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The Effects of Student and Teacher Level Variables on TIMSS 2007 and 2011 Mathematics Achievement of Turkish Students *

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Abstract

This study explores the relationship between student characteristics (perception regarding peer bullying, students' confidence in mathematics, students' like learning mathematics and students valuing mathematics) which affect mathematics achievement of eighth grade students in Turkey and teacher characteristics (working conditions of teachers, teacher's emphasis on academic success and collaboration with colleagues in order to enhance teaching) which are dealt with at school level. In this correlational study, 141 teachers and 4498 students were included from the Trends in International Mathematics and Science Study (TIMSS) 2007 and 219 teachers and 6928 students were included from TIMSS 2011. Samples were created with the stratified sampling method. Data collection sources of the study consist of the mathematics achievement tests and student and teacher questionnaires that were used in TIMSS 2007 and 2011 assessments. Study data was analysed with the hierarchical linear modelling (HLM) method. Data for the study was analysed with four HLMs. These models are: (i) Random Effects One Way the Analysis of Variance (ANOVA) Model; (ii) Regression Model in Which Means are Outcomes; (iii) Random Coefficients Model; (iii) Constant and Slope Coefficients as Outcomes. As a result of the analysis conducted to examine the level of relationship of the features regarding mathematics achievement of students at student and school level and the state of these relations between TIMSS 2007-2011 applications, it was found that in both TIMSS periods, eighth grade students' mathematics achievements vary significantly among schools. According to the results of both 2007 and 2011 TIMSS, at school level, student's mathematics achievement has a positive and significant relationship with teacher's emphasis on the

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academic achievement variable. No significant relationship between students' mathematics achievement and teachers' working conditions and teachers' collaboration for improving teaching variables were found in the 2007 and 2011 assessments. Students' performances in TIMSS 2007 and 2011 mathematics exams have a significant relationship with students not being subjected to bullying at school and students' like learning mathematics variables on student level. Students' confidence in mathematics variable has a significant effect in achievements in 2011, which is not the case in 2007 and students valuing mathematics variable does not have a significant relationship with students' mathematics achievement in either year.

Introduction

Students' mathematics achievement is closely related to the future economic performance of countries (Baker & LeTendre, 2005). For this reason, determining reasonable and consistent factors in relation to mathematics achievement and understanding them highly valued by national leaders, policymakers and educators around the world. To that end, leading policy and education organizations arrange international evaluation studies and they publish the educational report cards of countries on both domestic and international platforms. One such evaluation study, the Trends in International Mathematics and Science Study (TIMSS) has been conducted with a growing number of participating countries since 1995 (International Association for Evaluation of Educational Assessment [IEA], 2007). With TIMSS assessments, data is collected once every four years from fourth and eighth grade students in order to determine tendencies in students' mathematics and science achievements. Thus, assessment outcomes provide an opportunity for longitudinal comparisons and enable the observation of developments taking place in the process. Moreover, along with the students' achievements in mathematics and science, the factors affecting these achievements are also examined in this assessment programme. By participating in international assessment programmes such as TIMSS, countries have the opportunity to determine factors that are related to students' mathematics achievement using the achievement results gathered and rich data sets which include other contextual data (Wagemaker, 2003).

As stated in the Benchmarking Introduction of the Trends in International Math and Science Study, "TIMSS results, which were reported for the first time in 1996 caused arguments, led to reform movements and provided educators and decision makers all around the world with important data" (Mullis et al., 1999, p. 16). These data "provide with consistent, trustworthy, thorough and correct indicators regarding the condition of the education and tendency towards achievement" (Stigler, Gonzales, Kawanaka, Knoll, & Serrano, 1999, p. 1). Participating countries therefore make decisions about their education systems according to TIMSS results.

TIMSS results play an important role in Turkey as a participating country. Turkish students' achievement score is below the general average score (500) in TIMSS. The average mathematics achievement score of Turkish students was 432 in TIMSS 2007 (Mullis, Martin, & Foy, 2008), while it was 452 in TIMSS 2011 (Mullis, Martin, Foy, & Arora, 2012). The reasons underlying the low achievement of Turkish students have been the subject of many research studies. Moreover, the effects of characteristics of schools and teachers (e.g., Akyüz, 2014; Akyüz & Berberoğlu, 2010; Buluç, 2014; Tavşancıl & Yalçın, 2015), students' affective features (e.g. Akyüz, 2014; Arıkan, van de Vijver, & Yağmur, 2016; Ölçüoğlu & Çetin, 2016; Tavşancıl & Yalçın, 2015) on students' mathematics achievement have also been investigated.

This study seeks to examine, student characteristics (perception regarding peer bullying at school, confidence in mathematics, students' like learning mathematics and students valuing mathematics) affecting mathematics achievement of eighth grade students in Turkey and teacher characteristics (working conditions of teachers, teachers' emphasis on academic success and collaboration with colleagues in order to enhance teaching) which are approached at school level.

There are a number of reasons why the present study was conducted using data for eight grade students. Firstly, data related to the eighth grade students were analysed considering the importance of the transition period from middle school to high school (Rodriguez, 2004), in which mathematics knowledge and skills that education programmes require are differentiated significantly. Furthermore, as the middle school years are critical years for students in terms of learning mathematics (Reynolds, 1991), this study is designed according to eighth grade students' variables in the context of mathematics. How good students are in mathematics in middle school years determines their achievements in mathematics classes and participation in high school and this situation affects the profession that they will choose in the future. In other words, because mathematics classes advance cumulatively, students' achievement in mathematics classes, which are harder in high school, depends on the achievement in mathematics classes that the students took in the past years (Singh, Grandville, & Dika, 2002).

Student Level Affective Characteristics

Some of the factors affecting mathematics achievements of eighth grade students, who are in a critical period of their lives, are related to students' characteristics. To account for them, this study addresses affective characteristics towards mathematics such as peer bullying at school and confidence in mathematics, students' like learning mathematics and students valuing mathematics, which are among the student level variables in both TIMSS 2007 and 2011 assessments in which Turkey participated.

Some of the most frequent and widespread types of peer bullying, which is included in the scope of the study and an has impact on students' achievement, are; insulting, calling names, hitting, direct violence, theft, threatening and social exclusion (Akyüz, 2014). Studies about peer bullying (Akyüz, 2014; Konishi & Li, 2006; Nishina, Juvonen, & Witkow, 2005; Ponzo, 2013; Roman & Murillo, 2011; Schwartz, Gorman, Nakamoto, & Toblin, 2005) stress that bullying negatively affects students' achievement in classes and students who experience physical and verbal violence in their classes have lower achievements than students who do not come across such situations in their classes.

One of the affective variances that has a great influence on students' achievements is attitude towards mathematics. Neale (1969) defines attitude towards mathematics as enjoying mathematics or not, participating in mathematical activities or avoiding participation, belief in being good or bad at mathematics and beliefs whether mathematics is useful or useless. Based on this definition, the confidence in mathematics variable, being an important component of affective characteristics towards mathematics, is the student believing in himself/herself in learning mathematics and thinking of himself/herself as being good at mathematics (Demir & Kılıç, 2010). Bandura, Barbaranelli, Caprara, and Pastorelli (2001) indicate that students' self-confidence is an important factor and when they do not believe they can obtain the intended results, they will be not able to find the sufficient motivation to cope with difficulties. This affects many situations, varying from the professions that students will choose in the long term to their career plans (Zeldin, Britner, & Pajares, 2008). As for students' self-confidence, it affects students' motivations. Because motivation towards learning contains the sense of being able to achieve, students' self-confidence is closely associated with their motivations, affects their active participation in classes and hence, their achievement (Hansford & Hattie, 1982; Singh, Granville vd., 2002). In this sense, this variable has been the centre of attention for various studies in the field literature, and these both national (Akyüz, 2014; Demir & Kılıç, 2010) and international studies (Arıkan et al., 2016; Chen, 2013) indicate that students' confidence in mathematics affects achievement in a positive way.

Liking mathematics, being one of the affective characteristics that is oriented towards mathematics and related to mathematics achievement consist of the affective and behavioural reactions of students towards their interest in mathematics (Mullis, Martin, Foy, & Arora, 2012). National (Tavşancıl & Yalçın, 2015; Yıldırım, Yıldırım, Ceylan, & Yetişir, 2013) and international studies (Belbase, 2013; Khine, Al-Mutawah, & Afari, 2015) in the literature have reached the conclusion that students who enjoy learning mathematics have higher levels of achievement in mathematics. Students valuing mathematics is another feature of affective characteristics towards mathematics and is dealt with as a student level variable in this study. Students valuing mathematics is related to their external motivation and it states the attitude towards the importance and benefits of mathematics (Wigfield & Eccles, 2000). In a study using hierarchical linear modelling analysis on TIMSS 2011 data which examined the effects of valuing mathematics on fourth and eighth grade students in South Korea, Singapore and Finland, it was found that only for students in South Korea and Singapore valuing mathematics has a positive effect on mathematics achievement (Kim, Park, Park, & Kim, 2013). Likewise, in a study which benefited from TIMSS 2003 data using HLM, it was found that there is a positive relationship between eighth grade students in developed (Canada and the USA) and developing countries (Egypt and South Africa) valuing mathematics and their mathematics achievements (level 1 variables are student background features and home resources, level 2 variables are schools' background features and educational applications) (Phan, Sentovich, Kromrey, Dedrick, & Ferron, 2010). In another HLM study using TIMSS 2011 data, similar results were found (Ker, 2016). In that study, the roles of student level variables (like learning mathematics, attitude towards learning mathematics, self-confidence towards mathematics, engagement with mathematics) and teacher level variables (instruction to engage students in learning) in students' mathematics achievement were examined using data from the USA, China, Taiwan and Singapore.

Nevertheless, for eighth grade students who participated in the 2007 and 2011 assessments of Arıkan et al. (2016) from Turkey and Australia it was shown that their mathematics achievements and students' valuing mathematics do not have a significant relationship. An interesting aspect of the studies conducted is that different results emerge for different countries.

School Level Teacher Characteristics

The most important variable at school level that has influence over students' achievements is teacher characteristics. Variables regarding teachers at school level which are used in this study which are common to both TIMSS 2007 and 2011 assessments are; working conditions of teachers, teachers' emphasis on academic success and teachers' collaboration with colleagues in order to enhance teaching. Working conditions of teachers is important in attachment to school for both students and teachers. The working conditions of teachers have a close relationship with motivations of students and teachers, and impact on students' achievement (Marcondes, 1999). Hirsch and Church (2009) have similarly indicated that working conditions of teachers has an effect on student achievement and teachers' attachment to school. Teachers' emphasis on academic success is closely related to setting high academic goals that can be achieved for students, creating a systematic learning environment and motivating students for studying well (Hoy, Tarter, & Kottkamp, 1991). Studies have pointed out the positive relationship that this variable has with mathematics achievement at every level of the education from primary school to high school (Akyüz, 2014; Goddard, Sweetland, & Hoy, 2000; Hoy, 2012).

Another variable that was analysed in this study is teachers' collaboration in order to improve teaching. In educational settings, teacher collaborations require efforts regarding some important tasks such as instruction (Cha & Ham, 2012). Collaborations between teachers can be conducted in school or out of school by getting counselling from other colleagues. Collaborations between teachers affect their motivation (De Jesus & Lens, 2005), self-confidence (Shachar & Shmuelevitz, 1997), and especially students' learning (Printy, 2008) positively. There are studies which indicate the contribution of teacher collaboration to students' achievement in the field both in national (Demirtaş, 2010) and international literature (Levine & Marcus, 2010; McLaughlin & Talbert, 2006; Pang, 2006). Teachers collaborating in order to enhance the quality of teaching either in preparing lesson plans or in evaluating students'

activities increases students' achievement. At the same time, teachers being in collaboration with organizations related to the profession increases the quality of activities that they implement in teaching and this situation also positively affects students' achievement (Levine & Marcus, 2010).

In a national study, a positive significant relationship was found between teacher collaboration and eight grade students' achievement scores in placement tests implemented in the province of Elazığ (Demirtaş, 2010). Similarly, in an international study (Pang, 2006), interviews conducted with teachers revealed that teacher collaborations for improving teaching affect students' learning positively.

A review of literature shows that TIMSS data have been used frequently to determine the variables affecting students' achievements. There are several studies making international comparisons (e.g. Bofah & Hannula, 2015; Ker, 2016; Marsh et al., 2014; Phan et al., 2010) as well as dealing with only one country (e.g. Akyüz, 2014; Akyüz & Berberoğlu, 2010; Buluç, 2014; Mohammadpour, 2012; Tavşancıl & Yalçın, 2015). The literature also shows that the variables that are dealt with generally have significant effects on students' achievements in different countries.

In the national literature, several studies have performed multilevel analyses (Akyüz, 2014; Akyüz & Berberoğlu, 2010; Tavşancıl & Yalçın, 2015) in addition to structural equation modelling (Arıkan et al., 2016; Ölçüoğlu & Çetin, 2016). However, for student and teacher characteristics related to Turkish students' TIMSS mathematics achievement there has been no study that has addressed the student and teacher characteristics mentioned above simultaneously, that made a comparison between the years 2007 and 2011 and performed multilevel analyses.

There is only one study (Arıkan et al., 2016), which examines how effective these variables were on Turkish students' TIMSS mathematics achievement in the years 2007 and 2011 in a comparative way and addressed some of the variables (confidence in mathematics and students' valuing mathematics) included in this study. According to the result of the study conducted by Arıkan et al. (2016), while there was a statistically significant relationship between students' valuing mathematics and mathematics achievement of Turkish and Australian students who participated in TIMSS and confidence in mathematics was found to have a positive influence on these students' achievement. Considering the existence of only one study, this study will contribute to filling the gap in the literature by addressing the effects of several variables on students' achievement in a comparative way. Additionally, it was found in the literature review that research studies using multilevel data as is the case for the Programme for International Student Assessment (PISA) and TIMSS handled student and school level variables simultaneously at the same level. In fact, with data being multilevel, each level should be handled differently in order to decrease errors in measurements and to get more reliable results (Raudenbush & Bryk, 1992). For these reasons, trends of Turkish students' mathematics achievement in terms of stated student and teacher variables and these variables' effects on mathematics achievement were examined in this study by using a proper statistical approach which is suitable for the aim and data of the study. The following research questions were posed in the study to this end:

1. Are there any significant differences between mathematics achievements of schools which participated in TIMSS 2007 and 2011 studies?
2. If so, what are the teacher characteristics that explain the significant difference between mathematics achievements of schools which participated in the TIMSS 2007 and 2011 study?
3. If so, what are the student characteristics that explain the significant difference between mathematics achievements of schools which participated in the TIMSS 2007 and 2011 study?
4. Which school characteristics have a relation with the student characteristics that explain the significant difference between mathematics achievements of students who participated in the TIMSS 2007 and 2011 study?

Method

Research Model

As it aims to put forward the relationship between teacher and student characteristics with students' mathematics achievement, this study is a correlational study. Correlational studies are studies in which the direction and size of the relationship between more than one variables are determined without an intervention (Lodico, Spaulding, & Voegtle, 2006). Correlational research is important since it provides an understanding of an important phenomenon by examining the relations between variables and makes it possible to use the value of one variable to predict the value of another. Thus, correlational research leads the way in conducting higher order research (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2010).

Sample

The sample of this study is composed of eighth grade students who participated in TIMSS 2007 and 2011 assessments in Turkey and the teachers in these students' schools. Samples in the TIMSS are created using two stage stratified cluster sampling design. In the process of sampling, first schools then classes are chosen by using the systematic random sampling method. The number of students and schools selected for this study according to this procedure are given in Table 1 (Martin & Mullis, 2012; Olson, Martin, & Mullis, 2008).

Table 1. The Number of Students and Schools Participated in the TIMSS 2007 and 2011 from Turkey

Years	Participants	Population	Sample
2007	Schools	16 112	146
	Students	1 163 830	4498
2011	Schools	17 621	239
	Students	1 198 697	6928

Because of the missing values in the data sets, 141 teachers were included in TIMSS 2007 and 219 teachers were included in 2011. The average age of students are 9.5 and 13.5 for fourth and eighth grades respectively.

Data Collection Tools

Data collection tools of the study consist of questionnaires of student and teachers who participated in the TIMSS 2007 and 2011 assessments and mathematics achievement tests. Data about schools and students was obtained from the official website of TIMSS (http://timssandpirls.bc.edu/).

Student and School Questionnaires

Questionnaires in the TIMSS are developed according to standard methods (item development and redaction, pilot study, item analysis and item revision after pilot study, cooperation with experts at each stage, selection of methods providing generalization of the research etc.) by IEA (Martin & Mullis, 2012; Olson et al., 2008).

In the study, questionnaire items which belong to the variables that are common in TIMSS 2007 and 2011 assessments are included from the questionnaires. Variables that are included at student level are: being bullied at school, students' like learning mathematics, students' confidence in mathematics, students valuing mathematics. Variables at the teacher level are: teachers' working conditions, emphasis on academic success, collaboration to improving teaching.

Among student-level variables addressed in TIMSS, the variables *being bullied at school* "I was made to do things I didn't want to do by other students"; *learning mathematics* "I learn many interesting things in mathematics"; *students' confidence in mathematics* "I usually do well in mathematics", and *students valuing mathematics* "I need to do well in mathematics to get into the university of my choice" were measured by such items. Among school-level variables, the variables *teacher working conditions*

"classrooms are overcrowded"; *school emphasis on academic success* "students'desire to do well in school" and *collaboration to improve teaching* "work together to try out new ideas" were measured by such items.

Questionnaire items of these variables and reaction categories are given in Appendix 1.

Matematics Achievement Tests

The development process of the items to be included in the TIMSS achievement tests is coordinated by experts and is prepared within a framework of predetermined objectives. These prepared items are reviewed and open scoring rubrics are prepared. Pilot implementation of the prepared items is carried out in participating countries. Items that are qualified in the psychometric direction are included in the final application (Büyüköztürk, Çakan, Tan, & Atar, 2014).

In this study, data on mathematics achievements of students were obtained from mathematics achievement tests in the TIMSS 2007 and 2011 assessments. Mathematics achievement tests in TIMSS 2007 and 2011 consists of items that belong to four topics which are distributed as follows: 30% numbers, %30 algebra, 20% geometry and 20% data and probability (Martin & Mullis, 2012; Olson et al., 2008). Moreover, 35% of these items are at cognition, 40% at implementation and 25% at reasoning level. The cognitive domain includes recall, computing, recognisition, retrieval, measuring and classification and ordering sub-skills; the implementation domain includes selecting, representation, modelling, implementation and solving routine problems sub-skills and the reasoning domain involves analysis, generalisation/specialisation, integration/synthesis, justification and solving non-routine problems (Mullis, Drucker, Preuschoff, Arora, & Stanco, 2012). A number of items to be included in achievement test are applied in TIMSS assessments. The equivalance of the content and measurement of these items were established. These items were distributed in 14 booklets each of which included 12-18 items (Mullis, Martin, Ruddock, O'Sullivan, & Preuschoff, 2009). Each student was given one of these booklets.

Because the students do not all have the same items in the TIMSS assessments, five different plausible values which show the mathematics achievements of students are produced. In this study, all plausible values in question are used in the analysis of the data as they represent student achievement.

Data Analysis

Data sets were organized before data analysis was conducted. Along with this, index variables that belong to the variables in the scope of the study were created, and analysis on these variables were conducted. Specifically, because number of items regarding common variables that were included in the study differ in TIMSS 2007 and 2011 assessments, in order to provide validity for the implications that were to be obtained from the study, common items that were used for both years and index values of variables that are particular to Turkey were calculated. This calculation was carried out for questionnaire items and an index value was obtained for each student.

The following formula was used in creating new indices (OECD, 2014, p. 352):

$$Index\ value = \frac{\beta_1.x_1 + \beta_2.x_2 + \cdots + \beta_n.x_n}{\varepsilon_i}$$

β_n: Item factor loading

$x_1 \ldots x_n$: Individuals' reponses regarding items of the related variables

ε_i: Eigen value of the first factor

After principal component analysis was performed to determine factor loadings for each item and eigenvalues of the variables, indices of the variables were calculated according to this formula. Factor loading values of the items and Cronbach Alpha coefficients of the index variables are given in Appendix 1. Data of the research was analysed with hierarchic linear modelling (HLM) analysis. HLM is a kind of multiple regression analysis that includes interwoven random effects, and in which multi-layered sample method is used and is the complex form of ordinary least squares regression (Raudenbush & Bryk, 2002). Relations in data sets which are of a multilevel structure can be calculated

with HLM. Standard errors can be identified for each level and variable in HLM. Furthermore, single-level analyses do not take into account the shared variance, whereas HLM handles the shared variances at each level (Woltman, Feldstain, MacKay, & Rocchi, 2012). For these reasons, HLM gives reliable results.

Data of the study was analysed with four HLM models. These models were:

(i) Random Effects One Way ANOVA Model: Whether schools participated in the TIMSS 2007 and 2011 assessments had differences regarding mathematics achievement was analysed with this model.

(ii) Means-as-Outcomes Models: Determination of the school-level variables *(teachers' working conditions, school emphasis on academic success, collaboration to improve teaching)* which are found to have statistically significant effects on mathematics achievement and to be included in the later model "Intercepts and Slopes-as-Outcomes Model" was done with this model.

(iii) Random Coefficients Regression Model: This model was used to explain the individual differences in the students' mathematics achievement scores. In this model, student level variables *being bullied at school, like learning mathematics, confidence in mathematics* and *valuing mathematics* were included. This model was analyzed to determine the variables which are statistically significant and to be included in the late "Intercepts and Slopes- as- Outcomes Model".

(IV) Intercepts and Slopes-as-Outcomes Model: This model originates from the combination of the other models analysed. All significant student level variables and school level variables were included in the models.

After the models were analysed, HLM's assumptions were checked. At this stage, assumption of normality at both levels, homogeneity of variances in the first level and assumption of independence of errors were checked. The hypotheses were met. IBM SPSS Statistics 20 (SPSS, 2011) and HLM 6 (Raudenbush, Bryk, & Congdon, 2004) packages were used to analyse the data.

Findings

Findings Regarding Random Effects One Way ANOVA Model

According to the results of the analysis, the average mathematics achievement score of students who participated in TIMSS 2007 was 440.07. There were significant differences among schools in terms of mathematics achievement ($\chi 2$ (140,2)=3288.21, p<.05). Variance of within-school variability was found to be 7332.20, while between-schools variability was 5851.67. Within-group correlation was determined as .44. In other words, approximately 44% of differences observed in mathematics achievement resulted from the differences in average mathematics achievements among schools.

The average mathematics achievement value of students who participated in TIMSS 2011 was 450.79. Difference between schools regarding mathematics achievement was significant ($\chi 2$ (218, 2)=3073.82, p<.05). Variance of within-school variability was found to be 8403.57 while between-schools variability was 3928.74. Within-group correlation was determined as .32. In other words, approximately 32% of differences observed in mathematics achievement resulted from the differences in average mathematics achievements among schools. In this context, differences in average mathematics achievements among schools were greater in TIMSS 2007.

Findings Regarding Means-as-Outcomes Model

In this model, teacher's working conditions, emphasis on academic success and collaboration in order to enhance teaching are included in the model as second level variables. Results of the model are given in Table 2.

Table 2. Results of Means-As-Outcomes Model

Fixed Effect	**Years**	**Coefficient**	**S.E**	**t-ratio**	**df**	***p*-value**	**Effect Size**
Average mathematics achievement, γ_{00}	2007	440.17	5.57	78.96	137	<0.001	-
	2011	450.87	3.90	115.54	215	<0.001	-
Teacher working conditions, γ_{01}	2007	9.81	7.72	1.27	137	.21	
	2011	-.62	4.13	-.15	215	.88	
Emphasis on academic success, γ_{02}	2007	44.32	6.33	6.70	137	<0.001*	.69
	2011	37.18	5.22	7.13	215	<0.001*	.69
Collaboration to improving teaching, γ_{03}	2007	-12.78	9.80	-1.30	137	.19	
	2011	-2.43	5.12	-.47	215	.63	
Random Effect	**Years**	**sd**	**Variance**	**df**	**χ^2**	***p*-value**	
School level, u_0	2007	64.35	4140.87	137	2302.49	<0.001*	
	2011	53.74	2888.43	215	2301.18	<0.001*	
Student level, r	2007	85.63	7332.66				
	2011	91.67	8403.60				

*Statistically significant at p=.05 level.

According to Table-2, among school level variables in TIMSS 2007 and 2011, only teachers' emphasis on academic success has a statistically significant impact on students' mathematics achievements. This impact is positive and at a medium-level. According to the results, teachers' working conditions and collaboration to improving teaching variables do not have a statistically significant effect on mathematics achievement. For this reason, these variables were not included in the upcoming models. Furthermore, when other variables except for teachers' emphasis on academic success in the TIMSS 2007 are fixed, it was found that teachers' emphasis on academic success causes 29% of change in mathematics achievement performance. As for the TIMSS 2011, when other variables except for teachers' emphasis on academic success are fixed, it is confirmed that teacher's emphasis on academic success causes 26% of change in mathematics achievement performance.

Having a large sample can affect the significance of the results (Fishman & Galguera, 2003). For this reason, when practical significance of the variables in the study is evaluated separately, and if effect size of the teacher's emphasis on academic success variable is addressed for TIMSS 2007 and 2011, it would be expected that an increase of 1 standard deviation in teachers' emphasis on academic success will cause an increase of roughly .69 standard deviation in students' average mathematics achievements. In other words, school emphasis on academic success has a moderate effect on the mathematics achievement of the students.

Findings Regarding Random Coefficients Regression Model

In order to explain individual differences in the change in students' mathematics achievement scores, being bullied at school, students' like learning mathematics, students' confidence in mathematics and students valuing mathematics were included as level-one variables to the random coefficients regression model. Results of the model are given in Table 3.

Table 3. Findings Regarding Random Coefficients Regression Model

Fixed Effect	Years	Coefficient	S.E	t-ratio	df	*p*-value	Effect Size
Average mathematics achievement, γ_{00}	2007	440.08	6.61	66.54	140	<0.001	-
	2011	450.80	4.49	100.34	218	<0.001	-
Being bullied at school, γ_{10}	2007	-19.39	4.37	-4.44	195	<0.001*	-.25
	2011	-6.80	1.43	-4.75	62	<0.001*	-.11
Students' like learning Mathematics, γ_{20}	2007	26.81	1.87	14.31	38	<0.001*	.34
	2011	-3.33	1.68	-1.98	176	.049*	-.05
Students' confidence in mathematics, γ_{30}	2007	-2.37	1.32	-1.79	232	.074	
	2011	63.08	2.41	26.15	1649	<0.001*	.99
Students' valuing in mathematics, γ_{40}	2007	1.11	2.20	.51	261	.613	
	2011	2.13	1.64	1.30	83	.197	
Random Effect	**Years**	**sd**	**Variance**	**df**	χ^2	***p*-value**	
INTRCPT1, u_0	2007	76.70	5883.00	140	3639.07	<0.001*	
	2011	63.36	4014.32	218	4122.38	<0.001*	
Student level, *r*	2007	81.39	6624.19				
	2011	79.16	6266.38				

*Statistically significant at p=.05 level.

According to Table 3, in TIMSS 2007, being bullied at school and students' like learning mathematics variables had a significant impact on students' mathematics achievement performance and in TIMSS 2011 students' confidence in mathematics variable had significant impact on students' mathematics achievement performance. Adding these variables to the model as level-1 variables for TIMSS 2007 decreased within-school variability variance from 7332.66 to 6624.19. This shows that these variables explain 9.6% of change in students' mathematics achievement performance. Including the stated variables in the model as level-1 variables for TIMSS 2011 decreased within-school variability variance from 8403.60 to 6266.38. This shows that these variables in students' mathematics achievement performance explain 25% of within-school variability.

When the practical significance of the variable having the highest effect size in TIMSS 2007 is evaluated, an increase of one standard deviation in students' like learning mathematics is expected to cause an increase of approximately .34 standard deviation in average mathematics achievement. When the practical significance of the variable having the highest effect size in TIMSS 2011 evaluated, an increase of one standard deviation in self confidence in mathematics variable is expected to cause an increase of approximately .99 standard deviation in average mathematics achievement. In other words, confidence in mathematics had a small effect on students' mathematics achievement in TIMSS 2007 but a large effect in TIMSS 2011.

Findings Regarding Intercepts and Slopes-as Outcomes Model

The model in which constant and slope coefficients are outcomes originates from the combination of the other models analysed. In this sense, all significant student level variables and school level variables are included in the models. Results of the model are given in Table 4.

Table 4. Results Regarding Intercepts and Slopes-As-Outcomes Model

Fixed Effect	**Years**	**Coefficient**	**S.E**	**t-ratio**	**df**	***p*-value**	**Effect Size**
Average school mean achievement, γ_{00}	2007	440.14	5.65	77.84	139	<0.001	-
	2011	450.86	3.91	115.35	217	<0.001	-
School emphasis on academic success, γ_{01}	2007	45.31	6.70	6.76	139	<0.001*	.70
	2011	36.45	5.351	6.81	217	<0.001*	.67
Being bullied at school, γ_{10}	2007	-19.59	4.42	-4.43	209	<0.001*	-.30
	2011	-6.54	1.378	-4.76	80	<0.001*	-.12
Being bullied at school * School emphasis on academic success, γ_{11}	2007	.94	4.95	.19	555	.849	
	2011	-1.20	1.64	-.73	30	.470	
Students' like learning mathematics, γ_{20}	2007	27.21	1.88	14.47	30	<0.001*	.42
	2011	-2.92	1.52	-1.92	509	.055	
Students' like learning mathematics * School emphasis on academic success, γ_{21}	2007	-2.02	1.88	-1.08	131	.284	
	2011	3.09	1.79	1.73	355	0.084	
Students' confident in mathematics, γ_{30}	2011	63.80	2.33	27.35	2608	<0.001*	1.17
Students' confident in mathematics * School emphasis on academic success, γ_{31}	2011	-6.73	2.74	-2.46	72	.016*	-.12
Random Effect	**Years**	**sd**	**Variance**	**df**	**χ^2**	***p*-value**	
School level, u_0	2007	65.09	4237.31	139	2614.47	<0.001*	
	2011	54.29	2947.61	217	3092.56	<0.001*	
Student level, r	2007	81.41	6628.36				
	2011	79.12	6259.75				

*Statistically significant at p=.05 level.

According to Table 4, in TIMSS 2007 both student level and school level variables have significant effects on mathematics achievement. As for TIMSS 2011, teacher's emphasis on academic success among school level variables and bullying and having confidence in mathematics among student level variables have a significant effect on mathematics achievement. According to cross level interactions, interactions in TIMSS 2011 except for the interaction between students' confidence in mathematics and emphasis on academic success variables are not statistically significant. In other words, students' confidence in mathematics was positively affected by school emphasis on academic success, which had a positive influence on mathematics achievement. On the other hand, being bullied at school and liking learning mathematics were found not to have statistically significant effect on school emphasis on academic success.

Including variables in TIMSS 2007 at level 1 decreased within-school variability variance from 5883.00 to 4237.31. This situation points out that these variances explain 28% change in students' mathematics achievement performance. Including these variables in level 1 decreased within-school variability variance from 4014.32 to 2947.61. This situation points out that these variables in students' mathematics achievement performance explain 27 % change in within-school variability.

When the practical significance of the variable having the highest effect size in TIMSS 2007 is evaluated, an increase of one standard deviation in teachers' emphasis on academic success variable is expected to cause an increase of .70 standard deviation in students' average mathematics achievement.

When the practical significance of the variable having the highest effect size in the TIMSS 2007 is evaluated, an increase of one standard deviation in students' confidence in mathematics is expected to cause an increase of approximately 1.17 standard deviation in average mathematics achievement. In other words, while school emphasis on academic success had a moderate effect on students' mathematics achievement in TIMSS 2007, it has a large effect on students' mathematics achievement in TIMSS 2011.

Variables in the models analysed that have significant impact on eighth grade students' mathematics achievement in 2007 and 2011 at both student and school level are given in Table 5.

Table 5. Variables That Have a Significant Impact on Eighth Grade Students' Mathematics Achievement in TIMSS 2007 and 2011

	8.Grade (2007)	**8.Grade (2011)**
	Variables (Direction)	**Variables (Direction)**
Means as Outcomes Model	School emphasis on academic success (+)	School emphasis on academic success (+)
Random Coefficient Regression Model	Students bullied at school (-) Students like learning mathematics (+)	Students bullied at school (-) Students' students' confidence in mathematics (+) Students like learning mathematics (-)
Intercepts-and-Slopes-as-Outcomes Model	School emphasis on academic success (+) Students bullied at school (-) Students like learning mathematics (+)	School emphasis on academic success (+) Students bullied at school (-) Students' confidence in mathematics (+) Students' confidence in mathematics * School emphasis on academic success (-)

The self confidence in mathematics variable does not have a significant effect on students' mathematics achievement in TIMSS 2007, yet it does have a significant effect in 2011. Moreover in TIMSS 2011, although like learning mathematics variable has a significant effect on mathematics achievement when only student level variables are included in the analysis, this effect is not significant when school level variables are included in the analysis. At the same time as it is shown in Table 5, while this variable's effect on eighth grade students' mathematics achievement was positive in 2007, the direction of this effect changed to negative in 2011.

Variables chosen at student level for TIMSS 2007 explain 25% of variance, whereas school level variables explain 29% of variance. It is seen that the unexplainable part of differences between students at student level is greater than school level. For TIMSS 2011 variables chosen at student level explain 25% of variance, and variables at school level explain 26% of variance. It is seen that unexplainable part of differences between students is a little more at student level than school level.

Discussion, Conclusion and Suggestions

As a result of the analysis conducted in order to explore the level of relationship of characteristics related to students' mathematics achievements at student and school levels and to explain the status of these relations between TIMSS 2007 and 2011, it was seen that there are considerable differences in eighth grade students' mathematics achievements between schools in both TIMSS terms.

Student Level Affective Variables

An outcome of the study is that students who are not exposed to bullying have higher achievements in mathematics. This finding is supported by research results in the literature as well (Akyüz, 2014; Buluç, 2014; Roman & Murillo, 2011; Ponzo, 2013). In addition to diminishing academic achievement due to exposure to bullying at school, these students suffer socially and psychologically. That this has continued over two TIMSS terms shows that findings of research were not functionally put into effect. All concerned education partners should make more effective efforts on this matter. It may especially be recommended that school counsellors take precautions against students being exposed to bullying and students performing bullying.

According to the results of the study, students who enjoy learning mathematics and participated in TIMSS 2007 have a higher level of mathematics achievement. This variable is that with the highest impact factor among the variables that are were considered for 2007 at student level. It can be stated that this variable affects mathematics achievements of students who participated in TIMSS 2011 in a negative way. Taking the impact size of this result in consideration, it may be said that the negative effect is low enough to be ignored. Many studies that addressed the Turkey sample have stressed that students' like learning mathematics affects mathematics achievement positively (Tavşancıl & Yalçın, 2015; Yıldırım et al., 2013). Furthermore, in a study based on a sample from outside of Turkey, Mohammadpour (2012) states that students with positive attitude towards mathematics have higher mathematics achievements. In keeping with the literature, in the 2007 application students who like, enjoy mathematics class with a positive attitude have higher mathematics achievements. In this sense, carrying out activities towards increasing students' like mathematics and reading books on the subject can be suggested to teachers. Given students' interest in new technology, mobile applications and computer softwares can be used for mathematics lesson plans and topics.

Students' confidence in mathematics has a significant effect on 2011 mathematics achievement, yet it does not in 2007. Furthermore, among the student level variables that are dealt with in the 2011 TIMSS application, students' confidence in mathematics is the variable which has the highest impact factor. It is seen in the literature (Akyüz, 2014; Arıkan et al., 2016; Chen, 2013; Ker, 2016) that students with self-confidence have higher levels of mathematics achievement. It is thought that the reason why self-confidence did not have a significant effect on mathematics achievement in 2007 might be a result of the continuing teacher centred teaching approach, due to not fully adopting and understanding the student-centred teaching approach in the past. Internalizing the student centred teaching approach by the 2011 round of tests is thought to be effective in mathematics achievement as this increased the sense of self-confidence in students. For this reason, it would be beneficial to implement classroom tasks and extracurricular activities in order to enhance students' self-confidence towards mathematics.

The students valuing mathematics variable does not have a significant relationship with students' mathematics achievement in either year. It is seen in another study that while students valuing mathematics has a significant relationship with mathematics achievement of students in Korea and Singapore, it does not have such an effect on students' mathematics achievement in Finland (Kim et al., 2013). In the study conducted by Arıkan et al. (2016) it is confirmed that the relationship between students valuing mathematics and mathematics achievements of students participating in TIMSS 2007 and 2011 in Turkey and Australia was not significant for either country. It may be said that the results are the same for both the Finnish students who have a high level of achievement and Turkish students who have a low level of achievement. One interpretation may be that regardless whether mathematics

achievement is low or high, students have a high opinion of mathematics. Moreover, this situation can be thought to arise from students' realization of the importance of mathematics in daily life and in their professional life in the future. The importance of mathematics for both academic and social life of students should be reemphasized by teachers. Moreover, curriculum can be reorganized in order to enhance students' attitude towards mathematics by making lesson plans related to daily life activities.

School Level Teacher Characteristics

According to both 2007 and 2011 TIMSS results, at school level the relationship between students' mathematics achievement and teachers' emphasis on academic success is positive and significant. This variable has the highest impact factor among the school level variables that are addressed at the same time. This situation can be interpreted as teacher's emphasis on academic success affecting eighth grade students' mathematics achievement in an enhancing way. This is an expected outcome as emphasis on achievement by teachers plays a role in students' putting effort into academic achievement. Studies in the field literature offer results that support this finding (Akyüz, 2014; Goddard et al., 2000; Hoy, 2012; Tavşancıl & Yalçın, 2015). One study (Atar, 2014) conducted using TIMSS 2011, also confirmed that as the perception of importance of academic achievement increases in the school where teachers work, students' science achievement also increases. This situation can be interpreted as showing teachers' emphasis on academic success is influential in students' mathematics as well as science achievement. In this sense, teachers should understand the goals of the school programmes and they need to be clear about applications and family support for school achievement should be provided. Moreover, students' desire to be more achievementful at school should be promoted. Moreover, school principals should prioritise emphasis on academic success and implement activities/plans related to this aim in schools.

A significant relationship between teachers' working conditions and teachers' collaborations in order to enhance teaching variables and student's mathematics achievement is not found in the data for the years 2007 and 2011. While this study has found no significant relationship between teachers' working conditions and students' mathematics achievement, some studies in the literature (Hirsch & Church, 2009; Marcondes, 1999) indicate that teachers' working conditions are related to students' and teachers' motivations and this situation affects students' achievement. For the present study, the reason why a different finding was obtained from others is thought to be due to physical conditions not affecting achievement when qualified teachers and students are present. Another reason for this situation is thought to originate from the possibility of teachers not answering accurately due to social desirability.

Regarding the teachers' collaboration variable, some studies (Levine & Marcus, 2010; McLaughlin & Talbert, 2006; Pang, 2006) indicate that teachers' collaboration for improving teaching has an important effect on student achievement. The present study has found that teacher's collaboration for improving teaching does not significantly contribute to students' achievement. A similar finding is seen in the results of TIMSS 2011 for Australia (Thomson, Hillman, & Wernert, 2012). This might be a result of teachers preparing materials that improve teaching individually rather than collaborating as well as the varying achievement of teachers' collaboration for the improvement of teaching. At the same time, this can be related to what teachers understand from the concept of collaboration. Teachers' collaboration with colleagues includes situations such as preparing lesson plans that they are going to follow together, conducting joint work for implementing the curriculum effectively and developing measurement and evaluation tools (DuFour, Eaker, & DuFour, 2005). It is seen that teachers in Turkey do not give sufficient importance to observing each other's teaching activities, making plans together or developing programmes, projects and evaluation activities (Demirtaş, 2010). Most of the teachers collaborate with colleagues because it is a desired by school administrators rather than the teachers themselves (Bloom & Vitcov, 2010). School principals' decisions can be valuable for improving teacher collabration. A suitable environment should be created for collabration in the future. Moreover, seminars can be held in order to enhance collabration towards common aims.

According to results of this study, eighth grade students' mathematics achievement was very different among schools for both applications of TIMSS. In many studies (Akyüz, 2014; Akyüz & Berberoğlu, 2010; Berberoğlu & Kalender, 2005; Demir & Kılıç, 2010; Güzel, 2006; Turkish Education Association [TED], 2008; Yalçın & Tavşancıl, 2014; Yıldırım et al., 2013) conducted with applications such as PISA, TIMSS, Student Selection Examination and Placement Test, it is seen that differences in achievement between schools are considerably high. Having considerable differences in achievement between schools makes it necessary not to limit studies regarding student achievements to students' characteristics only, but to involve characteristics such as school features, quality of teachers and behaviour etc., which have a direct impact on student achievement and to determine their effect on student achievement.

Student performances in TIMSS 2007 and 2011 mathematics test have a significant relationship with the students not being bullied at school and students' like learning mathematics variables at student level. Students' confidence in mathematics variable has a significant effect on the achievement in 2011 yet it does not have such effect in 2007 and the students valuing mathematics variable does not have a significant relationship with students' mathematics achievement for either year.

There are some restrictions to this study and its results should be evaluated with an eye to its restrictions. First, this study is a relational study. Therefore, it does not produce results regarding causal comparisons. For this reason, in order to obtain causal results, experimental studies can be conducted within the scope of the variables addressed in this study. Secondly, one class from one school is selected while obtaining a sample for TIMSS. Because of this, effects of class level variables have not been examined and three level HLM analysis could not be carried out. Finally, taking the variance which cannot be explained regarding the differences between students' mathematics achievements regarding TIMSS 2007 and 2011 in this study, analyses can be conducted again with different variables (educational resources at home, socioeconomic status, taking private lessons, education levels of parents, frequency of doing homework, etc.) that explain the differences in students' mathematics achievements. Further research can be conducted on the cognitive characteristics of students such as learning strategies. Furthermore, this study focused on mathematic literacy in TIMSS. Similar studies should be conducted for science literacy.

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Appendix 1

Levels	Variables	Response Categories	Factor Loadings and Cronbach's Values	
			Years	
	Items		**2007**	**2011**
Student level variables	**Students Like Learning Mathematics**		α: .74	α: .81
	Mathematics is boring	Agree a lot	.75	.77
	I like mathematics	Agree a little	.88	.87
	I enjoy learning mathematics	Disagree a little	.82	.83
	I wish I did not have to study mathematics	Disagree a lot		.70
	I learn many interesting things in mathematics			.63
	Students Confident in Mathematics		α: .76	α: .86
	I usually do well in mathematics	Agree a lot	.78	.79
	Mathematics is harder for me than for many of my classmates*	Agree a little	.74	.63
	Mathematics is not one of my strengths	Disagree a little	.79	.75
	I learn things quickly in mathematics	Disagree a lot	.77	.73
	Mathematics makes me confused and nervous			.57
	I am good at working out difficult mathematics problems			.76
	My teacher thinks I can do well in mathematics with difficult materials			.58
	My teacher tells me I am good at mathematics			.76
	Mathematics is harder for me than any other subject			.67
	Students' valuing mathematics		α: .62	α: .76
	I think learning mathematics will help me in my daily life		.56	.60
	I need mathematics to learn other school subjects	Agree a lot	.67	.67
	I need to do well in mathematics to get into the university of my choice	Agree a little	.75	.77
	I need to do well in mathematics to get the job I want	Disagree a little	.75	.80
	I would like a job that involves using mathematics	Disagree a lot		.66
	It is important to do well in mathematics			.52
	Students Bullied at School		α: .72	α: .75
	Something was stolen from me		.63	.60
	I was hit or hurt by other student(s) (e.g., shoving, hitting, kicking)	At least once a week	.74	.73
	I was made to do things I didn't want to do by other students	Once or twice a month	.72	.65
	I was made fun of or called names	A few times a year	.67	.64
	I was left out of games or activities by other students	Never	.72	.68
	Someone spread lies about me			.73

Levels	Variables	Response Categories	Factor Loadings and Cronbach's Values	
			Years	
	Items		**2007**	**2011**
School Level Variables	**Collaborate to Improve Teaching**		α: .65	α: .83
	Discuss how to teach a particular topic	Every day or almost every day Once or twice a week Once or twice a month Never or almost never	.65	.86
	Collaborate in planning and preparing instructional materials		.68	.85
	Visit another classroom to learn more about teaching		.78	.45
	Visit another classroom to learn more about teaching		.74	
	Share what I have learned about my teaching experiences			.77
	Work together to try out new ideas			.84
	Teacher Working Condition		α: .52	α: .70
	The school building needs significant repair	Not a problem Minor problem Moderate problem Serious problem	.66	.59
	Classrooms are overcrowded		.66	.71
	Teachers do not have adequate workspace (e.g., for preparation, collaboration, or meeting with students)		.82	.72
	Teachers have too many teaching hours			.60
	Teachers do not have adequate instructional materials and supplies			.76
	School Emphasis on Academic Success		α: .83	α: .81
	Teachers' job satisfaction	Very high High Medium Low Very low	.76	
	Teachers'understanding of the school's curricular goals		.60	.72
	Teachers'degree of success in implementing the school's curriculum		.70	.76
	Teachers' expectations for student achievement		.72	.78
	Parental support for student achievement		.72	.78
	Parental involvement in school activities		.69	
	Students' regard for school property		.49	
	Students'desire to do well in school		.66	.73