446
3-2 years	334	13.3	542	86	8.7	483	240	13.4	531	38	5.4	449
4-3 years or more	315	11.8	520	122	11.1	476	213	12.8	515	63	7.4	389

Table 2 (continued)

	N	$\bar{x}$	s.e	N	$\bar{x}$	s.e	N	$\bar{x}$	s.e	N	$\bar{x}$	s.e
ASBHENT												
Early numeracy tasks	2761	9.9	0.1	1015	9.3	0.2	1885	9.7	0.2	774	8.9	0.2
ASBGSSB												
Students sense of school belonging	2761	10.8	0.1	1015	10.6	0.2	1885	10.7	0.1	774	10.7	0.2
ASBGSB												
Student bullying	2761	10.1	0.1	1015	10.0	0.1	1885	10.1	0.1	774	9.8	0.2
ASBGSLM												
Students like learning math	2761	11.3	0.1	1015	11.3	0.1	1885	11.3	0.1	774	11.3	0.1
ASBGEML												
Engaging teaching in math lessons	2761	10.8	0.1	1015	10.6	0.2	1885	10.7	0.1	774	10.6	0.1
ASBGSCM												
Students confident in math	2761	10.5	0.1	1015	10.3	0.1	1885	10.6	0.1	774	9.9	0.1
Family-related factors	**N**	**%**	**Math $\bar{x}$**	**N**	**%**	**Math $\bar{x}$**	**N**	**%**	**Math $\bar{x}$**	**N**	**%**	**Math $\bar{x}$**
ASDHEDUP												
Parents' highest education level												
1-Some primary lower secondary or no school	885	32.1	464	487	47.7	435	707	38.6	453	496	67.7	404
2-Lower secondary	338	12.3	479	131	14.7	477	217	12.8	482	93	13.6	445
3-Upper secondary	832	31.8	514	224	24.6	509	494	27.2	516	108	15.5	487
4-Post-secondary but not university	209	8.0	538	50	5,3	538	127	6.9	550	7	1.2	481
5-University or higher	407	15.9	569	74	7.8	581	236	14.5	582	15	2.0	516
ASDHOCCP												
Parents' highest occupation level												
1-Never worked for pay	202	7.1	480	92	9.2	431	132	7.5	456	95	13.2	374
2-General laborer	645	24.8	471	343	34.6	447	476	25.9	462	246	33.8	426
3-Skilled worker	460	17.0	496	212	22.4	470	409	22.5	488	244	35.6	437
4-Clerical	582	21.8	526	188	19.4	519	365	20.4	532	74	9.7	432

Table 2 (continued)

Family-related factors	**N**	**%**	**Math x̄**	**N**	**%**	**Math x̄**	**N**	**%**	**Math x̄**	**N**	**%**	**Math x̄**
5-Small business owner	405	15.4	505	77	8.3	494	199	10.8	498	42	5.9	445
6-Professional	348	14.0	549	55	6.2	554	195	13.0	566	14	1.9	451
	N	**x̄**	**s.e**	**N**	**x̄**	**s.e**	**N**	**x̄**	**s.e**	**N**	**x̄**	**s.e**
ASBHENA												
Early numeric activities before school	2761	9.4	0.1	1015	8.6	0.2	1885	9.2	0.2	774	8.2	0.2
ASBHPSP												
Parents perceptions of school performance	2761	10.5	0.1	1015	10.6	0.2	1885	10.08	0.1	774	11.0	0.1
ASBHAMS												
Parent attitude towards math and science	2761	10.7	0.1	1015	10.7	0.2	1885	10.7	0.1	774	10.7	0.1
School-related factors	**N**		**Math x̄**	**N**		**Math x̄**	**N**		**Math x̄**	**N**		**Math x̄**
ACDG03												
School composition by student background												
1-More disadvantaged	1111	41.41	472	699	73.5	465	853	47.9	464	440	60.6	407
2-Neither more affluent nor more disadvantaged	746	23.6	521	251	25.2	493	548	29.8	514	154	25.5	446
3-More affluent	815	34.99	530	16	1.4	590	364	22.3	533	111	13.9	407
	N	**x̄**	**s.e**	**N**	**x̄**	**s.e**	**N**	**x̄**	**s.e**	**N**	**x̄**	**s.e**
ACBGMRS												
Instruction affluent by math resource shortage	2761	7.8	0.2	1015	7.9	0.2	1885	7.8	0.2	774	8.3	0.4
ACBGEAS												
School emphasize on academic success	2761	9.8	0.2	1015	8.3	0.3	1885	9.5	0.3	774	8.1	0.2
ACBGDAS												
School discipline problems	2761	9.2	0.2	1015	8.4	0.4	1885	8.9	0.3	774	8.0	0.4

of school performance") to 5.4% (for the "parents' highest occupation level"). At the school-related factors, missing data ranged from 1.1% (for the "school discipline problems") to 5.4% (for the "school composition by student background"). According to Tabachnik and Fidell (2013), if a small fraction of data (e.g., 5% or less) is randomly missing in a large dataset, the problem is not serious and listwise deletion method would be used for the treatment of missing data. Preliminary analysis showed that more than half of the data for 21 students were missing, so, the data concerning these students were excluded from the whole analyses completely as stated previously.

Prior to main analyses, first, the assumptions of the regression were checked and then the data was analyzed via single level multiple linear regression to examine how well each set of the student, family and school-related factor sets predict 4th grade students' math achievement when each set of the factors was added over and above the other(s) by location of the school. The analyses were conducted using IDB analyzer 4.0 program. The models for each school location suggest how math achievement was predicted when the student, family and school-related factors were combined entirely (Engin-Demir, 2009; Field, 2009; Green et al., 2000; Pallant, 2010). In TIMSS-2015 database, math achievement scores were reported based on five plausible values and hence the analyses were conducted by considering those five plausible values. TIMSS used a multistage cluster sampling design and hence, the likelihood of selection sample units is not equal. To avoid this bias in parameter estimates and produce nationally representative findings, Student Sample Weights were used in the analyses (Rutkowski et al., 2010).

A three-step (Step-1: student; Step-2: student and family; Step-3: student, family and school-related factors) single level multiple linear regression was conducted. The causal priority of the factor sets explaining math achievement was determined based on the previous research results. Namely, Hattie (2009) claims that the potential predictors of achievement reside in students themselves. Ker (2016) suggests taking the student background and home environmental support variables first in the hiearchy while constructing the models of math achievement. So, the first step (Model I) includes only the student-related factors. Besides, Hurn (1993) asserts that family is another main factor that makes a difference in achievement. So, in the second step (Model II), the family-related factors were added on the student-related factors. Also, Holzberger et al. (2020) suggest determining the relationship between student's math achievement and school-related variables. Hence, the school-related factors were added on the student and family-related factors in the final step (Model III). Simultaneous-entry approach was used because the study aimed to determine a comprehensive relationship of aforementioned factors contributing to the explanation of the variance in the math achievement by location of the school. Hence, all selected variables were entered into the model regardless of the significance levels. The Results produced three models; each indicated how the math achievement was affected when each factor set was added over and above the other factor(s) by location of the school.

Results

Assumptions of the regression model

The assumptions of the regression were checked and no serious problem was encountered. According to Tabachnick and Fidell (2013), the minimum number of cases should

be greater than $50+8\ m$ (where m is the number of factors) for regression analysis. According to this criteria, the minimum cut-off point should be 202. As reported in Table 1, the number of cases is sufficiently higher than specified cut-off value. Zero-order correlation coefficients among independent variables (between − 0.552 and 0.555), variance inflation factors values (between 1.022 and 1.870) and tolerance statistics values (between 0.520 and 0.979) were all in acceptable ranges for all locations of the schools. Based on these data, it can be accepted that no strong relationship exists between two or more predictors (Pallant, 2010). Durbin–Watson values (urban = 1.855, suburban = 1.914, medium-size city = 1.779 and village = 1.894) are acceptable and indicate that regression errors are independent (Tabachnick and Fidell, 2013). According to Field (2009), the cut-off point for the Mahalanobis distance was 36.19. The analysis showed that all distances were smaller than the cut-off value. The standardized residual plot revealed that the relationship between residual and predicted dependent variable scores was almost linear. The scatterplot of the estimated standardized values (Z-Predicted) and standardized end values (Z-Residuals) showed that the points are scattered randomly around zero. Therefore, it suggests that the differences between predicted and observed values exhibit a normal distribution (Field, 2009; Pallant, 2010).

After satisfying the assumptions, single level multiple linear regression was conducted to examine the relative effects of the student, family and school-related factors on achievement for each location of the school. A three-step model was created in the analyses. The unstandardized regression coefficients (B), standard errors (SE B) and standardized regression coefficients (β) for the relations between aforementioned factors and math achievement by location of the school are presented in Table 3. In regression models, the significance of each independent variable is determined based on the *t*-values. For this, the table named "critical values of the *t*-distribution" which was published by Field (2009) was taken into account. Taking the significance level as $\alpha = 0.05$ and degrees of freedom (*df*) (urban df: 2147 [2166–19]; suburban df: 757 [776–19]; medium-size city df: 1382 [1401–19]; village df: 542 [561–19]) as reference, the cut off value was found as 1.96. Hence, all the variables having the value of $t = 1.96$ and above were considered as significant variables.

Student, family and school-related factors

The first research question was how well each set of the student, family and school-related factors predict 4th grade students' math achievement when they are added over and above the other set(s) by location of the school in Turkey. Results showed that the student-related factor set is significantly related to the math achievement in all school locations. R^2 change values showed that the student-related factors accounted for 31% ($F_{(2147)} = 107.99$, $p < 0.05$), 37% ($F_{(757)} = 39.50$, $p < 0.05$), 34% ($F_{(1382)} = 69.17$, $p < 0.05$) and 43% ($F_{(542)} = 45.53$, $p < 0.05$) of the total variance in math achievement in the schools located within urban, suburban, medium-size city and village areas respectively. It seems that the student characteristics explained the largest amount of variance in the schools of village by itself.

As seen from Table 3, Model II is also significant in all school locations. Both of the student and family-related factors accounted for 41%, 49%, 46% and 48% of the total variance in achievement in the schools of urban, suburban, medium-size city and

Table 3 Standardized regression coefficients for relations between student. family and school-related characteristics and the math achievement in terms of location of the school

	Model I			**Model II**			**Model III**		
	B	**SE B**	*β*	**B**	**SE B**	*β*	**B**	**SE B**	*β*
Urban									
Student-related									
Constant	160,75	23,55		269,46	23,15		209,70	36,08	
Gender	5.56	2.5	0.03*	4.87	2.46	0.03*	4.37	2.47	0.03
Often speak language of test at home	5.56	3.45	0.04	3.99	3	0.03	5.14	2.88	0.04
About how often absent from school	− 13.1	2.41	− 0.14*	− 12.05	2.28	− 0.13*	− 11.84	2.24	− 0.13*
Student attended pre-school	14.24	2.55	0.16*	1.86	2.37	0.02	0	2.45	0
Early numeracy tasks	6.57	0.86	0.16*	4.53	0.8	0.11*	4.38	0.79	0.11*
Students sense of school belonging	2.63	1.25	0.06*	2.47	1.04	0.05*	2.16	0.99	0.05*
Student bullying	− 2.26	0.9	− 0.05*	− 2	0.91	− 0.05*	− 2.01	0.89	− 0.05*
Students like learning math	3.35	1.53	0.06*	1.18	1.43	0.02	0.77	1.35	0.01
Engaging teaching in math lessons	1.36	1.24	0.03	0.4	1.18	0.01	0.01	1.1	0
Students confident in math	15.6	1.09	0.38*	13.05	1.01	0.32*	12.88	1.02	0.32*
Family-related									
Parents' highest education level				16.69	1.64	0.28*	13.14	1.82	0.22*
Parents' highest occupation level				3.53	1.01	0.06*	2.96	0.92	0.05*
Early numeric activities before school				4.64	1.13	0.11*	4.41	1.1	0.10*
Parents perceptions of school perf				− 0.36	0.92	− 0.01	− 1.26	0.86	− 0.03
Parent attitude towards math and science				− 1.01	1.08	− 0.02	− 0.07	1.03	0
School-related									
School emphasize on academic success							3.09	1.4	0.07*
Instruction affluent by math resource							0.58	1.7	0.01
School discipline problems							− 3.97	1.46	− 0.10*
School composition by students background							− 7.02	3.81	− 0.07
Adjusted R^2			0.31			0.41			0.44
ΔR^2			0.31			0.1			0.04
F		107,99			77,44			23,03	
Suburban									
Student-related									
Constant	44.28	42.22		169.17	33.95		83.42	71.72	
Gender	1.27	5.37	0.01	0.06	4.48	0	− 1.67	4.59	− 0.01
Often speak language of test at home	3.45	4.91	0.03	2.62	4.27	0.02	2.15	3.89	0.02
About how often absent from school	− 21.52	3.42	− 0.23*	− 17.61	− 2.82	− 0.19*	− 18.66	− 3.33	− 0.20*

Table 3 (continued)

	Model I			Model II			Model III		
	B	**SE B**	β	**B**	**SE B**	β	**B**	**SE B**	β
Student attended pre-school	2.27	4.41	0.02	− 4.28	2.63	− 0.04	− 2.61	2.72	− 0.02
Early numeracy tasks	9.47	1.58	0.22*	4.66	1.55	0.11*	4.68	1.57	0.11*
Students sense of school belonging	1.96	1.85	0.04	1.08	1.73	0.02	0.32	1.65	0.01
Student bullying	− 5.16	1.99	− 0.11*	− 5.23	− 1.59	− 0.11*	− 4.43	1.57	− 0.09*
Students like learning math	− 2.13	3.58	− 0.03	1.86	2.68	0.03	1.8	2.67	0.03
Engaging teaching in math lessons	6.24	1.98	0.12*	3.6	1.64	0.07*	3.35	1.82	0.06
Students confident in math	15.59	1.74	0.31*	12.3	1.49	0.25*	12.37	1.47	0.25*
Family-related									
Parents' highest education level				21.56	2.43	0.29*	20.1	3.18	0.27*
Parents' highest occupation level				5.39	2.36	0.07*	5.13	2.32	0.07*
Early numeric activities before school				7.03	1.48	0.17*	6.08	1.6	0.15*
Parents perceptions of school perf				0.34	1.61	0.01	− 0.52	1.66	− 0.01
Parent attitude towards math and science				0.44	1.42	0.01	0.91	1.35	0.02
School-related									
School emphasize on academic success							9.34	3.51	0.16*
Instruction affluent by math resource							− 0.36	5.44	0
School discipline problems							− 1.49	2.56	− 0.03
School composition by students background							6.59	11.5	0.03
Adjusted R^2			0.37			0.49			0.51
ΔR^2			0.37			0.12			0.02
F			39.5		50.48				7.26
Medium-size city									
Student-related									
Constant	107.53	33.04		235.57	37.84		222.45	45.3	
Gender	8.99	3.08	0.05*	8.25	3.43	0.05*	8.37	3.35	0.05*
Often speak language of test at home	4.6	3.8	0.04	3.64	3.03	− 0.03	2.06	3	0.02
About how often absent from school	− 8.69	2.96	− 0.08*	− 7.66	2.61	− 0.07*	− 8.28	2.65	− 0.08*
Student attended pre-school	15.35	3.97	0.16*	1.71	2.08	0.02	0.49	1.76	0
Early numeracy tasks	7.17	1.66	0.18*	3.94	1.25	0.10*	3.45	1.2	0.09*
Students sense of school belonging	3.58	1.77	0.07*	3.41	1.46	0.07*	3.26	1.49	0.07*
Student bullying	− 1.85	1.2	− 0.04	− 1.59	1.23	− 0.04	− 1.6	1.12	− 0.04
Students like learning math	0.94	1.99	0.02	2.04	1.52	0.03	2.1	1.33	0.04
Engaging teaching in math lessons	4.47	2.51	0.09	2.36	2.06	0.05	1.67	1.93	0.03

Table 3 (continued)

	Model I			Model II			Model III		
	B	**SE B**	β	**B**	**SE B**	β	**B**	**SE B**	β
Students confident in math	15.42	1.33	0.36*	12.57	1.16	0.30*	12.41	1.17	0.29*
Family-related									
Parents' highest education level				20.59	2.07	0.32*	18.5	2.08	0.29*
Parents' highest occupation level				5.32	1.84	0.09*	4.26	1.55	0.07*
Early numeric activities before school				3.8	1.49	0.09*	3.99	1.28	0.10*
Parents perceptions of school perf				1.98	1.33	0.04	1.76	1.39	0.03
Parent attitude towards math and science				− 0.45	1.38	− 0.01	− 0.23	1.28	0
School-related									
School emphasize on academic success							3.18	1.69	0.07
Instruction affluent by math resource							1.34	2.34	0.02
School discipline problems							− 0.39	1.59	− 0.01
School composition by students background							13.69	5.48	0.12*
Adjusted R^2			0.34			0.46			0.48
ΔR^2			0.34			0.12			0.02
F			69.17			69.59			15.31
Village									
Student-related									
Constant	50.59	52.63		150.54	55.51		− 32.07	100.76	
Gender	− 5.77	6.96	− 0.03	− 7.36	6.65	− 0.04	− 5.93	6.61	− 0.03
Often speak language of test at home	32.56	5.85	0.30*	28.78	5.25	0.26*	18.65	5.69	0.17*
About how often absent from school	− 11.25	3.58	− 0.12*	− 8.67	3.22	− 0.09*	− 10.92	3.39	− 0.11*
Student attended pre-school	4.57	3.87	0.04	0.97	4.45	0.01	0.08	4.4	0
Early numeracy tasks	10.67	1.76	0.24*	7.19	2.06	0.16*	6.65	1.98	0.15*
Students sense of school belonging	3.46	2.65	0.07	3.83	2.51	0.07	5.13	2.38	0.10*
Student bullying	− 1.55	1.87	− 0.03	− 1.65	1.71	− 0.03	− 0.02	1.76	0
Students like learning math	5.42	3.35	0.08	4.7	3	0.07	5.76	2.78	0.09*
Engaging teaching in math lessons	2.52	2.61	0.04	1.68	2.53	0.03	0.45	2.3	0.01
Students confident in math	15.12	2.28	0.29*	14.09	2.22	0.27*	14.05	2.32	0.27*
Family-related									
Parents' highest education level				15.56	3.82	0.15*	13.91	3.73	0.13*
Parents' highest occupation level				6.97	3.61	0.08	8.24	3.57	0.09*
Early numeric activities before school				5.57	2.03	0.12*	5.29	1.94	0.11*

Table 3 (continued)

	Model I			Model II			Model III		
	B	**SE B**	β	**B**	**SE B**	β	**B**	**SE B**	β
Parents perceptions of school perf				− 1.71	2.21	− 0.03	− 2.82	2.33	− 0.05
Parent attitude towards math and science				3.33	2.57	0.06	3.57	2.44	0.07
School-related									
School emphasize on academic success							17.49	7.83	0.23*
Instruction affluent by math resource							1.31	3.18	0.02
School discipline problems							− 1.29	3.42	− 0.03
School composition by students background							14.34	9.91	0.11*
Adjusted R^2			0.43			0.48			0.52
ΔR^2			0.43			0.05			0.04
F			45.53			10.85			28.01

* $p < 0.05$

village areas correspondingly. The change in R^2 (ΔR^2) revealed that, the family-related factors added extra 10% ($F_{(2142)} = 77.44$, $p < 0.05$), 12% ($F_{(752)} = 50.48$, $p < 0.05$), 12% ($F_{(1377)} = 69.59$, $p < 0.05$), and 5% ($F_{(537)} = 10.85$, $p < 0.05$) of the total variance in the schools of urban, suburban, medium-size city and village areas respectively. It seems that the highest contribution of the family-related factor set was made in both of the suburban and medium-size city schools.

Likewise, Model III was found to be significant in all school locations too as seen in Table 3. The entire models seem to account for 44%, 51%, 48% and 52% of the total variance in the schools of urban, suburban, medium-size city and village areas respectively. R^2 change values showed that the school-related factors added extra 3% ($F_{(2138)} = 23.03$, $p < 0.05$), 2% ($F_{(748)} = 7.26$, $p < 0.05$), 2% ($F_{(1373)} = 15.31$, $p < 0.05$) and 4% ($F_{(534)} = 28.01$, $p < 0.05$) of the total variance in achievement of urban, suburban, medium-size city and village schools. Although set of the school-related factors explained almost similar amounts of variance in all regions, the highest effect was obtained in the village schools. All three factor sets collectively explained the largest amount of variance in achievement in the village schools (52%), but the least one in the urban schools (44%) in the final model.

Student-related factors

The second research question was which of the student-related factors significantly explain 4th grade students' math achievement when the student, family and school-related factor sets were added over and above the other(s) by location of the school in Turkey. As seen from Table 3, the results indicate that the variables of the about how often absent from school (urban: $t_{(2147)} = 5.28$, $p < 0.05$, suburban: $t_{(757)} = 5.61$, $p < 0.05$, medium-size city: $t_{(1382)} = 3.12$, $p < 0.05$ and village: $t_{(542)} = 3.22$, $p < 0.05$), early numeracy tasks (urban $t_{(2147)} = 5.57$, $p < 0.05$, suburban: $t_{(757)} = 2.98$, $p < 0.05$, medium-size city: $t_{(1382)} = 2.88$, $p < 0.05$ and village: $t_{(542)} = 3.36$, $p < 0.05$), and students confident in

math (urban: $t_{(2147)} = 12.61$, $p < 0.05$, suburban: $t_{(757)} = 8.42$, $p < 0.05$, medium-size city: $t_{(1382)} = 10.61$, $p < 0.05$ and village: $t_{(542)} = 6.06$, $p < 0.05$) independently had significant contributions to math achievement in the schools located within all areas.

Field (2009) report that the standardized beta values are measured in standard deviation units and they are directly comparable and hence they provide a better insight into the 'importance' of a predictor in the regression model. When the final models are considered based on the standardized beta values, it is seen that the variable of the students confident in math was found to be the most significant predictor. Likewise, B value shows the individual contribution of each predictor variable to the models when the effects of all other predictors are held constant (Field, 2009). As seen from Table 3, an increase of one scale-point in student's confidence led to increase of 12.88, 12.37, 12.41 and 14.05 points in students' average math achievements in the urban, suburban, medium-size city and village schools respectively. Although the variable named about how often absent from school was the second significant predictor for math achievement in the schools located within urban and suburban areas, that of the early numeracy tasks was found to be second significant predictor in the schools of medium-size and village areas. The variable of the how often absent from school was measured under four-category (1-never or almost never, 2-once a month, 3-once every 2 weeks, 4-once a week or more). The results in the final models indicate that an increase of one category in the absenteeism led to the decreases of 11.84, 18.66, 8.28 and 10.92 points in the average achievements concerning the urban, suburban, medium-size city and village schools respectively. These findings indicate that there is significantly strong and negative relationships between the absenteeism and math achievements in all school locations. Likewise, an increase of one scale-point in the early numeracy task before enrolling in primary school led to the increases of 4.38, 4.68, 3.45 and 6.65 points in the average math achievements for the urban, suburban, medium-size city and village schools respectively. Interestingly, although the variable of the student bullying yielded significant contributions to math achievement in both of the schools located within the urban and suburban areas, it was found to be insignificant for the medium-size city and village schools correspondingly. It seems that an increase of one unit in the student bullying led to the decreases in average math achievements by 2.01 and 4.43 points for the urban and suburban schools respectively. Table 3 reveals that students' sense of school belonging was found to be another significant predictor in the schools of all areas except those of the suburban area. It seems that an increase of one unit in this variable led to the increase of 2.16, 3.26 and 5.13 points in the average math achievements for the schools of urban, medium-size city and village areas correspondingly.

As seen from Table 3, the variable labelled often spoken language of test at home was only significant predictor for the math achievement in the schools located within the village area. This variable consists of three-categories (1-sometimes or never, 2-almost always, 3-always). It reveals that the students who are studying in the village schools and speaking always Turkish at home seem to have 18.65 points higher average math achievement. In this sense, students who speak Turkish less at home in the village seem to be at a disadvantage. The other interesting factor is the gender which was found to be significant predictor only in the medium-size city schools in the final model. Male students studying in this settlement seem to outperformed female students by 8.37 points.

Besides, as presented in Table 3, the variable called as the students attended preschool was seem to be significant only in the urban and medium-size city schools in the first models. But the significances of it were lost when the family and school-related factor sets were entered into the models.

Family-related factors

The third research question was which of the family-related factors significantly explain 4th grade students' math achievement when the student, family and school-related factor sets were added over and above the other(s) respectively by location of the school in Turkey. The results based on the standardized regression coefficients indicate that the variables of the parents' highest education level (urban $t_{(2147)}=7.23$, $p<0.05$, suburban: $t_{(757)}=6.32$, $p<0.05$, medium-size city: $t_{(1382)}=8.91$, $p<0.05$, and village: $t_{(542)}=3.72$, $p<0.05$), parents' highest occupation level (urban: $t_{(2147)}=3.20$, $p<0.05$, suburban: $t_{(757)}=2.21$, $p<0.05$, medium-size city: $t_{(1382)}=2.76$, $p<0.05$ and village: $t_{(542)}=2.31$, $p<0.05$) and early numeric activities before school (urban: $t_{(2147)}=4.00$, $p<0.05$, suburban: $t_{(757)}=3.79$, $p<0.05$, medium-size city: $t_{(1382)}=3.12$, $p<0.05$ and village: $t_{(542)}=2.73$, $p<0.05$) were significant predictors for the math achievement, whereas the parents perceptions of school performance and parent attitude towards math and science insignificant for all schools of whole areas. Parents' highest education level was measured under five-category (1-some primary lower secondary or no school, 2-lower secondary, 3-upper secondary, 4-post-secondary but not, university, 5-university or higher). The results indicate that an increase of one level in the parents' education level led to the increase in the average achievements by 13.14, 20.10, 18.50 and 13.91 points for the schools located in the urban, suburban, medium-size city and village areas respectively. It is seen that parents' education level made the highest contribution to the prediction of achievement in the schools of suburban area whereas the lowest contribution was made in those of the urban area. Likewise, an increase of one level in parents' occupation which was measured under six category (1-never worked for pay, 2-general laborer, 3-skilled worker, 4-clerical, 5-small business owner, 6-professional) led to the increases in the average achievements by 2.96, 5.13, 4.26 and 8.24 points for the schools of the urban, suburban, medium-size city and village areas correspondingly. It seems that parents' occupation level explained the achievement most in the village schools. The early numeracy activities before school by family was the other significant predictor of math achievement. It seems that encouraging children conduct numerical activities before school is beneficial for their future math success in the schools of all settlements.The results revealed that an increase of one scale-point within the early numeric activities before school raised average achievements by 4.41, 6.08, 3.99 and 5.29 points for the schools located within the urban, suburban, medium-size city and village areas respectively. The highest contribution to achievement was obtained in the suburban schools.

School-related factors

The final research question was which of the school-related factors significantly explain 4th grade students' math achievement when the student, family and school-related factor sets were added over and above the other(s) by location of the school in Turkey. As Table 3 indicates, only the school emphasizes on academic success had significant

contribution to achievement in all settlement schools except that of the medium-size city (urban: $t_{(2147)}=2.21$, $p<0.05$, suburban: $t_{(757)}=2.66$, $p<0.05$, medium-size city: $t_{(1382)}=1.88$, $p>0.05$ and village $t_{(542)}=2.23$, $p<0.05$). It seems that an increase of one level in the school emphasizes led to the increases of 3.09, 9.34 and 17.49 points in the schools of urban, suburban, and village areas repectively. The highest contribution was obtained in the village and the least one was obtained in the urban schools. Table 3 also indicates that, the school composition by student background independently had significant contributions to math achievements in both of the schools located in the medium-size city and village areas respectively. Namely, the variable of the school composition by student background was measured using three categories (1-more disadvantaged, 2-neither more affluent nor more disadvantaged, 3-more affluent). The results revealed that, in the medium-size and village schools, the students who are more affluent tend to have 16.69 and 14.34 points higher achivements than those who are less affluent repectively. Finally, the school discipline problems made significant contribution to achievement in the schools located within the urban area only. It revealed that as the school discipline problem increases one degree, students' average math achievement in the urban schools decreases by 3.97 points.

Discussion and conclusions

This study aimed to investigate the relative effects of the student, family and school-related characteristics on 4th grade students' math achievement according to location of the school in Turkey. The results showed that, the highest amount of variance in achievement was accounted for the schools of the village (52%) and the least one was obtained in those of the urban (44%) when the student, family and school-related characteristics were added over and above the other(s) in the final models. All of the student, family and school-related characteristic sets made significant contributions to the prediction of math achievement in all school locations.

One of the significant findings of the current research is that, in all locations, the student-related characteristics accounted for the highest amount of variance in math achievement whereas the school-related characteristics explained the least. This finding is consistent with those of the previous research (Engin-Demir, 2009; Oral & McGivney, 2014; Yavuz et al., 2016) and contradicts with those of others (Heyneman & Loxley, 1983; Wößmann, 2003). The study conducted by Engin-Demir (2009) reports that the set of variables categorized as student characteristics accounted for 15% of the variance of primary school students' academic achievement in the slums of Ankara province. The author added that remaining 5.4% and 4.3% of the variance were explained by the family and school-related variables correspondingly. Likewise, in the study of Yavuz et al. (2016), 91% of the variance in math achievement was due to student characteristics and only 9% of that resulted from school characteristics. In their study, Oral and McGivney (2014) report that the individual characteristics made the greatest difference in academic achievement, but the effect of school characteristics was found to be insignificant. According to Coleman Report and many subsequent studies, the school explains only a limited portion of academic achievement and the effect of school parameters on students' success is negligible (Oral & McGivney, 2014). On the other hand, Heyneman and Loxley (1983) and Wößmann (2003) claim that schools have an important role in

supporting academic success. Even, in the study of Heyneman and Loxley (1983), the impact of school resources on academic achievement far exceeded that of individual characteristics.

The results revealed that the student-related characteristics made the highest contribution to the math achievement in the schools of the village (43%) and the least in those of the urban (31%) by itself. When the family-related characteristics were added on the student-related characteristics, it added the highest variance to the achievement in the schools of both the suburban and medium-size city (12%), and the least in those of the village (5%). This outcome in both of the suburban and medium-size city schools may be explained with the family properties living in these regions. In the literature, it is stated that these regions are usually inhabited by families migrated from the countryside, with lower incomes and lower education levels and the families desire to change their socio-cultural and economic conditions (Açıkalın, 2008). Since education is the most important tool enabling individuals have vertical social mobility in society, the parents are willing to educate their children. They have positive attitudes and high expectations about their children's education (Kadıoğlu Ateş & Adam, 2016) and believe that children will have better living conditions thanks to education (Kongar, 1999). Similarly, the lower effects of the family characteristics on math achievement in the schools of the village can be attributed to socio-cultural and economic barriers. The parents' educational level is generally low in the villages. The descriptive results showed that only 2% of the parents in the village graduated from university or higher education, but 67.7% of them graduated from some primary, lower secondary or not attended any school. It is thought that parents' low levels of education can also lower the value attributed to education within the family. This can affect the forms of support provided due to the inadequacies and limitations of families in creating the environment for educational success as Alokan et al. (2013) claim. The study of Karaca and Gür (2004) supports this idea. In their study, most of the parents in the village have stated that they are unable to support their children academically at home because they lack the necessary knowledge and skills.

The other remarkable finding of the current study is that when the school characteristics were added on the student and family-related characteristics, it added almost small amounts of contributions to the math achievement (4% for the village, 3% for the urban, 2% for both the urban and medium-size city schools). Even, the highest contribution was made in the village schools. This finding supports the previous research (Tatar, 2006) which reports that the school characteristics are more effective on the achievements of students from low socioeconomic backgrounds. Namely, it is thought that openness and deprivation in the villages within the context of familial characteristics may have increased the effect of the school characteristics on achievement in this settlement schools. The relatively higher effect of the school characteristics on achievement of the village schools suggests that the schools may have the power to compensate the disadvantages related to the socioeconomic background. It is also noteable to point out the necessity of using the school as an opportunity in policies aimed at reducing the success differences between school locations.

The results point out that the self-confidence among the student-related characteristics made the highest contribution to the achievement in all school locations. This finding is consistent with those of national (Akyüz, 2014) and international (Chiu & Klassen,

2010; Chowa et al., 2015; Ker, 2016; Singh et al., 2002) studies which all conclude that the student's self-efficacy and self-confidence are significant predictors of math achievement. Similarly, the variable of the how often absent from school was the other most negative significant predictor for the math achievement in the schools of all settlements. The findings revealed that as the frequency of absenteeism decreased, the math achievement increased. This outcome supports the results of previous research (Altınkurt, 2008; Lavy, 2010) which report positive relationship between the frequency of school attendance and success at all levels of education. The other finding revealed that the variable of the early numeracy task was the significant predictor for math achievement in each school location, especially in the village area. The significant finding suggests supplying children with activities including numeracy tasks.

Another remarkable outcome is that when only the student-related characteristics were used, the variable of the attending preschool was found to be significant predictor for the math achievement in both of the urban and medium-size city schools rather than those of the suburban and village. But, when the family and school-related characteristics were added to the models, the significance of the attending preschool was lost. As known, the preschool education aims to prepare child for upper education in terms of cognitive, affective, social and dynamic aspects. But, Harman and Çeliker (2012) present that the child's readiness does not depend on only the preschool education, it also depends on lots of other factors such as the family, family environment, physical structure of the house, parents' highest education level and socioeconomic level of the family. Hence, the introduction of the family and school-related variables may have removed the significant impact of the preschool education on math achievement in the schools of the urban and medium-size city.

This study revealed that both of the parents' highest education and occupation levels are significant predictors for math achievement in the schools of all locations. In other words, students who have parents with higher education and higher occupation levels tend to have higher math achievement. This finding is consistent with those of the studies conducted in Turkey (Akyüz, 2014) and other countries (Bacolod & Tobias, 2005; Carnoy et al., 2015) in terms of parents' education level. It is thought that the higher education level increases the likelihood of a person having a better profession, a better job income and marrying someone with a better education level. Having more educated parents may provide relatively better socioeconomic and cultural level, in turn a higher quality of academic support (Alokan et al., 2013; Kudari, 2016; McNeal, 1999). The results also indicated that the variable of the early numeric activities before school was another significant predictor of math achievement. It seems that the relative impact of the variable was highest in the schools of the suburban and lowest in those of the urban and medium-size city areas in the final models. There is an interesting situation; although the percentage of students having early numeric activities is lower (8.6%) in the schools of the suburban than those of the urban (9.4%) and medium-size city (9.2%), the impact of this predictor is higher in the suburban schools. This contradictory result should be investigated in further studies.

The results also showed that the contribution of the set of the school-related characteristic to math achievement was significant for the schools in all settlements even it was added as the last entry into the regression model. But, amoung the four variables, only

the school emphasize on academic success was found to be significant predictor in all locations except the medium-size city area. This outcome is consistent with the findings of previous research (Cassity, 2012; Kirby & DiPaola, 2011; Oral & McGivney, 2014). Cassity (2012) found a positive relationship between academic emphasis and student achievement. Similarly, Kirby and DiPaola (2011) report that school's academic emphasis had a strong impact on student's math achievement. Likewise, Yavuz et al. (2017) found positive effect of the emphasis on math success. In addition, Oral and McGivney (2014) conclude that high academic emphasis of the school increases the probability of students to perform better. Findings also indicated that the relative effect of the school emphasis on achievement seems to be greater in the village schools. This outcome supports the previous research (Hoy & Sabo, 1998; Shouse, 1998) which report that schools with strong academic emphasis affect positively the success of disadvantaged students. Similarly, Goddard et al. (2000) found that a one-unit increase in the academic emphasis score of a school, where disadvantaged students attended, leads to an increase of 16.53 points in math achievement. It is thought that academic emphasis is a social perception that supports teaching and learning in schools. This perception creates a school environment that increases the likelihood of both teachers and students to persist in academic efforts. Teachers set high achievable goals, believe students will succeed, take responsibility for students' success and are not disappointed with the problems they encounter (Goddard et al., 2000). Therefore, the result of the current research suggests that academic emphasis may be an important opportunity to increase math success within disadvantaged schools located in the villages and to reduce the math achievement differences between schools located in different residential areas.

This study highlights that there is a negative significant relationship between the frequency of discipline problems in schools and math achievement in the schools of urban area which supports the previous research (Simith, cited by Kılıç, 2015; Warren, 2007). In the study of Warren (2007), a negative significant correlation was found between student discipline problems such as drug use, violence, fighting, armed assault and math achievement. According to Simith (2005 cited by Kılıç, 2015) the higher effect of the discipline problems on math achievement may be attributed to the higher average number of punishments per student in urban schools. It is thought that, the probability of encountering large schools with crowded classes increases in the urban centers due to the population density. As Slate and Jones (2005) claim, the population density can make student control difficult, create a basis for the emergence of disciplinary problems in school and raise the possibility of encountering more disciplinary problems. Therefore, decreasing student population in classes of urban schools may reduce discipline problems and increase math performance.

The current research examined the relative effects of the student, family and school-related characteristics on 4th graders' math achievement according to location of the school in Turkey based on TIMSS-2015 data. The results revealed that the entire models explained the largest amount of variance in the schools of village area and the least one in those of urban area. In the schools of all locations, the set of the student characteristics explained the largest amount of variance, but that of the school characteristics explained the least amount of variance in math achievement when the student, family and school-related factor sets were added over and above the other(s). Students'

confidence in math contributed almost the highest amount of variance in the schools located everywhere. Early numeracy tasks, absenteeism in school, parents' highest education level, parents' highest occupation level and early numeric activities before school also explained small amounts of variance in students' math achievement in the schools of all residential areas. But, although the current research explained certain amounts of variance in math achievement in the schools of all locations, it seems that there are still other factors that can explain the reaming variance.

Implications

It is expected that the findings of the current study make significant contributions to the literature. The results suggest that it would be beneficial to increase the number of in-class and out-of-class activities that will protect and develop students' self-confidence in math. School administrators may set goals that will increase the emphasis on academic achievement. In addition, some precautions can be taken to reduce absenteeism in the schools. It seems that there are other foctors explaining students' math achievement in the schools of all locations. Further studies should investigate them and would compensate this gap by considering the other potential predictors. Besides, similar studies can be conducted to establish causal connections between the variables that are questioned with different grade levels and their results are compared with the findings of the current research.

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Authors' contributions
All authors contributed equally to the article. All authors read and approved the final manuscript.

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Declarations

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Competing interests
The authors declare that they have no competing interests.

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References

Açıkalın, N. (2008). Yoksulluk ve genç kuşakların toplumsal hareketlilik olanakları: İstanbul ve Gaziantep örnekleri. *Çalışma Ve Toplum, Ekonomi Ve Hukuk Dergisi, 2*, 131–154.
Adak, N. (2017). Türkiye'de aile kurumu ve nüfusla ilgili sorunlar. İçinde Türkiye'nin toplumsal yapısı. In Z. Sungur Taşdemir (Ed.). (ss.66–93). Anadolu Üniversitesi.
Adeogun, A. A., & Osifila, G. I. (2008). Relationship between educational resources and students' academic performance in Lagos State Nigeria. *International Journal of Educational Management, 5*(6), 144–153.
Akyüz, G. (2014). The effects of student and school factors on mathematics achievement in TIMSS 2011. *Education and Science, 39*(172), 150–162.
Alokan, B. F., Osakinle, O. E., & Onijingin, O. E. (2013). The influence of parents' education background and study facilities on academic performance among secondary school students. *Ozean Journal of Social Science, 6*(2), 27–33.
Altınkurt, Y. (2008). The reasons for students irregular attendance and the effect on this students irregular attendance on their academic achievement. *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi, 20*(1), 129–142.
Ataç, E. (2019). Modeling educational inequalities: Class, academic achievement, and regional differences in Turkey. *Education and Urban Society, 51*(5), 659–692.
Bacolod, M., & Tobias, J. (2005). *Schools, school quality and academic achievement: Evidence from the Philippines (No. 12249)*. Iowa State University, Department of Economics.
Bailey, D. H., Siegler, R. S., & Geary, D. C. (2014). Early predictors of middle school fraction knowledge. *Developmental Science, 17*(5), 775–785.
Bassey, S. W., Joshua, M. T & Asim, A. E. (2011). *Gender differences and mathematics achievement of rural senior secondary students in Cross River State, Nigeria*. Mathematics Connection. 10.
Bosker, R. J., & Witziers, B. (1996). *The magnitude of school effects, or: Does it really matter which school a student attends*. In Annual meeting of the American Educational Research Association, New York.
Butt, I. H., & Dogar, A. H. (2014). Gender disparity in mathematics achievement among the rural and urban high school students in Pakistan. *Pakistan Journal of Social Sciences (PJSS), 34*(1), 93–100.
Byrnes, J. P., & Wasik, B. A. (2009). Factors predictive of mathematics achievement in kindergarten, first and third grades: An opportunity–propensity analysis. *Contemporary Educational Psychology, 34*(2), 167–183.
Canatan, K., & Yıldırım, E. (2009). *Aile sosyolojisi*. Açılım Kitap.
Carnoy, M., Khavenson, T., & Ivanova, A. (2015). Using TIMSS and PISA results to inform educational policy: A study of Russia and its neighbors. *Compare: A Journal of Comparative and International Education, 45*(2), 248–271.
Cassity, A. H. (2012). *Relationships among perceptions of professional learning communities, school academic optimism, and student achievement in Alabama middle and high schools.* Unpublished doctoral dissertation, University of Alabama, Tuscaloosa.
Chevalier, A., & Lanot, G. (2002). The relative effect of family characteristics and financial situation on educational achievement. *Education Economics, 10*(2), 165–181.
Chiu, M. M., & Klassen, R. M. (2010). Relations of mathematics self-concept and its calibration with mathematics achievement: Cultural differences among fifteen-year-olds in 34 countries. *Learning and Instruction, 20*(1), 2–17.
Chohan, B. I., & Khan, R. M. (2010). Impact of parental support on the academic performance and self concept of the student. *Journal of Research and Reflections in Education, 4*(1), 14–26.
Chowa, G. A. N., Masa, R. D., Ramos, Y., & Ansong, D. (2015). How do student and school characteristics influence youth academic achievement in Ghana? A hierarchical linear modeling of Ghana Youth save baseline data. *International Journal of Educational Development, 45*, 129–140.
Christenson, S. L. (2004). The family-school partnership: An opportunity to promote the learning competence of all students. *School Psychology Review, 33*(1), 83–104.
Dinçer, M. A., & Uysal Kolaşin, G. (2009). *Türkiye'de öğrenci başarısında eşitsizliğin belirleyicileri*. Sabancı Üniversitesi Eğitim Reformu Girişimi.
Earthman, G. I. (2002). *School facility conditions and student academic achievement*. Los Angeles: UCLA's Institute for Democracy, Education, and Access (IDEA).
Engin-Demir, C. (2009). Factors influencing the academic achievement of the Turkish urban poor. *International Journal of Educational Development, 29*(1), 17–29.
ERG. (2017). *Türkiye'de erken çocukluk bakımı ve okul öncesi eğitime katılım*. İstanbul: Sabancı Üniversitesi.
European Commission. (2011). *Mathematics education in Europe: Common challenges and national policies*. Retrieved from https://doi.org/10.2797/72660
Fantuzzo, J., Tighe, E., & Childs, S. (2000). Family Involvement Questionnaire: A multivariate assessment of family participation in early childhood education. *Journal of Educational Psychology, 92*(2), 367.
Farkas, G., Grobe, R. P., Sheehan, D., & Shuan, Y. (1990). Cultural resources and school success: Gender, ethnicity, and poverty groups within an urban school district. *American Sociological Review, 55*, 127–142.
Farooq, M. S., Chaudhry, A. H., Shafiq, M., & Berhanu, G. (2011). Factors affecting students' quality of academic performance: A case of secondary school level. *Journal of Quality and Technology Management, 7*(2), 1–14.
Ferreira, F. H. G., Gignoux, J., & Aran, M. (2010). *Measuring inequality of opportunity with imperfect data the case of Turkey*. The World Bank. Policy Research Working Paper 5204.

Field, A. (2009). *Discovering statistics using SPSS*. Sage Publications.
Fredriksson, P., & Öckert, B. (2008). The supply of skills to the teacher profession. *Scandinavian Journal of Economics, 110*(2), 277–296.
Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2012). Experimental and quasi-experimental studies of inquiry-based science teaching. *Review of Educational Research, 82*(3), 300–329.
Geary, D. C., Hoard, M. K., Nugent, L., & Bailey, D. H. (2013). Adolescents' functional numeracy is predicted by their school entry number system knowledge. *PLoS ONE, 8*(1), e54651.
Gershenson, S., Jacknowitz, A., & Brannegan. A. (2014). Are student absences worth the worry in U.S. primaryschools? (Working paper). American University.
Gersten, R., Jordan, N. C., & Flojo, J. R. (2005). Early identification and interventions for students with mathematics difficulties. *Journal of Learning Disabilities, 38*(4), 293–304.
Giambona, F., & Porcu, M. (2015). Student background determinants of reading achievement in Italy. A quantile regression analysis. *International Journal of Educational Development, 44*, 95–107.
Goddard, R. D., Sweetland, S. R., & Hoy, W. K. (2000). Academic emphasis of urban elementary schools and student achievement in reading and mathematics: A multilevel analysis. *Educational Administration Quarterly, 36*(5), 683–702.
Gottfried, M. A. (2014). Chronic absenteeism and its effects on students' academic and socioemotional outcomes. *Journal of Education for Students Placed at Risk (JESPAR), 19*(2), 53–75.
Green, S. B., Salkind, N. J., & Akey, T. M. (2000). *Using SPSS for windows: Analyzing and understanding data* (2nd ed.). Prentice Hall.
Güvendir, M. A. (2014). Student and school characteristics' relation to Turkish achievement in student achievement determination exam. *Education and Science*, *39*(172).
Hannover Research. (2016). *Early skills and predictors of academic success*. Hannover Research. Retrieved from https://portal.ct.gov/-/media/SDE/ESSA%20Evidence%20Guides/Early_Skills_and_Predictors_of_Academic_Success.
Harju-Luukkainen, H., Vettenranta, J., Wang, J., et al. (2020). Family related variables effect on later educational outcome: a further geospatial analysis on TIMSS 2015 Finland. *Large-Scale Assessments in Education, 8*, 3. https://doi.org/10.1186/s40536-020-00081-2
Harman, G., & Çeliker, D. (2012). Eğitimde hazır bulunuşluğun önemi üzerine bir derleme çalışması. *Eğitim Ve Öğretim Araştırmaları Dergisi, 1*, 147–156.
Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses related to achievement*. Routledge, Taylor and Francis Group.
Hedges, L. V., Pigott, T. D., Polanin, J. R., Ryan, A. M., Tocci, C., & Williams, R. T. (2016). The question of school resources and student achievement: A history and reconsideration. *Review of Research in Education, 40*(1), 143–168.
Heyneman, S. P., & Loxley, W. A. (1983). The effect of primary-school quality on academic achievement across twenty-nine high-and low-income countries. *American Journal of Sociology, 88*(6), 1162–1194.
Holzberger, D., Reinhold, S., Lüdtke, O., & Seidel, T. (2020). A meta-analysis on the relationship between school characteristics and student outcomes in science and maths-evidence from large-scale studies. *Studies in Science Education, 56*(1), 1–34.
Hoxby, C. M. (2000). The effects of class size on student achievement: New evidence from population variation. *The Quarterly Journal of Economics, 115*(4), 1239–1285.
Hoy, W. K., & Sabo, D. J. (1998). *Quality middle schools: Open and healthy*. Corwin Press.
Hurn, C. J. (1993). *The limits and possibiliteis of schooling: An introduction to the sociology of education* (3rd ed.). Allyn and Bacon.
Juma, L. S. A., Simatwa, E. M. W., & Ayodo, T. M. O. (2012). Impact of family socio-economic status on girl students' academic achievement in secondary schools in Kenya: A case study of Kisumu East District. *Educational Research, 3*(3), 297–310.
Kadıoğlu Ateş, H., & Adam, E. (2016). Gecekondu araştırması. *Çekmece Izü Sosyal Bilimler Dergisi, 4*(8–9), 349–373.
Karaca, D., & Gür, H. (2004). *Köy ve şehir yerleşim yerlerindeki ailelerin matematik öğretimine katılımı. Balıkesir Üniversitesi*. V. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi. Retrieved from http://www.fedu.metu.edu.tr/ufbmek-5/b_kitabi/b_kitabi.htm.
Karip, E. (2007). İlköğretimde kalite: Avrupa Birliği kalite göstergeleri çerçevesinde kalitenin değerlendirilmesi. In İS. Özdemir, H. Bacanlıve, & M. Sözer (Eds.), *Türkiye'de okul öncesi eğitim ve ilköğretim sistemi temel sorunlar ve çözüm önerileri* (pp. 211–268). Ankara: TED Yayınları.
Ker, H. W. (2016). The effects of motivational constructs and engagements on mathematics achievements: A comparative study using TIMSS 2011 data of Chinese Taipei, Singapore, and the USA. *Asia Pacific Journal of Education, 37*(2), 135–149.
Kılıç, Y. (2015). An empirical study on the relationship between school size and discipline in secondary education in Turkey. *Kuram Ve Uygulamada Eğitim Yönetimi, 21*(1), 51–68.
Kirby, M. M., & DiPaola, M. F. (2011). Academic optimism and community engagement in urban schools. *Journal of Educational Administration, 49*(5), 542–562.
Kongar, E. (1999). *Turkey in 21st century: The social structure of Turkey in 2000s* (16th ed.). Remzi Kitapevi.
Kraft, M. A., & Dougherty, S. M. (2013). The effect of teacher–family communication on student engagement: Evidence from a randomized field experiment. *Journal of Research on Educational Effectiveness, 6*(3), 199–222.
Kudari, J. M. (2016). Survey on the factors influences the students' academic performance. *International Journal of Emerging Research in Management and Technology, 5*(6), 30–36.
Kyriakides, L., Stylianou, A., & Menon, M. E. (2019). The link between educational expenditures and student learning outcomes: Evidence from Cyprus. *International Journal of Educational Development, 7*, 102081.
Lavy, V. (2010). *Do differences in school's instruction time explain international achievement gaps in math, science, and reading? Evidence from developed and developing countries*. NBER working papers.

Lee, C.-Y., & Kung, H.-Y. (2018). Math self-concept and mathematics achievement: Examining gender variation and reciprocal relations among Junior High School Students in Taiwan. *Eurasia Journal of Mathematics, Science and Technology Education, 14*(4), 1239–1252. https://doi.org/10.29333/ejmste/82535
Lee, K., Ning, F., & Goh, H. C. (2014). Interaction between cognitive and non-cognitive factors: The influences of academic goal orientation and working memory on mathematical performance. *Educational Psychology, 34*(1), 73–91.
Lehrl, S., Ebert, S., Blaurock, S., Rossbach, H. G., & Weinert, S. (2020). Long-term and domain-specific relations between the early years home learning environment and students' academic outcomes in secondary school. *School Effectiveness and School Improvement, 31*(1), 102–124.
Lu, L., Weber, H. S., Spinath, F. M., & Shi, J. (2011). Predicting school achievement from cognitive and non-cognitive variables in a Chinese sample of elementary school children. *Intelligence, 39*(2–3), 130-140.3.
Mancebon, M. J., & Molinero, C. M. (2000). Performance in primary schools. *Journal of the Operational Research Society, 51*(7), 843–854.
Marchesi, A., & Martin, E. (2002). Evaluation in secondary education. Snapshot from a controversial era. Institution IDEA, Madrid.
Marks, G. N. (2006). Are between-and within-school differences in student performance largely due to socio-economic background? Evidence from 30 countries. *Educational Research, 48*(1), 21–40.
McCoach, D. B. (2010). Hierarchical linear modeling. *The reviewer's guide to quantitative methods in the social sciences*, 123–140.
McNeal, R. B. (1999). Parental involvement as social capital: Differential effectiveness on science achievement, truancy, and dropping out. *Social Forces, 78*(1), 117–144.
MEB. (2005). *PISA 2003 projesi ulusal nihai rapor*. [PISA 2003 project national final report.] MEB yayınları.
MEB. (2019). *Millî Eğitim Bakanlığı okul öncesi eğitim ve ilköğretim kurumları yönetmeliğinde değişiklik yapılmasına dair yönetmelik*. Retrieved from https://www.resmigazete.gov.tr/eskiler/2019/07/20190710-6.htm.
Mickelson, R. A., Bottia, M. C., & Lambert, R. (2013). Effects of school racial composition on K–12 mathematics outcomes: A metaregression analysis. *Review of Educational Research, 83*(1), 121–158.
Mohammadpour, E. (2013). A three-level multilevel analysis of Singaporean eighth-graders science achievement. *Learning and Individual Differences*. https://doi.org/10.1016/j.lindif.2012.12.005
Mullis, I. V., Martin, M. O., Foy, P., & Arora, A. (2012). *TIMSS 2011 international results in mathematics* (pp. 139–171). Chestnut Hill: TIMSS & PIRLS International Study Center.
Muola, J. M. (2010). A study of the relationship between academic achievement motivation and home environment among standard eight pupils. *Educational Research and Reviews, 5*(5), 213–217.
Murillo, J., & Román, M. (2011). Latin America: School bullying and academic achievement. *Cepal Review*.
Nartgün, Ş, & Çakır, M. (2014). Causes of conflict in the classroom at technical and vocational high schools (Tuzla Case). *Journal of Research in Education and Teaching, 3*(3), 379–391.
OECD. (2009a). *PISA 2009 results: What students know and can do-student performance in reading, mathematics and science* (Vol. I). OECD Publishing.
OECD. (2009b). *PISA 2009 results: Overcoming social background equity in learning opportunities and outcomes* (Vol. II). OECD Publishing.
OECD. (2018). *Equity in education: Breaking down barriers to social mobility*. Organisation for Economic Co-operation and Development OECD.
OECD. (2019). *PISA 2018 results (Volume II): Where all students can succeed*. PISA, OECD Publishing. https://doi.org/10.1787/b5fd1b8f-en
Ölçüoğlu, R., & Çetin, S. (2016). TIMSS 2011 sekizinci sınıf öğrencilerinin matematik başarısını etkileyen değişkenlerin bölgelere göre incelenmesi. *Eğitimde Ve Psikolojide Ölçme Ve Değerlendirme Dergisi, 7*(1), 202–220.
Önder, E. (2016). Okulların eğitsel kaynakları ve TEOG puanları. *Elektronik Sosyal Bilimler Dergisi, 15*(58), 837–848.
Önder, E., & Uyar, Ş. (2018). Factors affecting the academic achievement in socioeconomically disadvantaged students. *Pegem Eğitim Ve Öğretim Dergisi, 8*(2), 253–280.
Oral, I., & McGivney, E. J. (2014). *Türkiye eğitim sisteminde eşitlik ve akademik başarı araştırma raporu ve analiz [Equity research reports and academic achievement and analysis of the education system in Turkey]*. ERG Yayınları.
Oral, I., Yaşar, D., & Tüzün, I. (2016). *Her çocuğa eşit fırsat: Türkiye'de erken çocukluk eğitiminin durumu ve öneriler*. Anne Çocuk Eğitim Vakfı (AÇEV) ve Eğitim Reformu Girişimi (ERG).
Özer, Y., & Anıl, D. (2011). Öğrencilerin fen ve matematik başarılarını etkileyen faktörlerin yapısal eşitlik modeli ile incelenmesi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 41*(41), 313–324.
Pallant, J. (2010). *SPSS survival manual. "A step by step guide to data analysis using SPSS."* McGraw-Hill Education.
Papanastasiou, C. (2000). Effects of attitudes and beliefs on mathematics achievement. *Studies in Educational Evaluation, 26*(1), 27–42.
Pitsia, V., Biggart, A., & Karakolidis, A. (2017). The role of students' self-beliefs, motivation and attitudes in predicting mathematics achievement: A multilevel analysis of the Programme for International Student Assessment data. *Learning and Individual Differences, 55*, 163–173.
Quin, D. (2017). Longitudinal and contextual associations between teacher–student relationships and student engagement: A systematic review. *Review of Educational Research, 87*(2), 345–387.
Ramos, R., Duque, J. C., & Nieto, S. (2016). Decomposing the rural-urban sifferantial in student achievement in Colombia using PISA microdata. *Estudios the Economia Aplicada, 2*(34), 379–412.
Ribner, A. D., Willoughby, M. T., & Blair, C. B. (2017). Executive function buffers the association between early math and later academic skills. *Frontiers in Psychology, 8*, 869.
Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica, 73*(2), 417–458.
Rohatgi, A., & Scherer, R. (2020). Identifying profiles of students' school climate perceptions using PISA 2015 data. *Large-Scale Assessments in Education, 8*, 4. https://doi.org/10.1186/s40536-020-00083-0
Ross, T., Kena, G., Rathbun, A., KewalRamani, A., Zhang, J., Kristapovich, P., & Manning, E. (2012). *Higher education: Gaps in access and persistence study. statistical analysis report*. NCES 2012-046. National Center for Education Statistics.

Rutkowski, L., Gonzalez, E., Joncas, M., & von Davier, M. (2010). International large-scale assessment data: Issues in secondary analysis and reporting. *Educational Researcher, 39*, 142–151.
Şad, S. N. (2012). Investigation of parental involvement tasks as predictors of primary students' Turkish, math, and science and technology achievement. *Eğitim Araştırmaları-Eurasian Journal of Educational Research, 49*, 173–196.
Sarı, M., Arıkan, S., & Yıldızlı, H. (2017). Factors predicting mathematics achievement of 8th graders in TIMSS 2015. *Journal of Measurement and Evaluation in Education and Psychology, 8*(3), 246–265. https://doi.org/10.21031/epod.303689
Sarouphim, K. M., & Chartouny, M. (2017). Mathematics education in Lebanon: Gender differences in attitudes and achievement. *Educational Studies in Mathematics, 94*(1), 55–68.
Schmitt, M., & Kleine, L. (2010). The influence of family-school relations on academic success. *Journal for Educational Research Online, 2*(1), 145–167.
Semeraro, C., Giofrè, D., Coppola, G., Lucangeli, D., & Cassibba, R. (2020). The role of cognitive and non-cognitive factors in mathematics achievement: The importance of the quality of the student-teacher relationship in middle school. *PLoS ONE, 15*(4), e0231381.
Shouse, R. C. (1998). Restructuring's impact on student achievement: Contrasts by school urbanicity. *Educational Administration Quarterly, 34*, 677–699.
Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *The Journal of Educational Research, 95*(6), 323–332.
Siraj-Blatchford, I. (2010). A focus on pedagogy: Case studies of effective practice. In *Early childhood matters* (pp. 165–181). Routledge.
Şirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research, 75*(3), 417–453.
Slate, J. R., & Jones, C. H. (2005). Effects of school size: A review of the literature with recommendations. *Essays in Education, 13*(1), 1–24.
Smits, J. (2007). *Parents' investments in children's education in Morocco, Algeria, Tunisia, Egypt and Syria*. NICE Working Paper, Radboud University.
Tabachnik, B. G., & Fidell, L. S. (2013). *Using multivariate statistics* (6th ed.). Pearson.
Takashiro, N. (2017). A multilevel analysis of Japanese middle school student and school socioeconomic status influence on mathematics achievement. *Educational Assessment, Evaluation and Accountability, 29*(3), 247–267.
Taslidere, E. (2020). Factors affecting 12th-grade students' physics achievement. *Psychology in Schools, 57*(9), 1385–1403.
Tatar, M. (2006). Okul ve öğretmenin öğrenci başarısı üzerindeki etkisi. *Milli Eğitim, 171*, 156–166.
Thapa, A., Cohen, J., Guffey, S., & Higgins-D'Alessandro, A. (2013). A review of school climate research. *Review of Educational Research, 83*(3), 357–385.
TIMSS. (2015). *TIMSS 2015 International database*. Retrieved from https://timssandpirls.bc.edu/timss2015/international-database.
Tomul, E., & Savasci, H. S. (2012). Socioeconomic determinants of academic achievement. *Educational Assessment, Evaluation and Accountability, 24*(3), 175–187.
TUIK. (2013). *İstatistik göstergeler 1923–2012*. Türkiye İstatistik Kurumu.
TUIK. (2014). *Gelir ve yaşam koşulları araştırması. Haber bülteni*. Türkiye İstatistik Kurumu.
Wang, Z., Osterlind, S. J., & Bergin, D. A. (2012). Building mathematics achievement models in four countries using TIMSS 2003. *International Journal of Science and Mathematics Education, 10*(5), 1215–1242.
Warren, A. F. (2007). *The relationship between reported incidents of student discipline and student achievement across four eastern states*. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University Blacksburg, Virginia.
Watts, T. W., Duncan, G. J., Siegler, R. S., & Davis-Kean, P. E. (2014). What's past is prologue: Relations between early mathematics knowledge and high school achievement. *Educational Researcher, 43*(7), 352–360.
Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology, 25*(1), 68–81.
World Bank. (2011). *Improving the quality and equity of education in Turkey, challenges and options*. Human Development Department, Europe and Central Asia Region.
World Bank. (2012). *Expanding and ımproving early childhood education in Turkey*. World Bank.
Wößmann, L. (2003). Schooling resources, educational institutions and student performance: The international evidence. *Oxford Bulletin of Economics and Statistics, 65*(2), 117–170.
Yamamoto, Y., & Holloway, S. D. (2010). Parental expectations and children's academic performance in sociocultural context. *Educational Psychology Review, 22*(3), 189–214.
Yavuz, H. Ç., Demirtasli, R. N., Yalçin, S., & Dibek, M. I. (2017). The effects of student and teacher level variables on TIMSS 2007 and 2011 mathematics achievement of Turkish students. *Eduaction and Science, 42*(189).
Yavuz, S., Odabaş, M., & Özdemir, A. (2016). Öğrencilerin sosyoekonomik düzeylerinin TEOG matematik başarısına etkisi. *Eğitimde Ve Psikolojide Ölçme Ve Değerlendirme Dergisi, 7*(1), 85–95.
Yayan, B., & Berberoglu, G. (2004). A re-analysis of the TIMSS 1999 mathematics assessment data of the Turkish students. *Studies in Educational Evaluation, 3*, 87–104.
Zippert, E. L., & Rittle-Johnson, B. (2020). The home math environment: More than numeracy. *Early Childhood Research Quarterly, 50*, 4–15.

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