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Parental influence on students' mathematics achievement: the comparative study of Turkey and best performer countries in timss 2011

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Abstract

This paper assessed the impact of students' background and parents' attitude towards their children on mathematics achievement across four countries which were participated to Trends in International Mathematics and Science Study (TIMSS) 2011. Since Republic of Korea, Singapore and Chinese Taipei were ranked as the first three countries in terms of the achievement in mathematics scores, they were selected for the comparison with Turkey. Multilevel logistic regression model was used to estimate coefficients and to model differences in mathematics achievement within and between schools for each country. Gender, student-parent relationship, possessions of computer, room and internet were taken as student level variables, while school composition by student economical background, discipline and safety of school climate were taken as school level variables. According to results, owning a desk was the most effective factor on achievement of students for both Turkey and Republic of Korea, at the student level. Furthermore, at school level, the most effective factor on achievement was found the school composition by student economical background for all countries.

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Keywords: mathematics achievement, TIMSS 2011, multilevel modeling, student-parent relationship

1. INTRODUCTION

Turkish educational system has modern, secular, democratic and co-education characteristics. Educational reforms in Turkey have been developing slowly. These reforms are included changes in structural and curriculum program. After having negotiations with European Union in 2004, Turkey has applied various reforms in

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curriculum program for accomplishing educational targets of European Union. Turkey should develop some strategic plans to increase the performance of education system and these plans should contain not only national but also international strategies. Besides national assessment studies were done in educational field, it was a need of educational indicators to locate at the international level. Turkey was involved in some projects such as Programme for International Student Assessment (PISA), Trends in International Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy Study (PIRLS) to improve the educational level of other participating countries.

International assessment studies reflect many comparative surveys among countries pertaining to educational achievement. These assessments are concerned with the study of mathematics, reading and science. Mathematics is one of the fundamental lessons that used in everyday life and associated with other lessons, that's why we focused on mathematics in this study. Mathematics has become increasingly important and has been taken up at the highest level in educational field.

In this study, we compared the effects of students' background and parents' attitude towards their children on mathematics success across four countries; Republic of Korea, Singapore, Chinese Taipei and Turkey. It was shown considerable variation in the countries by using explanatory variables.

For this purpose, the research questions can be designed as follows:

1) How the variability in the mathematics achievement of eighth grade students is distributed within and between schools for each country?
2) Are the student and school factors influencing mathematics achievement in all countries?
3) To increase the mathematics success of Turkish eighth grades, what changes should be implemented?

2. Data and Method

2.1. Data

We use the Trends in International Mathematics and Science Study (TIMSS) which is an international assessment of student achievement in mathematics and science. The study conducted by the International Association for the Evaluation of Educational Achievement (IEA) in 1995, 1999, 2003, 2007 and 2011. The target population in TIMSS 2011 was fourth and eighth grades, teachers and school administrators. This data comprises for 63 countries and 14 benchmarking participants. The main purpose of TIMSS is to measure and improve teaching and learning abilities in mathematics and science. Furthermore, the internationally comparable results provided by TIMSS allow countries to determine how well eighth grades are prepared for life.

2.2. Sample

The sample for this study was restricted to four countries - Republic of Korea, Singapore, Chinese Taipei and Turkey - which participated in TIMSS 2011. This restriction was implemented to make comparative research for countries with a high level of success and Turkey.

According to the findings from TIMSS 2011, Republic of Korea (613), Singapore (611) and Chinese Taipei (609) were the top-performing countries at eighth grade students, respectively. The scores in parenthesis show the mean math score of students in these countries. Mathematics success of Turkey (452) was below the average success (500) of TIMSS 2011.

The sample design is structured for two-level system; students as level-1 and schools as level-2. The study involves 6077 eighth grades nested within 218 Turkish secondary schools, 4789 eighth graders nested within 139 Korean secondary schools, 5544 eighth graders nested within 155 Singaporean secondary schools and 4737 eighth graders nested within 143 Chinese secondary schools after deletion of missing data.

2.3. Variables

Mathematics Achievement (outcome): The mathematics assessment for TIMSS 2011 was designed along two dimensions: content (number, algebra, geometry, data and chance) and cognitive skills (knowing, applying and reasoning) (TIMSS, 2011). Students were taken as "unsuccessful" if their mathematics score was below the average mathematics score of each country; otherwise they were taken as "successful".

Student level variables (predictors): Gender (*G*), the possession of computer (*C*), desk (*D*) and internet (*I*), the frequency of the student's relationship with the family about school were obtained from the students' questionnaires. Four items, to measure parents' interest about their children's schoolwork, were included in analysis. These items were described as follows:

(*P1*) My parents ask me what I am learning in school
(*P2*) I talk about my schoolwork with my parents
(*P3*) My parents make sure that I set aside time for my homework
(*P4*) My parents check if I do my homework

School level variables (predictors): School composition by student economic background (*SES*) and discipline-safety (*DS*) were derived from the school principal's questionnaire. They were used to explain school level variance in mathematics achievement.

2.4. Method

Multilevel models applied to clustered or longitudinal data, repeated measures with observational units at one level nested within units at other levels in social and educational sciences. The samples are taken from high level units firstly and then from the sub-units (Heck and Thomas, 2000). Multilevel models are also known as hierarchical linear models or random coefficient models.

Multilevel logistic models do not require any assumptions, such as linearity, normality, independence of residual terms and homogeneity of error variance. We consider multilevel logistic models as special case of multilevel model for binary outcomes with a Binomial sampling model and logit link function (Raudenbush and Bryk, 2002). Since students are nested within schools for each country, we constructed hierarchical structure and used R software for the implementation.

Level 1: Student Level

The model we estimated was

$$\begin{aligned} Y_{ij} = {} & \beta_{0j} + \beta_{1j}(G) + \beta_{2j}(C) + \beta_{3j}(D) + \beta_{4j}(I) + \beta_{5j}(P1) + \\ & \beta_{6j}(P2) + \beta_{7j}(P3) + \beta_{8j}(P4) + e_{ij} \end{aligned} \tag{1}$$

where β_{0j} is the average outcome in school j, e_{ij} is the error term for student i in school j.

Level 2: School Level

The level 2 model is then

$$\beta_{0j} = \gamma_{10} + \gamma_{11}(DS) + \gamma_{12}(SES) + u_{0j} \tag{2}$$

where γ_{10} is the average intercept in level two unit j. u_{0j} is the error term for school j (Hox, 2002).

3. Findings and Results

Republic of Korea, Singapore, and Chinese Taipei were top performer countries in TIMSS 2011 study. Thus, the similarities and differences in students' achievement across countries were tried to explain by using a two-level model. For this study, the students' achievement in mathematics, students' and school principals'

questionnaires were used. Since data had a hierarchical structure: observational units at one level were nested within units at other levels, multilevel models were preferred.

The percentage of variables for each country was shown in Table 1.

Table 1. Percentage of variables

			Turkey	Republic of Korea	Singapore	Chinese Taipei
Dependent Variable	Mathematics success	Below country average	51%	48%	48%	44%
		Above or equal country average	49%	52%	52%	56%
Level 1 Variables	Gender	Male	50%	47%	51%	52%
		Female	50%	53%	49%	48%
	Computer	Yes	59%	99%	97%	97%
		No	41%	1%	3%	3%
	Study Desk	Yes	66%	96%	89%	88%
		No	34%	4%	11%	12%
	Internet	Yes	46%	97%	96%	93%
		No	54%	3%	4%	7%
	My parents ask me what I am learning in school	Every day or almost every day*	54%	20%	24%	27%
		Once or twice a week	28%	40%	38%	32%
		Once or twice a month	9%	23%	20%	21%
		Never or almost never	9%	16%	18%	21%
	I talk about my schoolwork with my parents	Every day or almost every day*	51%	19%	22%	20%
		Once or twice a week	30%	36%	33%	28%
		Once or twice a month	10%	28%	22%	25%
		Never or almost never	9%	17%	23%	28%
	My parents make sure that I set aside time for my homework	Every day or almost every day*	61%	8%	41%	36%
		Once or twice a week	23%	18%	29%	21%
		Once or twice a month	7%	22%	14%	15%
		Never or almost never	8%	52%	16%	28%
	My parents check if I do my homework	Every day or almost every day*	32%	15%	19%	26%
		Once or twice a week	29%	22%	23%	17%
		Once or twice a month	12%	21%	16%	14%
		Never or almost never	27%	43%	41%	43%
Level 2 Variables	Discipline and Safety	No problem	24%	36%	50%	64%
		Fever problem	49%	52%	50%	35%

	Lots of problem	26%	11%	0%	1%
School Composition by Student Economical Background	Disadvantages	61%	29%	13%	13%
	Neither Affluent nor disadvantages	25%	51%	61%	68%
	Affluent	14%	20%	26%	19%

** Reference category*

As it can be seen in Table 1, there was no significant difference within country in terms of the percentage of mathematics success. While the rates of computer, internet and study desk possession in top performer countries were between 88% and 99%, they were between 46% and 66% in Turkey. We put emphasize on students' own study place and instruments of information technology since the proportions of not having these variables are much lower in Turkey compared to other countries. In addition, Turkish parents were interested about their children's schoolwork every day or almost every day. In general, most of Turkish students felt unsafe at school and had lower socioeconomic families than other countries.

Based on TIMSS 2011 dataset, the following research hypotheses were tested through the use of multilevel logistic regression model:

1. Male students outperform female students in mathematics achievement.
2. The possession of computer was a factor that increase students' mathematics achievement.
3. The possession of internet was a factor that increase students' mathematics achievement.
4. The possession of study desk was a factor that increase students' mathematics achievement.
5. The higher rate of parents interest in students' schoolwork, the higher their score in mathematics.
6. Students who feel safe in school were more successful in mathematics.
7. Students from higher socioeconomic status families achieved a higher score in mathematics than others.

Table 2 presented the results of multilevel logistic regression analysis for each country.

Table 2. Results of multilevel logistic regression analysis

HLM Output			**Turkey**	**Republic of Korea**	**Singapore**	**Chinese Taipei**
Intercept			-1.0312***	-1.2157**	-2.8790***	-0.8080**
LEVEL-I	Gender (Male)		0.2781***	0.2386***	0.1680*	0.1146
	Computer (Yes)		0.3424***	-0.8146*	0.8521**	0.5364*
	Study Desk (Yes)		0.5344***	0.8546***	0.7629***	0.2918**
	Internet (Yes)		0.1766*	1.5054***	0.6687**	0.0707
	My parents ask me what I am learning in school	Every day or almost every day[a]	-	-	-	-
		Once or twice a week	0.0492	-0.2393*	0.2873**	-0.2752**
		Once or twice a month	0.0534	-0.2286*	0.3384**	-0.1029
		Never or almost never	0.1852	-0.1311	0.6653***	-0.2302
	I talk about my schoolwork with my parents	Every day or almost every day[a]	-	-	-	-
		Once or twice a week	-0.3454***	-0.2458*	-0.0501	-0.2945**
		Once or twice a month	-0.4106***	-0.5531***	-0.2573*	-0.5123***
		Never or almost never	-0.7505***	-1.0041***	-0.4231***	-0.9375***

	My parents make sure that I set aside time for my homework	Every day or almost every day[a]	-	-	-	-
		Once or twice a week	-0.3591***	-0.0672	-0.1668*	-0.0538
		Once or twice a month	-0.4174***	0.0249	-0.2668*	-0.1801
		Never or almost never	-0.5241***	0.0193	-0.2059	-0.1760
	My parents check if I do my homework	Every day or almost every day[a]	-	-	-	-
		Once or twice a week	0.4446***	-0.0963	0.0765	-0.2057*
		Once or twice a month	0.7945***	-0.0503	0.1893	0.0640
		Never or almost never	0.8915***	-0.2036	0.2587*	0.3188***
LEVEL-II	Discipline and Safety (negative scale)		-0.2350**	-0.1043	-0.6261**	0.0149
	School Composition by Student Economical Background		0.5176***	0.5303***	0.8674***	0.6856***
Model Fit		AIC	7275	6213	6173	5915
		BIC	7443	6375	6338	6077
		Log Likelihood	-3613	-3082	-3061	-2933
		Deviance	7225	6163	6123	5865

[a] *Reference category,* $^{*}0.05$, $^{**}0.01$, $^{***}0.001$

Gender difference had a statistically significant effect on mathematics success in all countries, except Chinese Taipei. It was shown that boys outperformed girls in Turkey, Republic of Korea and Singapore. Besides, the largest difference between two genders was in favor of girls in Turkey. Boys were about 1.32 ($e^{0.2781}$), 1.27 ($e^{0.2386}$) and 1.18 ($e^{0.1680}$) times greater than girls in mathematics success in Turkey, Republic of Korea and Singapore, respectively. Also, it was stated that gender variable was a positive influence on students' mathematics achievement in the literature (Ayalon and Livneh, 2013; Else-Quest, Hyde and Linn, 2010). In fact, this study was consistent with previous studies.

Although computer possession of students in Republic of Korea had the highest percentage among all countries, it had a negative impact (2.25 times lower) on mathematics achievement unlike the other countries. Furthermore, the possession of internet had a significantly positive effect (about 4.5 times higher than non-internet users) on mathematics achievement in Republic of Korea. These results were shown that students from Republic of Korea use internet for schoolwork, but they do not use their computer just for internet. They probably use it for playing games, listening music etc. Although the possession of computer has a positive impact on mathematics success in all countries, except Republic of Korea, the possession of internet had not statistically significant impact on mathematics achievement in Chinese Taipei.

Study desk was one of the most important factor that affecting mathematics achievement for all countries. Students who have an own study desk were about 1.7, 2.3, 2.1 and 1.3 times greater than others in mathematics achievement in Turkey, Republic of Korea, Singapore and Chinese Taipei, respectively. Consequently, the most important student background factors were found to be the possession of computer in Singapore and Chinese Taipei, in Turkey it was study desk, in Republic of Korea it was internet.

Parents attitudes towards children about schoolwork were taken into consideration in this study. It was composed of four attributes: to ask what he/she learnt at school, to talk about schoolwork, to make sure that he/she set aside time for homework and to check if he/she did his/her homework. As it was seen that parents behaviour separated into two basic attributes which were about schoolwork and homework.

In Turkey, most of the parents were asked their children what they learnt in school, but it was not an important role in mathematics achievement. However, students whose parents talk about schoolwork everyday or almost everyday, were more successful than others. In other countries, asking what children learn and talking about schoolwork had statistically significant effect on mathematics achievement. In Republic of Korea and Chinese Taipei, students whose parents ask what they learn at school everyday, were more successful than other students. On the other hand, the parents frequently asked what they learn at school has a negative effect on the mathematics achievement of students in Singapore.

Parents attitudes towards children's schoolwork and homework were other issues in mathematics achievement. Children behaviour was different from country by country in these issues. For example, the frequency of making sure that children set aside time for their homework was not important factor for achievement in Republic of Korea and Chinese Taipei, but it was important for students from Turkey and Singapore. Another issue was to check their students if homework was done. Turkish and Singaporean students whose parents check if they did their homework everyday, had lower score in mathematics than other students. However, in Republic of Korea and Chinese Taipei, students whose parents did not frequently check if they did their homework, were more successful than other students.

Mathematics scores were also associated with school climate. There was evidence for a negative effect between achievement and school safety (Thomson, Hillman and Wernert, 2012). Moreover, students who feel safe at school from Turkey and Singapore were more successful than others. In this study, discipline and safety of school and school composition by student economical background were tested whether they had a statistically significant effect on mathematics achievement. For all countries, students from higher socioeconomic status families achieved a higher score in mathematics than others (Kılıç, Çene and Demir, 2013).

The intraclass correlation coefficient is (ICC) an indicator of between-group heterogeneity or within-group homogeneity. It represents the proportion of group-level variance in total variance. The estimated ICC can be used to evaluate between group heterogeneity in multilevel logistic regression models. This coefficient is similar to Pearson correlation which is used to measure the association of two variables.

The variability in mathematics achievement by eighth graders was modelled as a function of student- and school-level factors in four countries. In Turkey dataset, we can see that the school level variance estimate was 0,642 and for the logistic regression model, the student level variance component was $\pi^2/3=3,289$. The intraclass correlation coefficient was 0,642/0,642+3,289=0,1633. This percentage of the variability in mathematics achievement was accounted for by the school-level differences and remaining variation was at the student level. It showed a moderately large between-school heterogeneity or within-school homogeneity and the variance of the school level was statistically significant. Thus the multilevel model should be applied to this data (Wang, Xie and Fisher, 2011). The school-level variability of total variability was about 37,79%, 1,89% and 14,25% in Singapore, Republic of Korea and Chinese Taipei, respectively.

4. Conclusions

Our results show that this study may open a new angle in the investigation of gender inequality, students' background and parents attitudes toward children in mathematics achievement. Moreover, it was revealed that there were some factors affect mathematics achievement in a nagative way such as internet and computer use, socio economic and cultural status in Turkey. Also it was showed that similiar factors affected students' achievement for all countries, so Turkey should create better strategies which were used to increase the performance of education system. There should be more studies for future comparative study on students' background and parents' attitude towards their children in mathematics achievement.

References

Ayalon, H., & Livneh, I. (2013).Educational standardization and gender differences in mathematics achievement: A comparative study. *Social Science Research, 42,* 432 – 445.

Else-Quest, N. M., Hyde, J. S., & Linn, M. C. (2010). Cross-national patterns of gender differences in mathematics: a meta-analysis. *Psychological Bulletin 136*, 102–127.

Heck, R. H., & Thomas, S. L. (2000). *An introduction to multilevel modeling techniques*. London: Lawrence Erlbaum Associates.

Hox, J. (2002). *Multilevel Analysis: Techniques and Applications*. London: Lawrence Erlbaum Associates.

Kılıç, S., Çene, E., & Demir, İ. (2012). Comparison of Learning Strategies for Mathematics Achievement in Turkey with Eight Countries. *Educational Sciences: Theory & Practice, 12.4,* 2594-2598.

Mohammadpour, E. (2013). A three-level multilevel analysis of Singaporean eighth graders science achievement. *Learning and Individual Differences,* http://dx.doi.org/10.1016/j.lindif.2012.12.005

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, California: Sage.

Thomson, S., Hillman, K., & Wernert, N. (2012). *Monitoring Australian year 8 student achievement internationally: TIMSS 2011*. Australia: Australian Council for Educational Research.

TIMSS. (2011). TIMSS 2011 Assessment Frameworks. Retrieved March 12, 2012, from http://timssandpirls.bc.edu/timss2011/downloads/TIMSS2011_Frameworks-Chapter1.pdf

Wang, J., Xie, H., & Fisher, J. H. (2011). *Multilevel models: Applications using SAS*. De Gruyter.