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SES-Related Mathematics Achievement Gap in Turkey Compared to European Union Countries

Türkiye'deki Sosyoekonomik Seviyeye Bağlı Matematik Başarı Farklılıklarının Avrupa Birliği Ülkeleri ile Karşılaştırılması

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Abstract

This study's purpose was to examine SES-related mathematics achievement gaps among Turkish middle-school students as compared to achievement gaps in the European Union (EU) countries. The data used belonged to 2007 Trends in International Mathematics and Science Study (TIMSS). The sample of the countries included Turkey and the EU countries that provided the necessary variables: Bulgaria, Cyprus, Czech Republic, Hungary, Italy, Lithuania, Malta, Romania, and Slovenia. Results showed substantial achievement gaps between low- and high-SES students in Turkey. Correlations between students' SES levels and their mathematics achievement were the largest in Turkey compared to the sample EU countries. Among the sample countries, only Hungary had as large or even somewhat larger disparities as Turkey between low- and high-SES students' mathematics achievement.

Keywords: middle school; mathematics achievement; equity; achievement gap; comparative study

Öz

Bu çalışmanın amacı, Türkiye ve Avrupa Birliği ülkelerindeki ortaokul öğrencileri arasında matematik derslerinde sosyoekonomik seviyeye bağlı başarı farklılıklarını karşılaştırmalı olarak incelemektir. Uluslararası Matematik ve Fen Eğilimleri Araştırması'nın (TIMSS) 2007 datası kullanılmıştır. Örneklemi, Türkiye ve bu çalışma için gerekli değişkenleri sağlayan Avrupa Birliği ülkeleri (Bulgaristan, Kıbrıs, Çek Cumhuriyeti, Macaristan, İtalya, Litvanya, Malta, Romanya ve Slovenya) oluşturmuştur. Çalışmada Türkiye'deki düşük ve yüksek sosyoekonomik seviyedeki öğrenciler arasında önemli başarı farklılıkları olduğu ortaya çıkmıştır. Öğrencilerin sosyoekonomik seviyeleri ve matematik başarıları arasındaki korelasyon Türkiye'de örneklemdeki Avrupa Birliği ülkelerine kıyasla daha fazladır. Örneklemdeki ülkeler arasında sadece Macaristan'da düşük ve yüksek sosyo-ekonomik seviyedeki öğrencilerin matematik başarıları arasındaki farklılıklar Türkiye'deki kadar büyük veya Türkiye'dekinden biraz daha fazladır.

Introduction

Equity in Mathematics Education

Achieving equity in mathematics education is a challenging though a paramount goal with potential promises to remedy social and economical disparities. As Moses (2001) argued, "today

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… the most urgent social issue affecting poor people and people of color is economical access. In today's world, economic access and full citizenship depend crucially on math and science literacy" (p. 5). From an economical perspective, mathematics is a gatekeeper course to science and technology careers (Ma & Johnson, 2008; Sells, 1980), and as noted by Lippman (2002) "a workforce that is highly skilled in mathematics is valued and often cited as a policy goal by nations, as the global economy increasingly demands technical skills that require mathematics proficiency at their base" (p. 71). From a more social perspective, regardless of one's profession, wise decision making in personal lives and participation in civic and democratic life increasingly demand to "reason and communicate using mathematical ideas" (Schoenfeld, 2002, p. 12).

Equity in mathematics education has been defined in terms of student achievement outcomes, treatment of students, and students' access to educational resources (National Council of Teachers of Mathematics [NCTM], 2008). The Commission of the European Communities (2006) views equity as "the extent to which individuals can take advantage of education and training, in terms of opportunities, access, treatment and outcomes" (p. 2). Equity in students' mathematics achievement outcomes, which is the most commonly used indicator of equity, is usually associated with closing the achievement gap among various groups. Gutierrez (2002) defined equity in student outcomes in terms of achievement as "erasure of the ability to predict students' mathematics achievement and participation based solely on characteristics such as race, class, ethnicity, sex, beliefs and creeds, and proficiency in dominant language" (p. 9). Equitable achievement is a critical aspect of equity, and studies that identify disparities in students' mathematics achievement are fundamental towards removing differences (Lubienski, 2008).

For decades achieving equity in educational systems in member countries has been a prominent goal for the European Union (EU). From the first action plan in education, developed in 1976, to the most recent educational strategic framework, ET 2020, equity has been retained as a major objective. However, "Equity continues to be a challenge to most education and training systems in the EU. Less favoured family backgrounds, migrant origins and gender differences continue to affect educational achievement" (the Commission of the European Communities, 2008, p. 119). For 2020, EU aims "the share of low-achieving 15-years olds in reading, mathematics and science should be less than 15%" (Commission of the European Communities, 2009, p. 14). Achievement in mathematics is an important factor in students' choices to take more and/or advanced level mathematics courses and to enter mathematics related careers as well as in their retention in those courses and careers (Simpkins, Davis-Kean, & Eccles, 2006; Updegraff, Eccles, Barber, & O'Brien, 1996). Thus, improving mathematics achievement levels of students who are in the lower tail of the achievement distribution can subsequently contribute to a larger representation of traditionally low-achieving students, such as low-income students, minorities, migrants, and girls, in mathematics courses and mathematics-related careers.

Because equity in educational systems is a prominent goal for the EU, on its path toward successful completion of the negotiation process and an eventual membership to the EU, Turkey needs to understand how it compares to EU countries in terms of achievement gaps among various groups (e.g., by gender, SES, or minority status). The European Council (2006) urged member states to advance their reform movements to ensure equal opportunities for all students. In order to achieve social and economic integration with the EU, Turkey needs to enhance its level of educational equity to international standards. That is true even more so in mathematics education because achievement levels and tertiary graduates in mathematics have been a particular area of attention in EU's recent educational objectives (Commission of the European Communities, 2009).

SES-Related Achievement Gaps in Mathematics in Turkey and the European Union Countries

The major study in Turkey that provided information on SES-related achievement gaps in mathematics was the Examination of Student Achievement (Turkish acronym OBBS) by the Education Research and Development Directorate under MoNE (Eğitimi Araştırma ve Geliştirme

Dairesi Başkanlığı [EARGED], 2007). Results of MoNE's study indicated that across all grades from fourth to eighth, students who came from families with higher SES or whose parents had higher educational attainment achieved better in mathematics. However, lack of effect sizes in OBBS reports precluded comparing SES-based achievement gaps in Turkey with gaps in other nations.

Some information on SES-based mathematics achievement gaps at the middle-school level across EU countries came from a secondary analysis of TIMSS 2003 data (Akiba, LeTendre, & Scribner, 2007). On TIMSS 2003, Hungary, Romania, and Slovak Republic had the largest SES-related achievement gaps, whereas the gap in Latvia was relatively smaller (Akiba, LeTendre, & Scribner, 2007). To our knowledge, there has not been any prior comparative study between Turkey and EU countries on SES-related mathematics achievement gaps at the middle-school level.

At the high-school level, PISA 2003 and 2006 studies provided comparisons of the relationships between students' SES and their mathematics achievement in Turkey to that in the participating EU countries. The PISA 2003 socio-economic index of parents' occupational status explained 11.8% of the total variation in students' mathematics achievement in Turkey, which was a little over the OECD average of 11.7% (OECD, n.d). In some EU countries, such as Hungary (r^2 = 16.9), Germany (r^2 = 15.5), and Belgium (r^2 = 15.3), the relationship between students' socio-economic status and their mathematics achievement was even larger than it was for Turkey. Among the EU countries, socio-economic status had the weakest relationship with 15 year olds' mathematics achievement in Latvia (r^2 = 6.0), followed by Finland (r^2 = 7.2) (OECD, n.d). Demir, Kilic, and Depren (2009), in their secondary analysis of PISA 2003 data, concluded that student background factor, which included parents' highest educational levels and home educational resources and possessions among its indicator variables, was an important variable ($\beta = 0.41$, SE = 1.29) in predicting 15-year olds' mathematics achievement controlling for students' self-cognition in mathematics, their learning strategies, and school climate.

Students' SES levels were still an important factor in Turkish students' mathematics performances on PISA 2006 (OECD, n.d). The highest level of parental education and the highest level of parents' occupational status each accounted for 10% of the variance in students' mathematics performance on PISA 2006. In his secondary analyses of PISA 2006 data, Tomul (2009) found that parental education and income together accounted for Adj R^2 = 17% of the variance in mathematics achievement in Turkey although there were regional differences. In East Anatolia, there was no effect of parental education and income on mathematics achievement, whereas the effect in Aegean and Middle Anatolia regions was as high as 25%.

In PISA 2006, in Hungary, Bulgaria, the Slovak Republic and Slovenia, both the highest level of parental education and the highest level of parents' occupational status explained larger percentages of variance in mathematics achievement than it was for Turkey (i.e., 10%). In Denmark, Finland, Italy, Latvia, Spain, and Ireland, relationships between mathematics achievement and parental education and occupational status were smaller than the relationships in Turkey (OECD, n.d). PISA 2009 results also showed positive association between SES and mathematics achievement in Turkey although this relationship was not as strong as it was for Israel, Russia, Greece, and Bulgaria (Kilic, Cene, & Demir, 2012).

A notable finding on PISA 2003 was the variation among high-schools in Turkey was the largest among the OECD countries on the mathematics scale. The proportion of between-school variation explained by students' socio-economic status was 10% in Turkey, which was higher than the OECD average of 8.5%. On the other hand, the within-school variance explained by students' socio-economic status was 0.7%, which was lower than the OECD average of 4.4% (OECD, 2005). These results suggested that Turkish high schools differed in their social intake, whereas within high schools students were homogeneous in terms of their socioeconomic backgrounds. Among the EU countries participated in PISA 2003, Hungary had the largest between-school variation. Hungary also came right after Turkey with the second largest between-school variation among OECD countries. Hungary, followed by Netherlands, were the two European countries where the between-school variation was larger than the within-school variance (OECD, 2005). These results suggested that, like Turkey, in Hungary and Netherlands, students with similar achievement levels were likely to be placed together in schools. The virtually negligible amount of variation between schools in Finland in addition to the small overall variance, on the other hand, suggested that Finland is succeeding in the development of an equitable education system. The between-school variance in Finland was the smallest in EU and exceeded the between-school variation in only Iceland among OECD countries (OECD, 2005).

Dramatic variation among Turkish schools in terms of students' mathematics achievement was still apparent on PISA 2006 (EARGED, 2007). Alacaci and Erbas (2010) found the between-school variance accounted for a large percentage (i.e., 55%) of the variation in students' mathematics achievement, and students' socio-economic status and gender explained only 1.43% of the between-school variance. These results replicated PISA 2003 findings and once again suggested the homogeneity of Turkish high-schools in terms of students' ability levels and socio-economic statuses.

The dramatic variation in mathematics achievement across high schools on PISA 2003 can largely be explained by the tracking nature of Turkish education system. Transition from primary to secondary education in Turkey is mainly based on students' scores on national high-stakes tests, which include mathematics sections, administered during primary school years. Secondary analyses of PISA showed that students in the most selective public high schools, namely Anatolian, Science, and Police high schools, and private high schools performed recognizably better in mathematics than their counterparts in other schools (EARGED, 2005). Further, Berberoglu and Kalender (2005) found that students in such prestigious high schools performed better on the mathematics-science section of the highly competitive national university entrance examination. Thus, national high-stakes tests that students take during their primary school years, indeed, have long lasting consequences in their secondary and upper-secondary educations. Given the consequential, high-stakes tests that primary-school students take, achieving equity at the primary-school level is crucially important in Turkey. However, research in Turkey on gap analysis in mathematics education among primary-school students is very limited. This is rather unfortunate because

> Research on gaps between underserved groups and their more advantaged peers are important for shaping public opinion and informing education policy. Analyses of gaps also inform mathematics education research and practice, illuminating which groups and curricular areas are most in need of intervention and additional study. (Lubienski, 2008, p. 350)

In Turkish education system, gaps at the primary school among different groups are likely to continue and, even worse, to grow in secondary and upper-secondary schooling years. Consequently, identifying underserved and underachieving groups in primary schools and informing policy makers about evidence-based interventions to alleviate the disparities are essential.

Significance of the Study

Achievement gap studies are very rare in Turkey, particularly at the middle-school level. Indeed, the only study that investigated gender- and SES-related achievement gaps with a representative national sample at the middle-school level was the Examination of Student Achievement study by the MoNE (EARGED, 2007). Further, there has not been a cross-national study that used consistent assessment and variables to measure the level of SES-related achievement gaps at the middle-school level in Turkey and the EU countries. International studies such as TIMSS provide opportunities not only to compare achievement levels of students across countries but also to answer questions such as "How large are the differences between subgroups of students (gender, socio-economic groups, urban/rural, and so on), and how do these differences compare with those in our system?" (Postlethwaite & Leung, 2007, p. 216) Indeed, Postlethwaite and Leung argued cross-national comparisons of achievement gaps are among major research arenas that inform policy. This cross-national study fills a gap by examining the magnitude of the SES-related achievement gaps in mathematics at the middle-school level in Turkey compared to achievement gaps in EU countries. In addition to identifying under-achieving groups, this study also highlights the mathematics content domains in which achievement gaps are larger.

Research Questions

The following research questions guided this study:

1. How does Turkey compare to the sample EU countries in terms of the relationship between students' SES levels and their achievement in mathematics?
2. How does Turkey compare to the sample EU countries in terms of the extent of the achievement gap between the socioeconomically most disadvantaged students and their more affluent peers?
3. How does Turkey compare to the sample EU countries in terms of the representation of low- and high-SES students in the upper quartile and above in overall mathematics achievement?

Methods

Participants

Sample countries were Turkey and the EU countries that provided the necessary variables: Bulgaria, Cyprus, Czech Republic, Hungary, Italy, Lithuania, Malta, Romania, and Slovenia. Target populations were all of the eighth graders in each participating country, except for Lithuania, where the target population was restricted to students who were taught in Lithuanian.

Instrument

Mathematics achievement test. The framework for mathematics assessment had two dimensions: a content dimension and a cognitive dimension. The content dimension laid out the subject matter assessed, which were (a) number, (b) algebra, (c) geometry, and (d) data-and-chance. The cognitive dimension classified thinking processes assessed under different cognitive domains: (a) knowing, (b) applying, and (c) reasoning.

Scaling of the mathematics achievement data. In TIMSS, item response theory (IRT) together with multiple imputation, also known as plausible value, was used to make reliable estimates of students' abilities. For most of the analyses in the current study, IDB Analyzer, an add-on for the statistical package SPSS developed by the International Association for the Evaluation of Educational Achievement to take into account sample and test design, was used.

Score reliability. TIMSS 2007 technical reports included the internal consistency reliability coefficient of mathematics scores for each country. Reliability coefficients for the countries included in the present study were sufficiently large (Nunnally & Bernstein, 1994).

Analyses

First research question. Parental education was used as the SES measure. Hampden-Thompson and Johnston (2006) showed parental education was a consistent indicator of mathematics achievement across countries. Correlations analyses were conducted between the parental education level and achievement scores in mathematics, overall, and in various content and cognitive domains. The parental education variable, which was the education level of the parent who had the highest educational attainment, was on a 7-point ordinal scale (*ISCED Level 0* to *Beyond ISCED 5A, first degree*). Because the scaling of parental education was ordinal, the most appropriate correlation method would have been the Spearman's rank correlation. However, the

IDB analyzer did not support Spearman rank correlation. To compensate for the unavailability of Spearman rank procedure, three different correlation analyses were conducted for triangulation: (a) Pearson *r* correlations between the parental education level and achievement scores, (b) Pearson *r* correlations between the parental education level and achievement scores transformed to ranks, and (c) Spearman rank correlations between the parental education level and achievement scores in SPSS using sampling weights. Three different correlation analyses conducted for triangulation revealed very similar results in mathematics, overall, and in content and cognitive domains. Therefore, results from the first set of correlation analyses, that is, Pearson *r* correlations between the parental education level and achievement scores, are reported. Confidence intervals for correlation coefficients were calculated and also graphed to ease comparisons.

Second research question. After examining the relationship between SES and mathematics achievement, achievement gaps between the lowest and highest SES groups were further investigated. The rationale for exploring these achievement gaps was both to identify the extent of the achievement gap between the socioeconomically most disadvantaged students and their more affluent peers in each country and to cross-nationally compare achievement levels of students from different socioeconomic strata. Students in the lowest SES group were those whose parents' education levels were no more than ISCED 0/1/2. Students in the highest SES group were those who came from families where the education level of the parent who had the highest educational attainment was at least ISCED 5B. Differences between low- and high-SES groups were examined using CIs around the mean achievement scores and Cohen's *d* effect sizes. For all effect size calculations, low-SES students' achievement scores were subtracted from high-SES students' achievement scores.

Third research question. In addition to understanding achievement differences between low- and high-SES students, it was also important to know how likely it was for low-SES students, compared to their more affluent peers, to be high achievers in mathematics. Thus, percentages of low- and high-SES students performing in the 75th to 99th percentile were calculated. Confidence intervals around the estimated percentages were displayed to ease the comparison of low- and high-SES students' representations in the upper quartile and above.

Results

Sample countries differed in terms of the percentages of students who came from low-, medium-, and high-SES families (see Figure 1). Whereas the Czech Republic had the smallest percentage of students who came from low-SES families (i.e., 2.36%), Turkey had the largest (i.e., 68.08%). Turkey also had the smallest percentage of students from high-SES background (i.e., 11.05%). Among the EU countries, Malta had the largest percentage of low-SES students, 48.49%, followed by Italy (i.e., 28.78%). An important observation was the four countries whose average mathematics achievements were above the TIMSS scale average of 500, namely the Czech Republic, Hungary, Lithuania, and Slovenia, had the lowest percentages of low-SES students.

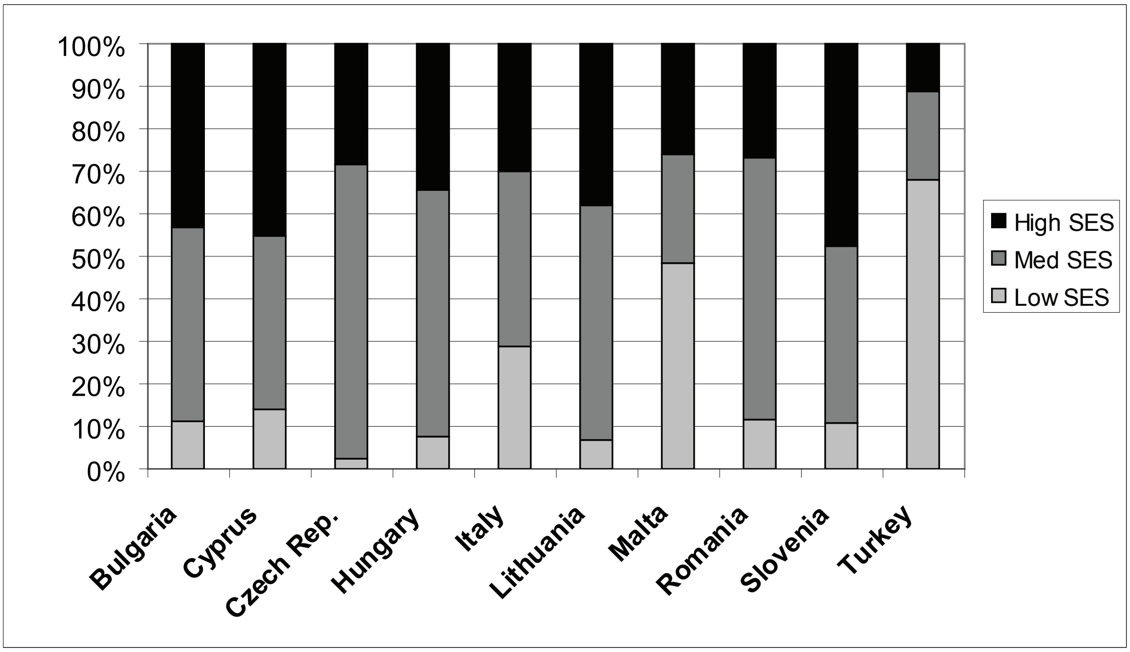

Figure 1. Percentages of students from low-, medium-, and high-SES families in each sample country.

Findings for the First Research Question

The magnitude of the relationship between SES and mathematics achievement scores was the smallest in Malta (r = 0.19, SE = 0.02) and was the largest in Turkey (r = 0.39, SE = 0.02) (see Figure 2). Thus, Turkey not only did have the lowest average achievement in mathematics but also the largest inequality based on SES when compared to the sample EU countries. Hungary, which ranked the highest in terms of the average mathematics achievement among the sample countries, had the second largest correlation between SES and mathematics achievement (r = 0.35, SE = 0.03). After examining the relationship between SES and overall mathematics achievement, results were disaggregated by content and cognitive domains. Because of space limitations, the authors could not include all the tables or figures for the various content and cognitive domains. While the main findings of the disaggregated analyses are presented here, the interested reader can contact the authors for more detailed results.Turkey had the largest correlation between SES and achievement in all of the content and cognitive domains, followed, in order, by Hungary and Bulgaria.

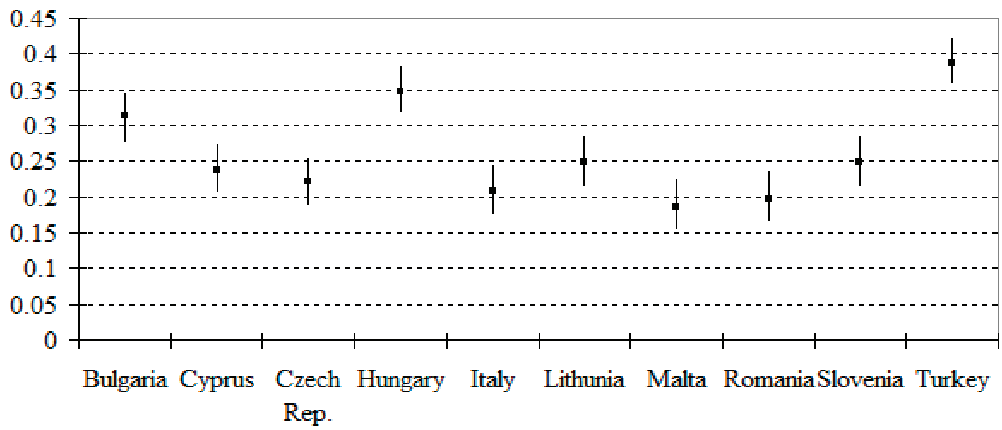

Figure 2. Pearson r correlations between SES and achievement scores in mathematics in each sample country.

In addition to comparing effect sizes across the countries, it was noteworthy to compare these current effect sizes to those obtained in other studies or in other countries. In his meta-analytic review of the US research literature on the relationship between SES and academic achievement, Sirin (2005) found that the average effect size between SES and mathematics achievement was r = 0.35. In all the countries in the current study, except for Hungary and Turkey, correlations between SES and achievement in mathematics, overall, and in all content and cognitive were smaller than 0.35. In Turkey, relationships between SES and achievement in mathematics, algebra, number, geometry, knowing, and applying were stronger than the average relationship in Sirin's meta-analysis. Although effect sizes obtained for Hungary never exceeded Sirin's average, correlations between SES and achievement in mathematics, overall, and in applying cognitive domain for Hungary were the same as Sirin's average effect size (i.e., r = 0.35).

Findings for the Second Research Question: Comparison of Achievement Levels Between Low- and High-SES Groups

The magnitude of the difference in the mean mathematics achievement scores between low- and high-SES students was the smallest in Malta (Cohen's d = 0.45) and the highest in Hungary (Cohen's d = 1.45) (see Table 1). Turkey had the second largest difference between low- and high-SES students mathematics achievement (Cohen's d = 1.22) after Hungary. Interpretations of Cohen's d effect sizes in terms of percentile standing might illustrate the extent of the disparities better. Cohen's d effect sizes indicated that means of the high-SES students were at approximately 93rd and 88th percentiles of the low-SES students in Hungary and Turkey, respectively.

Table 1

Cohen's d Effect Sizes and 95% CIs Around Means for Achievement Differences Between Low- and High-SES Students in Mathematics in Each Sample Country

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Low	348	415.4	103.9	[394.5, 436.3]	0.84
	High	2066	495.4	93.6	[484.8, 505.9]	
Cyprus	Low	624	421.1	93.5	[413.0, 429.3]	0.75
	High	1973	487.0	85.3	[482.5, 491.4]	
Czech	Low	106	460.5	68.2	[437.5, 483.5]	0.86
	High	1425	526.4	77.3	[519.3, 533.4]	
Hungary	Low	269	432.9	72.7	[417.7, 448.2]	1.45
	High	1543	551.9	83.5	[542.7, 561.1]	
Italy	Low	1241	448.6	77.2	[439.6, 457.5]	0.65
	High	1362	497.2	73.0	[490.3, 504.1]	
Lithuania	Low	255	445.7	75.9	[431.8, 459.6]	1.03
	High	1604	527.8	80.2	[515.6, 540.0]	
Malta	Low	2241	467.7	91.8	[463.0, 472.3]	0.45
	High	1227	508.4	89.9	[500.3, 516.6]	

Tablo 1'in devamı

Romania	Low	352	410.8	93.1	[394.9, 426.7]	0.73
	High	1308	483.7	102.5	[470.1, 497.4]	
Slovenia	Low	413	466.5	69.4	[455.5, 477.4]	0.71
	High	1987	517.8	72.7	[512.3, 523.2]	
Turkey	Low	2936	405.5	97.7	[396.9, 414.0]	1.22
	High	583	528.5	116.6	[513.1, 543.9]	

An important finding in Figure 3 was that low-SES Turkish students' performances in mathematics were among the lowest across sample countries whereas high-SES Turkish students' performances exceeded their high SES peers in Bulgaria, Cyprus, Italy, Romania, and Malta and was exceeded by only high-SES Hungarian students. From another point of view, although Turkey had lower mathematics achievement on TIMSS 2007 than all of the countries in the present study, Turkish students from high-SES families performed comparably to their high-SES peers in countries whose average mathematics achievements were above TIMSS scale average of 500 (i.e., the Czech Republic, Lithuania, and Slovenia).

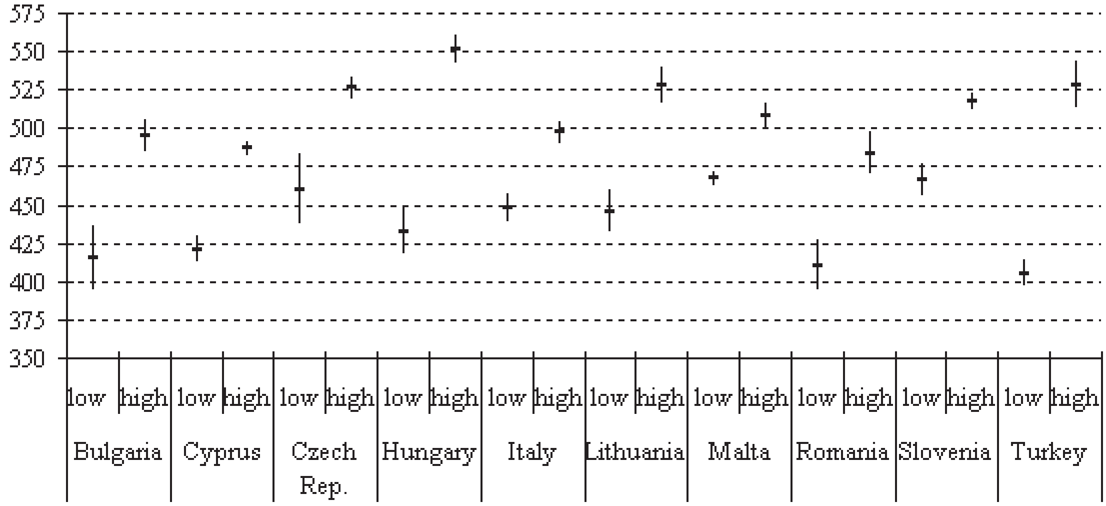

Figure 3. 95% CIs around means for achievement differences between low- and high-SES students in mathematics in each sample country.

After examining differences between low- and high-SES students in overall mathematics achievement, results were disaggregated by content and cognitive domains. Across all content and cognitive domains, Malta had the smallest SES-based achievement gap whereas Hungary had the largest. Turkey had the second largest achievement gap between low- and high-SES students in all domains. Low-SES Turkish students were among the lowest performers in all content and cognitive domains, except for data-and-chance. In data-and-chance, low-SES students from Bulgaria and Romania achieved lower than Turkish low-SES students. Indeed, in data-and-chance, Bulgarian and Romanian high-SES students also performed lower than their high-SES peers in the remaining countries in the present study.

Average achievement scores of Turkish high-SES students in all content and cognitive domains were above the TIMSS scale average of 500. In algebra, Turkish high-SES students, together with Hungarian high-SES peers, performed better than their peers in other countries. Indeed, high-SES Hungarian students were consistently among the top achievers in all content and cognitive domains. Turkish high-SES students' performances were comparable to those of high-SES students from Hungary in the cognitive domain of applying. In other content and cognitive domains, although Turkish high-SES students did not perform as well as their high-SES peers from Hungary, Turkish high-SES students' performances were comparable to their high-SES peers in Slovenia, and, in some domains, in Lithuania and the Czech Republic, all of which had substantially better rankings than Turkey on TIMSS 2007.

Findings for the Third Research Question: Percentages of Low- and High-SES Students Performing in the Upper Quartile and Above in Mathematics

Representations of low-SES students in the upper quartile and above in overall mathematics achievement were substantially smaller than their high-SES peers in all the countries in the present study (see Figure 4). The most dramatic difference between percentages of low-SES and high-SES students performing in the upper quartile and above in mathematics was in Hungary. Compared to 40.6% of high-SES students, only 2.6% of low-SES Hungarian students were performing in the top 25% in mathematics. In other words, the representation of high-SES Hungarian students in the upper quartile and above was approximately 15 times as much as the representation of their low-SES peers. Such striking differences were found across content and cognitive domains in Hungary although in data-and-chance representation of high-SES students among high achievers dropped to 7.6 times as much as their low-SES peers.

Lithuania, the Czech Republic, Turkey, and Romania, respectively, followed Hungary in terms of the size of the difference between low- and high-SES students' percentages in the top 25% in mathematics. In mathematics, overall, and across content and cognitive domains, representations of high-SES students in the upper quartile and above were approximately 3.4 to 5.3, 2.3 to 4.4, 3.2 to 4.1, and 3.0 to 3.9 times as much as that of low-SES students in Lithuania, the Czech Republic, Turkey, and Romania, respectively. The difference between percentages of low- and high-SES students in the top quarter was the smallest in Malta. Representations of high-SES Maltese students were less than two times as much as that of their low-SES Maltese peers in mathematics, overall, and in all content and cognitive domains.

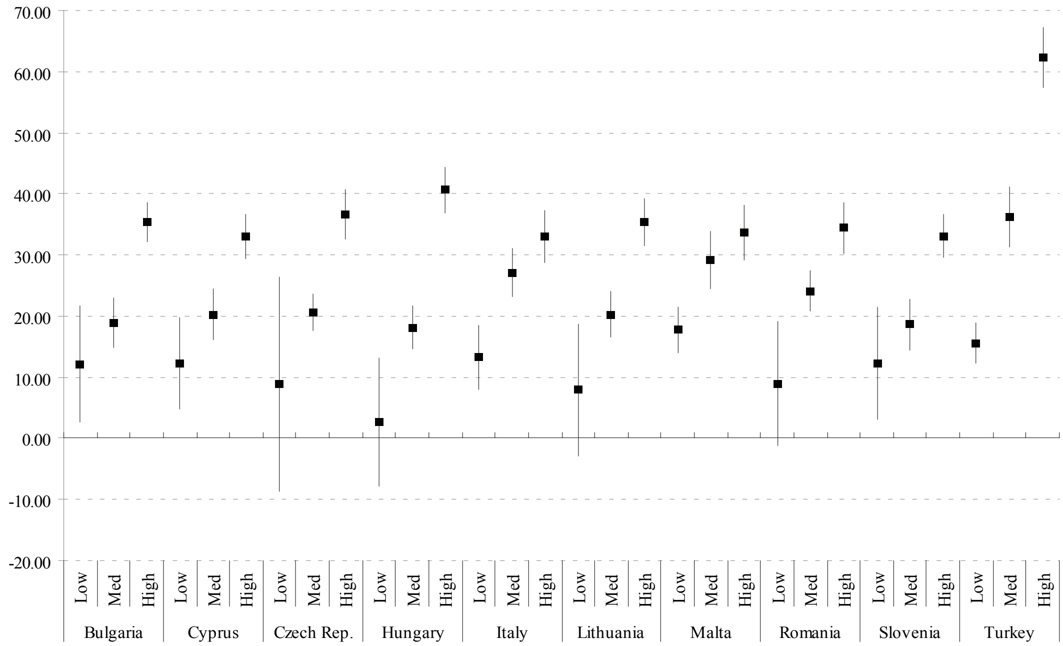

Figure 4. 95% CIs around percentages of low-, medium, and high-SES students performing in the upper quartile and above in mathematics.

Discussion

The current study revealed important achievement gaps between low- and high-SES Turkish eighth-grade students' in mathematics. Turkey and Hungary, the former with the lowest and the latter with the highest average achievement on TIMSS 2007 among the sample countries in the current study, had the strongest correlations between SES and mathematics achievement. Sizes of the achievement gaps in mathematics between low- and high-SES students were also the largest in Hungary (Cohen's d = 1.45) and Turkey (Cohen's d = 1.22).

A major resemblance between Turkey and Hungary that may explain the high SES-related achievement gap is the selective nature of their education systems. The apparent selectivity of Turkish and Hungarian education systems resulted in large between-school variations in mathematics achievement of 15-year olds in these two countries on PISA studies. The early tracking in the Turkish education system causes stress for most Turkish students and their parents resulting in seek for supplementary external resources. Using such resources, like private tutoring, poses a serious economic burden on parents. Thus, SES levels of middle- and high-school students become an indicator for receiving private tutoring (Tansel & Bircan, 2008). In a study on the high school examination data from Konya province of Turkey, Yavuz (2009) found a direct relationship between mother's education and eighth-grade students' mathematics achievement. Fathers' education was both directly and indirectly, by increasing the family income and students' attendances to private tutoring centers, related to performance in mathematics (Yavuz, 2009). Our results also suggest that economical reasons of access to private tutoring sessions may be contributing to the inequity among middle-school students' mathematics achievement on TIMSS. Regarding the selectivity of the education system in Hungary, an OECD report (Hoffman, Ferreira, Levin, & Field, 2005) concluded that "Many countries have selection mechanisms, but Hungary appears to have every kind at all levels of schooling; and they add up to a system that deeply disadvantages the poor, visible minorities, and special education students" (p. 15). Unlike the central and homogeneous public education during socialism in Hungary, today

> A wide array of educational institutions are competing to attract children and retain or increase their per pupil financing. The result is a system out of balance: high performance schools with excellent reputations select students by exam and grades since they can fill more places than they have available; middling schools take the next tier, and isolated, marginal, or weak schools have small classes for children who are "leftovers" with few options. Usually these are the children of the poor and disadvantaged. (Hoffman et al., 2005, p.16)

Thus, Hungarian school system, which isolates disadvantaged and low-SES students rather than mixing them with their more advantaged and affluent peers, and the poor educational resources that low-SES students get can provide useful explanations for the SES-related inequity in mathematics outcomes among Hungarian students.

Turkish, Romanian, and Bulgarian low-SES students were the lowest achieving students when compared cross-nationally with EU countries. However, Romania (11.19%) and Bulgaria (11.68%) also had substantially lower percentages of low-SES students than Turkey. Thus, Turkey was the only country in the current study where more than half (i.e., 68.08%) of the students were from low-SES families and where such a large portion of students achieved below their peers in the sample EU countries. The magnitude of the relationship between SES and mathematics achievement scores was also large in Bulgaria compared to other EU countries; Bulgaria ranked third after Turkey and Hungary. The World Bank (n.d.) noted that despite Bulgaria's impressive economic performance lately, inequities in access to quality education are still prominent. Students from low-income families, rural areas, or ethnic minorities are at the risk of dropping out of school or being illiterate. The 2005 survey of the Bulgarian Academy of Science revealed that the percentage of illiterate children, that is children who graduated from fourth grade or below was 9% among the Bulgarian ethnic group, 24% among the Turkish ethnic group, and 64%

for the Roma ethnic group (Simeonova, Korudjieva, & Petrova, n.d.). The SES-based inequity in access to education was found to be larger in Bulgaria that in Hungary, Poland, or Romania (the World Bank, n.d.). A particular reason that was suggested as an explanation for the low-income families' indifference to education in Bulgaria was that those families did not believe that the benefits of education are worth its cost (the World Bank, n.d.).

The EU country in the current study that had the closest percentage of low-SES students to Turkey was Malta (i.e., 48.49%). However, the SES-related achievement gap in mathematics in Malta (Cohen's $d = 0.45$) was not only smaller than that of in Turkey but was also smaller than the SES-related achievement gaps in all sample EU countries. After the current study's results were obtained, in a personal communication with the TIMSS 2007 national research coordinator for Malta, the authors were informed that secondary schools for very low achievers were excluded from Malta's TIMSS 2007 sample because these schools did not use the mainstream curriculum (R. Camilleri, personal communication, September 23, 2010). Because it is very likely that students who were considered very low achievers and thus were excluded from Malta's sample came from the most disadvantaged families in terms of SES, the author refrains from making judgments about the achievement gaps between Maltese low- and high-SES students' achievement levels based on TIMSS 2007 results.

Educational Implications

Turkey needs to overcome the large SES-based gap in Turkish eighth-grade students' mathematics achievement. One of the important contributors to the achievement gap can be the tracking in Turkish education system. Tracking maintains inequities as it disproportionately allocates students from low-SES backgrounds to lower learning tracks. Countries where students' mathematics achievement levels rank top on international studies, such as Japan and Finland, tracking is rare or does not exist (Ansalone, 2004). One of the main education reforms in Poland, the only country that moved up from below average to above average on PISA, was to delay tracking. As argued by Burris and Welner (2005), "dismantling tracking and providing the high-track curriculum to all" (p. 595) can help to bridge the achievement gap.

After-school programs and remedial courses have also been suggested by researchers as tools to help boost low-SES students' achievement (Rothstein, 2006). Indeed, another reform movement of Poland towards improving achievement was to increase hours of instruction. In their study on factors that help bridge the achievement gap, Balfanz and Byrnes (2006) followed multiple cohorts of low-SES students over several years and concluded that "a string of good teachers and successful instructional experiences, a new-found self-confidence in mathematics, increased effort, and better attendance" (p. 155) were the most prominent factors. Thus, Turkey needs to consider the quality of teachers and teaching and learning experiences of low-SES students as a part of its efforts to close the achievement gap. Providing low-SES students with after-school programs similar to those their more affluent peers are exposed to can be another tool in bridging the achievement gap.

It is important to note that another effective way to bridge the gap between students of low- and high-income families is to provide the students with high quality pre-school education. Indeed, in the United States, where Black and Hispanic students are usually from low-income families, the effectiveness of preschool education programs on bridging the achievement gap has been noted.

By the time balck and Hispanic children reach kindergarten, they are on average already far behind their more advantaged peers in reading and math readiness. Such disparities in achievement persist or even increase during the school years. Educational programs for parents and preschool education programs for children have the potential to narrow these disparities by at least half. (Haskins & Rouse, 2005, p. 1)

Conclusion

The current study highlighted the substantial relationship between eighth-grade students' socioeconomic backgrounds and their mathematics achievement in Turkey. Such a powerful relationship between SES and students' mathematics achievement was also found in Hungary among the EU countries. The highly selective nature of Turkish education system can be contributing this SES-related disparity as more affluent families provide additional support, such as private tutors, outside of school. The role of additional subsidies for educational activities have been noted by the World Bank (2005) as they found that although Turkey's total expenditure on education was higher than that of many of the OECD countries, only 4.34% of GDP was the public expenditures and 2.63% of GDP was private and other expenditures. The risk that early tracking poses to equity has been a particular concern for the EU, and the current study's findings are aligned with similar concerns.

TIMSS 2007 data were rich and collected using rigorous sampling procedures allowing for comparisons across countries, however, the data also had some limitations. For example, family income was not collected so parental education was used as a proxy for SES. Further, questionnaire items about parental education were not administered in England and Scotland or were missing for more than half of the students in Sweden. Thus, these three countries had to be excluded from the current study.

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