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Comparison of Learning Strategies for Mathematics Achievement in Turkey with Eight Countries

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Abstract

The purpose of this study was to examine learning strategies accounted for mathematics achievement across Turkey and neighboring countries. Turkey, Bulgaria, Greece, Azerbaijan, Russian Federation, Israel, Serbia, Romania and Jordan were involved in Programme for International Student Assessment (PISA 2009) study. Since other neighbors of Turkey were not participated in PISA study, they were not evaluated. In this study, PISA mathematics test score and questionnaire responses of 17224 students aged 15 year-old were analyzed via multilevel models. Three-level model was used to estimate coefficients and to model differences across countries and schools. At the first level, gender, socio–economic status (SES), elaboration, memorization, control strategy, home educational resources and cultural possession were considered and it was determined that all the variables except memorization strategy had positive effect on students' mathematics achievement. School size and student-teacher ratio were considered at the second level and gross domestic product (GDP) was considered at the third level. At the second and third level, it was revealed that all the variables except student-teacher ratio had a positive effect on students' achievement. The signs of significant coefficients on students' mathematics scores for each country were shown by using two- level regression. These results were crucially important for the education system to be effective in terms of increasing students' mathematics achievement due to the fact that changing school climate and improving the learning strategies are much easier to achieve than changing other variables affecting students' performance.

Key Words

Learning Strategies, Multilevel Models, Mathematics Achievement, Neighbor Countries, PISA.

A lot of factors and various strategies affect students' learning abilities. Therefore, using these strategies and applying these factors in appropriate and right way is important in helping students to reach their optimum learning abilities. Among these strategies, using reflective thinking and minimizing rote memorization optimize students' learning strategies (Halpern, 1998; Snow, 2002). In addition, it is inevitable that there would be difference between learning and success among countries (Gow et al., 1996 cited in Chiu, Chow, & McBride-Chang, 2007). Besides country properties like socio-economic status [SES] (Demir & Kılıç., 2008, 2010), country GDP also affects student success along with learning strategies (Chiu & Xihua, 2008). Recent studies (Chiu et al., 2007; Fonseca, Valente, & Conboy, 2011) also indicate that, variables such as gender, social and cultural values, school size and teacher-student ratio might also have influence on student success.

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Purpose and Significance of the Study

This study aims to exhibit two main purposes first of which is to construct a hierarchical model in order to find the variables which affect students' mathematical success. The second purpose is to compare the findings of the model among countries and determine Turkey's place. After obtaining model results, suggestions have been made for the improvement of mathematical success in Turkey.

Method

PISA

PISA whose results have been published in every 3 years since 2000 is a project that researches level of knowledge and skills of 15 years old students in industrialized countries. A total of 75 countries including 34 OECD members and 41 non-OECD members participated in PISA 2009. Turkey stage tests and surveys of PISA 2009 project were applied to 4996 students from randomly selected 170 schools around 12 regions of Turkey in May 2009.

Data Set

In this study, Turkey, Bulgaria, Romania, Azerbaijan, Russia Federation, Israel, Greece, Serbia and Jordan are selected as subject countries and PISA 2009 data sets from these 9 countries have been used. Two criteria were determined for the selection of the countries: First, geographic coordinates and distance to Turkey are taken into account. Secondly among those countries, the ones participated in PISA 2009 are selected. Data set is consisted of 17224 students aged 15 years old from 9 subject countries. Since variables that affect mathematical success of students is the focus of the current study, mathematic success is chosen as the dependent variable. In addition, 10 different variables are chosen as independent variables which are thought to be influencing mathematical success.

Variables

Mathematical success is chosen as dependent variable and it is tried to be explained by using a three staged hierarchical linear model. For this purpose, three different levels were determined for 10 different independent variables: student level variables, school level variables and country level variable respectively.

Student level variables include, gender (Chiu & Xihua, 2008; Fonseca et al., 2011; Wößmann, 2003; Wößmann & West, 2006), home education resources (Chiu & Khoo, 2005; Parcel & Rufur, 2001; Wößmann), socio – economic and cultural level (Baker, Goesling, & Letendre, 2002; Chiu & Xihua; Fonseca et al.) and cultural possession (Dumais, 2002; Hofstede, Neuijen, Ohayv, & Sanders, 1990) variables. Learning strategies are also taking place in student level variables which are memorization strategy (Chiu et al., 2007; Czuchry & Dansereau, 1998; Isaacs & Carroll, 1999), elaboration strategy (Halpern, 1998; Kang, 1997; Kincannon, Gleber, & Kim, 1999; Teong, 2003; Vermunt & Vermetten, 2004) and control strategy (Chiu et al.; Eğitim Araştırma ve Geliştirme Dairesi Başkanlığı [EARGED], 2007, 2010). School level variables consist of two variables: School size (Cotton, 1996; Lee & Loeb, 2000; Wößmann & West) and teacher-student ratio (Cotton). Country level variable includes only one variable which is gross domain product (Chiu & McBride-Chang, 2006; Worldbank 2009; Wößmann).

It should be also noted that the variables except school size, teacher-student ratio, gender and log GDP are all form of indices and can be found in the PISA 2009 data. Socio-economic and cultural status index is formed with the combination of three variables which are parents' highest education level, parents' highest job status and resources at home. Similarly, a home education resource is an index that measures whether a student has sufficient study environment and sufficient education resources at home. Another index is the cultural possession index. Indices are for the comparison purpose only and a higher index shows that variable has more impact on the mathematical success.

Analysis

In this study, multilevel models have been constructed in order to explain mathematical success. Samples gathered from hierarchical structure are called as multi-level samples and it is assumed that samples are taken from high level units firstly and then from the sub-units (Heck & Thomas, 2000). Such sampling method provides the advantage of more homogenous sub-samples when compared to simple random sampling (Hox, 1998). Multilevel models are especially needed in case of hierarchical structure since this type of data violates the assumption of independency of units (Osborne, 2000). Besides, multilevel models are also being used at a wide variety of fields including health,

psychology and education. This type of model is also very useful and efficient when someone wants to determine and control clustered structures and heteroscedasticity (Raudenbush & Bryk, 2002). SAS 9.1 Statistical Package Program is being used for the study. First level of the data set consists of students while second level represents schools and third level denotes countries.

Findings and Results

Results of the three leveled hierarchical model are shown at Table-1. According to the table, male students are more successful than female students. Moreover, in general terms it can be interfered that, SES, home resources, cultural possession have an increasing effect on mathematical success. Among learning strategies, while elaboration and control strategy have a positive effect on mathematical success, it is shown that memorization has converse effect. When school level variables are analyzed, it can be seen that larger schools provide more mathematical success. However, as students per teacher increase, mathematical success decreases.

1:Male; 2: Socio – Economic Status; 3: Home Education Resources; 4: Cultural Possession; 5: Memorization; 6: Elaboration; 7: Control Strategy; 8: Student Teacher Ratio; 9: School Size

Looking closer to the Table-1, the differences among countries are easily seen. Empty cells state that variables have no significant effect on students' mathematical success. Moreover, every coefficient in the model is significant at least p=0.05 level. Gender's effect is very high especially at Romania, Israel, Greece, Turkey and Serbia. There are at least 20 points of difference between males and females at those countries while this difference is relatively low at Russia, Bulgaria and Azerbaijan. Socio-economic and cultural status mainly affect mathematical success at Israel, Russia, Bulgaria and Greece. Azerbaijan is the least affected country in terms of this variable. Home education status has an effect mostly in Russia and Romania while it affects fewer students at Turkey, Azerbaijan and Serbia. Cultural possession is especially significant at Bulgaria and Serbia but also it should be noted that it has negative effect on students at Jordan and no effect could be found at Azerbaijan. When it comes to learning strategies, it is seen that memorization has negative effect on mathematical success. This effect is really high at all the countries except Azerbaijan. It can also be interfered that memorization did not affect Jordan. Elaboration is statistically significant in only five countries in which Greece, Jordan, Serbia and Turkey showed positive relation with the variable but, Russia showed negative relation. Control strategy influences mathematical success positively for all the countries. This influence is high at Israel, Russia, Greece, Jordan and Turkey. Increase at the class size tends to decrease success in mathematics with the exception of Greece. All other countries impacted negatively from this variable at a statistically significant level where Bulgaria and Israel seemed to be affected most. The last variable is school size which is significant only in four countries including Bulgaria, Russia, Serbia and Israel where this effect is low.

Discussion and Suggestions

It can be easily seen from Graph-1, students' mathematical success are affected differently from variables. This study showed that most of the variables influence mathematical success positively with two exceptions which are memorization and teacher-student ratio.

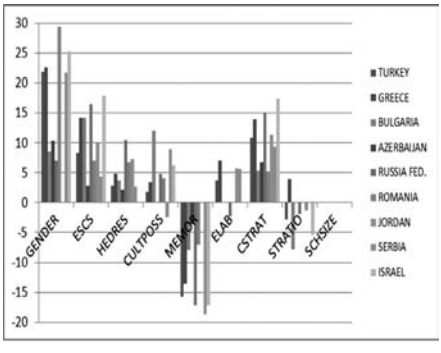
Recent studies show that male students have higher mathematical achievement than females (Chiu &

Table 1.
Coefficient Values of Multilevel Hierarchical Regression for Mathematical Success

	1	2	3	4	5	6	7	8	9
TURKEY	21.8529*	8.2412*	2.8477*	1.7745**	-15.7827*	3.6321*	10.8496*	-2.8012*	
GREECE	22.5499*	14.1103*	4.8035*	3.4132*	-13.5335*	7.0311*	13.9615*	3.9905**	
BULGARIA	8.5727*	14.2238*	3.7197*	11.9955*	-7.9751*		5.4133*	-7.7819*	0.1248*
AZERBAIJAN	10.3256*	2.8325*	2.1037*		-3.5867*		6.7033*		
RUSSIA FED.	7.0526*	16.4162*	10.4458*	4.8873*	-17.1784*	-2.3719**	14.9055*	-1.8855*	0.03065*
ROMANIA	29.3791*	6.9974*	6.8136*	4.0581*	-7.0192*		5.2772*		
JORDAN		9.9326*	7.3237*	-2.4742*		5.6819*	11.3181*	-1.2750**	0.03836*
SERBIA	21.7494*	4.3389*	2.7144*	8.8723*	-18.6204*	5.6144*	9.3144*		
ISRAEL	25.2274*	17.8976*		6.2800*	-17.0903*		17.3732*	-5.3771*	0.05139*

*p<0,01 **p<0,05

Xihua, 2008; Fonseca, et al., 2011; Wößmann, 2003; Wößmann & West, 2002). The results of the current study confirmed the results of these studies in that it was found that in all countries being male has a positive effect on mathematical success. This effect is especially high in Romania, Israel, Greece, Turkey and Serbia. Besides, it was noted that gender does not statistically affect mathematical success in Jordan. On the other hand, according to recent studies that, SES, home education resources and cultural possession should have positive effect on mathematical success (Baker et al., 2002; Chiu & Khoo, 2005; Chiu & Xihua, 2008; Dumais, 2002; Hofstede et al., 1990; Parcel & Rufur, 2001; Wößmann, 2003). As seen on the graph, this finding of the studies has been almost met at a statistically significant level in countries. Socio-economic status has influence especially in Israel, Russia, Greece and Bulgaria while home education resources are important in Russia. Cultural possession is especially high in Bulgaria and Serbia. Results of the multilevel model showed that results of learning strategies are in line with the results of previous studies (Chiu et al., 2007; Halpern, 1998; Isaacs & Carroll, 1999; Kang, 1997; Vermunt & Vermetten, 2004) which determine while memorization affects success negatively, elaboration and control strategy affect it positively. All of the countries are adversely affected from memorization and positively affected from elaboration and control strategy. The only exception is Russia which is affected negatively from elaboration strategy. Serbia, Israel, Russia, Turkey and Greece is adversely affected by the memorization at significant level while Greece, Jordan and Serbia gain the most benefit from elaboration and Israel, Russia, Greece and Turkey take the advantages of control strategy. Teacher-student ratio indicates that higher number of students per teacher decreases student success (Cotton, 1996). Same result stands for this study with the exception of Greece.



Graph 1. *Coefficient Values of Multilevel Hierarchical Regression for Mathematical Success with Histogram*

Looking from Turkish students' perspective, it can be said that Turkish students might have troubles in reaching education resources since this variable does not affect mathematical success too much. Introducing more home education resources to the students would bring more success in mathematics. Same argument can be valid for the cultural possession too. This effect might be due to lack of directing students to leisure time activities such as art and books. It can be suggested to teachers that either they should give place to leisure time activities in their classes or encourage students to do so. Looking at the learning strategies, it can be understood that Turkey has been immensely affected from memorization. This is due to structure of Turkish education system depending on memorization. Restructuring curriculum and changing learning strategies from memorization to elaboration and control strategy would improve mathematical success of students. Despite of the negative result of memorization Turkey takes a firm place both in elaboration and control strategy. This result shows that Turkish students can use metacognitive strategies if the chance is given and they could combine old learning with the new ones efficiently. Meanwhile, according to the analysis of the results, Turkey has the highest teacher-student ratio and this situation obstructs students' mathematical success. In order to solve this problem, number of teachers should be increased immediately.

References/Kaynakça

Baker, D. P., Goesling, B., & Letendre, G. K. (2002). Socioeconomic status, school quality, and national economic development: A cross-national analysis of the "Heyneman–Loxley effect" on mathematics and science achievement. *Comparative Education Review*, *46*, 291–312.

Chiu, M. M. & Xihua, Z. (2008). Family and motivation effects on mathematics achievement: Analyses of students in 41 countries. *Learning and Instruction*, *18* (4), 321–336.

Chiu, M. M., & Khoo, L. (2005). Effects of resources, inequality, and privilege bias on achievement: Country, school, and student level analyses. *American Educational Research Journal*, *42*, 575–603.

Chiu, M. M., & McBride-Chang, C. (2006). Gender, Context, and Reading: A comparison of students in 41 countries. *Scientific Studies of Reading*, *10*, 331–362.

Chiu, M. M., Chow, B., & McBride-Chang, C. (2007). Universals and specifics in learning strategies: Explaining adolescent mathematics, science, and reading achievement across 34 countries. *Learning and Individual Differences, 17* (4), 344–365.

Cotton, K. (1996). School size, school climate, and student performance. *School Improvement Research Series, May*, Close-Up #20. http://educationnorthwest.org/webfm_send/513 adresinden 23 Eylül 2011 tarihinde edinilmiştir.

Czuchry, M., & Dansereau, D. F. (1998). The generation and recall of personally relevant information. *Journal of Experimental Education*, *66* (4), 293–315.

Demir, İ. ve Kılıç, S. (2008). Matematik başarısına etki eden faktörlerin HLM ile incelenmesi. *ABMYO Dergisi*, *12*, 63-75.

Demir, İ. ve Kılıç, S. (2010). Türkiye'deki matematik başarısının iki aşamalı Bernoulli Modeli kullanılarak incelenmesi. *İstatistik Araştırma Dergisi*, *7* (1), 175-185.

Dumais, S. A. (2002). Cultural capital, gender, and school success: The role of habitus. *Sociology of Education*, *75* (1), 44-68.

Eğitim Araştırma ve Geliştirme Dairesi Başkanlığı (EARGED). (2007). *Öğrenci başarısını belirleme programı (PISA-2006) Ulusal Ön Rapor*. Ankara: Yazar.

Eğitim Araştırma ve Geliştirme Dairesi Başkanlığı (EARGED). (2010). *Öğrenci başarısını belirleme programı (PISA-2009) Ulusal Ön Rapor*. Ankara: Yazar.

Fonseca, J., Valente, M. O., & Conboy, J. (2011). Student characteristics and PISA science performance: Portugal in cross-national comparison. *Procedia - Social and Behavioral Sciences, 12*, 322–329.

Halpern, D. F. (1998). Teaching critical thinking for transfer across domains. *American Psychologist*, *53*, 449–455.

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

Hofstede, G., Neuijen, B., Ohayv, D. D., & Sanders, G. (1990). Measuring organizational cultures: A qualitative and quantitative study across twenty cases. *Administrative Science Quarterly*, *35*, 286–316.

Hox, J. (1998). Multilevel modeling: When and Why? In: I. Balderjahn, R. Mathar & M. Schader (Eds.). *Classification, data analysis and data highways* (pp. 147-154). New York: Springer Verlag.

Isaacs, C., & Carroll, W. (1999). Strategies for basic-facts instruction. *Teaching Children in Mathematics*, *5* (9), 1–17

Kang, D. H. (1997). *Assessing Korean middle school students' language learning strategies in input-poor environments*. Retrieved October 20, 2005, from ERIC database.

Kincannon, J., Gleber, C., & Kim, J. (1999, February). *The effects of metacognitive training on performance and use of metacognitive skills in self-directed learning situations*. Paper presented at the National Convention of the Association for Educational Communications and Technology, Houston, TX.

Lee, V. E., & Loeb, S. (2000). School size in Chicago Elementary Schools: Effects on teachers' attitudes and students' achievement. *American Educational Research Journal, 37* (1), 3-31.

Osborne, J. W. (2000). Advantages of hierarchical linear modeling. *Practical Assessment, Research and Evaluation*, *7* (1). Retrieved June 1, 2005, from http://PAREonline.net/getvn.asp?v=7&n=1.

Parcel, T. L., & Rufur, M. J. (2001). Capital at home and at school: Effects on student achievement. *Social Forces, 79* (3), 881-911.

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

Snow, C. (2002). *Reading for understanding: Toward a Research and Development Program in Reading Comprehension*. Santa Monica, CA: RAND.

Teong, S. K. (2003). The effect of metacognitive training on mathematical word-problem solving. *Journal of Computer Assisted Learning*, *19*, 46–55

Vermunt, J. D., & Vermetten, Y. J. (2004). Patterns in student learning: Relationships between learning strategies, conceptions of learning, and learning orientations. *Educational Psychology Review*, *16* (4), 359–384.

Worldbank (2009). *World Development Indicators 2009*. Retrieved January 01, 2011 from http://data.worldbank.org/indicator/NY.GDP.MKTP.CD

Wößmann, L. (2003). Schooling resources, educational institutions and student performance: The international evidence. *Oxford Bulletin of Economics and Statistics, 65* (2), 117–170.

Wößmann, L., & West, M. (2006). Class-size effects in school systems around the world: Evidence from between-grade variation in TIMSS. *European Economic Review, 50* (3), 695–736.