ACHIEVEMENT AND OPPORTUNITY GAPS IN MATHEMATICS EDUCATION IN TURKEY COMPARED TO EUROPEAN UNION COUNTRIES

A Dissertation

by

ZEYNEP EBRAR YETKINER

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2010

Major Subject: Curriculum and Instruction

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Approved by:

Co-Chairs of Committee,	Yeping Li
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ABSTRACT

Achievement and Opportunity Gaps in Mathematics Education in Turkey Compared to European Union Countries. (December 2010)

Zeynep Ebrar Yetkiner, B.S., Marmara University

Co-Chairs of Advisory Committee: Dr. Yeping Li
Dr. Bruce Thompson

One of the main purposes of this dissertation was to examine gender- and socioeconomic status (SES)-related mathematics achievement gaps among Turkish middle-school students compared to achievement gaps in European Union (EU) countries. A further purpose of the present study was to investigate qualified mathematics teachers' distribution in relation to student SES among Turkish middle schools. Finally, relationships between mathematics teacher quality indicators and students' mathematics achievement within Turkish middle-school classrooms were explored.

In this dissertation, Trends in International Mathematics and Science Study 2007 data were used. Sample countries were Turkey, Bulgaria, Cyprus, Czech Republic, Hungary, Italy, Lithuania, Malta, Romania, and Slovenia. Achievement gaps by gender and SES were examined using Cohen's *d* effect sizes and 95% confidence intervals. Relationships between mathematics teacher quality and students' mathematics achievement were investigated using hierarchical linear modeling.

Results showed none or only negligible gender differences but substantial SES-related gaps in Turkish students' achievement in mathematics, overall, or in various content and cognitive domains. Correlations between students' SES levels and their achievement were the largest in Turkey compared to the sample EU countries. Among the sample EU countries, only Hungary had as large or even somewhat larger disparities as Turkey between low- and high-SES students' mathematics achievement. The current study also identified SES-related inequities in access to qualified mathematics teachers in Turkey. Low-SES students were more likely to be taught by mathematics teachers who had less than 3 years of experience or who did not hold a degree in mathematics or mathematics education. On the other hand, years of experience and a degree in mathematics or mathematics education were found to be substantially related to Turkish eighth-grade students' mathematics achievement. Low-SES students' mathematics teachers were also more likely to report lack of confidence in their preparation to teach various mathematics contents.

To narrow achievement gaps, Turkish policy-makers can explore and benefit from policies of the countries identified in the present study as more equitable in terms of student achievement than Turkey. The current study also shows Turkish policy-makers importance of the equitable distribution of qualified mathematics teachers in closing the mathematics achievement gap in middle schools.

DEDICATION

To my beloved family –

my parents, my sister, my precious nephew Mustafa,

and my fiance Serkan

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NOMENCLATURE

EARGED	Egitimi Arastirma ve Gelistirme Dairesi Baskanligi
MoNE	Ministry of National Education
OBBS	Examination of Student Achievement

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CHAPTER I

INTRODUCTION

The introduction of this dissertation presents the purpose of the study and brief literature to support and justify the proposed research. Research questions are presented followed by a discussion of the significance of the study.

Purpose of the Study

One of the main purposes of this dissertation was to examine educational equity in terms of student achievement outcomes in mathematics among middle-school students in Turkey as compared to that in the European Union (EU) countries. Disparities in Turkish middle-school students' mathematics achievement by socioeconomic status (SES) and gender were investigated with attention to the interaction between SES and gender. A further purpose of the present study was to investigate the distribution of qualified mathematics teachers in relation to students' SES among Turkish middle schools. Finally, relationships between mathematics teacher quality indicators and students' mathematics achievement within Turkish middle-school classrooms were explored.

Equity in Mathematics Education

Achieving equity in mathematics education is a challenging though a paramount

This dissertation follows the style of *Educational Researcher*.

goal with potential promises to remedy social and economical disparities. As Moses (2001) argued, “today … 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 from different perspectives. National Council of Teachers of Mathematics [NCTM] perceives equity in terms of student achievement outcomes, treatment of students, and students’ access to educational resources (NCTM, 2008). Indeed, such a conceptualization of equity is shared by the EU. 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. For example, 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 opportunities indicate that students are not discriminated in their educational endeavors and in benefiting from quality educational resources based on socio-economic background, sex, race or ethnicity, disabilities, and minority or migration status. Demeuse, Baye, and Doherty (2007) referred to equitable opportunities as "potential" (p. 3) equity because equitable opportunities do not necessarily ensure "actual" (p. 3) equity in terms of equitable access or treatment. Equitable access and treatment imply, for example, comparable representation of students with various demographics at different levels of education as well as equitable access to quality curriculum, advanced courses, well-qualified teachers, or favorable school resources such as small classes and up-to-date educational materials.

The Stage of Equity in Mathematics Education in Turkey

The big picture of Turkish students' mathematics achievement in international and national studies reflects disparities. In international studies Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA), more than half of Turkish students performed at or below the lowest international benchmarks in mathematics. A notable finding in TIMSS 2007 was although Turkey had a larger percentage of students than the participating EU countries who performed at the lowest level in mathematics, only Hungary, England, Lithuania, and the Czech Republic had larger percentages of students than Turkey who reached the advanced benchmark (Martin, Mullis, & Foy, 2008). PISA 2003 results were similar. The percentage of students achieving at the highest level or above in mathematics section of PISA was larger in Turkey than it was in some of the participating EU countries (Organisation for Economic Co-operation and Development [OECD], n.d.b). These findings confirm the World Bank's (2005b) suggestion that

> Turkey's challenge is to transform a school system that succeeds in educating a small number of students to the highest international standards into one that does a good job at educating all students. If the education system does not move in this direction, the vast majority of students will develop few skills and inadequate competencies, a result that is neither equitable nor sustainable. (p. 18)

The striking inequities in achievement at the secondary-school level and onward into university among Turkish students 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. Students who score high enough on these tests can attend prestigious public and private high schools. Students whose scores do not suffice to attend these schools can enroll in public general and vocational high schools and many other private schools. Due mainly to this tracking system, among all the countries participated in PISA 2003, whose participants were mainly ninth-grade students, the variation in mathematics achievement across schools was the largest in Turkey. 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 (Egitimi Arastirma ve Gelistirme Dairesi Baskanligi [EARGED], 2005). Further, Berberoglu and Kalender (2005) found that students in such 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. However, a rigorous literature search to locate studies on achievement and opportunity gaps in mathematics among primary school students showed the scarcity of relevant research in Turkey.

The major, if not the only, study in Turkey that provided information on the mathematics achievement level differences based on gender and family backgrounds was the Examination of Student Achievement (Turkish acronym OBBS) by the Education Research and Development Directorate under MoNE (EARGED, 2007). Random samples of fourth, fifth, sixth, seventh, and eighth graders in 829 public and private primary schools were administered mathematics achievement tests. Achievement results were reported as absolute percentage scores disaggregated by grade, SES, and gender. The Examination of Student Achievement study was an important step towards identifying the extent of the gaps among different groups and when these gaps began. However, more and better research is needed on mathematics achievement gaps in Turkey.

Equity in Mathematics Education in the European Union

For decades achieving equity in educational systems in member countries has been a prominent goal for the 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, education systems where students from low and high income families, minorities and nonminorities, immigrants and natives, or boys and girls have equitable educational opportunities and outcomes are yet to be accomplished (European Parliament, 2000).

Among important hindrances to providing equitable opportunities to all students have been economical constraints and the economical perspective on education that is more concerned about efficiency as compared to equity. Nonetheless, the Commission of the European Communities (2006) concluded that “it is frequently assumed that efficiency and equity objectives are mutually exclusive.… However, the evidence shows that viewed in a wider perspective, equity and efficiency are, in fact, mutually reinforcing…” (p. 2). The Commission further stated “inequities in education and training also have huge hidden costs which are rarely shown in public accounting systems” (p. 2). In addition to concerns about social justice, long term negative consequences of educational disparities on social resources have been one of the major reasons for the increased attention to equity in both research and policy arenas (Baker, LeTendre, Goesling, 2005).

To alleviate disparities in educational outcomes, the EU has identified benchmarks for the member states. One of the five EU benchmarks for 2010 was an “increase of at least 15% in the number of tertiary graduates in Mathematics, Science and Technology (MST), with a simultaneous decrease in the gender imbalance” (Commission of the European Communities, 2009, p. 14). The 15% increase in mathematics, science, and technology tertiary graduates was achieved before 2005 with some countries reaching the benchmark level and some coming very close to it. However, the gender imbalance is still notable as 68% of the Mathematics, Science and Technology graduates are males (Commission of the European Communities).

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.

Some information on the extent of equity in mathematics education in EU countries comes from comparative studies. In their secondary analysis of TIMSS 2003 data, Akiba, LeTendre, and Scribner (2007) examined the mathematics achievement gap between eighth-grade low and high-SES students and differential access to qualified teachers in the US as compared to the other participating countries. Akiba et al. found variations across the sample EU countries in the amount of both mathematics achievement gap and opportunity gap in access to qualified mathematics teachers between low- and high-SES students. Whereas Hungary and Romania were among the countries where the difference between the national averages of low- and high-SES students’ mathematics achievements was the largest, in Latvia this difference was relatively smaller. Akiba et al. further found that in Romania and Slovenia the percentage point differences between low- and high-SES students taught by qualified mathematics teachers were larger than the average difference for the countries included in the study. On the other hand, in Bulgaria, Lithuania, Italy, and Sweden more equitable percentages of poor and wealthy students were taught by qualified mathematics teachers. In another TIMSS 2003 secondary analysis by Caceres (2009), which was conducted at the individual teacher level as opposed to the national level analyses by Akiba et al., there were negligible correlations between the classroom mean SES and teacher quality in Romania and Sweden at the eighth-grade level. Because Turkey did not participate in TIMSS 2003, Akiba et al.'s and Caceres' studies did not include any information on achievement and opportunity disparities among Turkish students.

At the high-school level, Baker et al. (2005) conducted a comparative study with TIMSS 1999 data to examine if American students from disadvantaged backgrounds, measured by mothers' educational levels, are "more at risk of educational failure" (p. 74). The EU countries included in Baker et al.'s study were Netherlands, Sweden, Denmark, Austria, France, and Germany. Disadvantaged students in Netherlands, Sweden, Denmark, and Austria had a larger mean mathematics achievement than the international average for disadvantaged students. Although students from disadvantaged families in France and Germany had mean scores that were below the international average, their achievement were still above their disadvantaged peers from the US.

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).

Research Questions

The following research questions were examined in this dissertation:

1. How does Turkey compare to other EU countries in terms of the achievement gap in mathematics, overall, and in various content (i.e., number, algebra, geometry, and data-and-chance) and cognitive (i.e., knowing, applying, and reasoning) domains among different SES groups in middle school?
2. How does Turkey compare to other EU countries in terms of the gender-based achievement gap in mathematics, overall, and in various content (i.e., number, algebra, geometry, and data-and-chance) and cognitive (i.e., knowing, applying, and reasoning) domains, with attention to the interaction between SES and gender, in middle school?
3. In Turkey, if and to what extent is there differential access to qualified mathematics teachers based on students' SES in middle school?

4. In Turkey, what is the relationship between mathematics teacher quality and student achievement and, more specifically, if and to what extent mathematics teacher quality is associated with the achievement of low-SES students?

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). Results of MoNE's study indicated that low-SES students were behind their high-SES peers in mathematics achievement, and findings regarding gender-gap were inconsistent across grades. This dissertation contributed to the research by examining gender- and SES-related achievement gaps in mathematics, with particular attention to the interaction between gender and SES, among Turkish middle-school students.

Researchers have suggested "more skilled and nuanced analyses" (Lubienski, 2002, p. 350) of achievement and opportunity gaps to inform research, practice, and policy. McGraw, Lubienski, and Strutchens (2006) argued that gender gap studies would not be complete without investigating how SES and gender interacted on achievement gaps (i.e., if any potential gender differences endured across SES groups). Lubienski, on the other hand, argued mathematics achievement gap studies should not only identify underachieving groups but also the mathematics content domains in which achievement gaps are larger. This dissertation study examined gender and SES together to provide a more subtle understanding of SES and gender related achievement gaps in Turkey. Also, in the current study achievement gaps in overall mathematics were disaggregated by content domains (i.e., number, algebra, geometry, and data and chance) to provide a more differentiating understanding of disparities across curricular areas.

There has not been a cross-national study that used consistent assessment and variables to measure the level of gender- and SES-related achievement gaps at the middle-school level in Turkey and the EU countries. This cross-national study provided a comparison of the magnitude of the gender- and SES-based achievement gap to that in the sample 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. Policy-makers’ concerns about the relative educational disparities in their countries compared to other countries are understandable for various reasons. First and foremost, countries want to be informed about their standing in terms of social justice in education. Further, inequality in education is not only bad for social justice but also bad for economy (Baker et al., 2005; The Commission of the European Communities, 2006). Disparities in Science, Technology, Engineering, and Mathematics (STEM) education are even more consequential in today’s society for countries’ economical competitiveness and growth. Thus, knowledge about the countries that are doing better in terms of equitable achievement outcomes can subsequently lead policy-makers to examine social and educational policies in such countries that can potentially serve as a model for them.

Cross-national comparisons of achievement levels of traditionally low-achieving countries can also inform policy-makers about the significant negative impacts of achievement gaps on countries' international competitiveness in mathematics education. For example, Baker et al. (2005) showed that if US students from disadvantaged backgrounds performed as well as did their disadvantaged Swedish peers, US students' rank on TIMSS 1999 would have been considerably higher. Thus, students from disadvantaged background can potentially lower the mean achievement of nations where students from more advantaged backgrounds perform at or substantially above international averages. It would be worth to know if such a scenario is valid for Turkish middle-school students given the substantial achievement gaps at high-school level on PISA.

In addition to the achievement disparities, the present study examined the opportunity gap in access to quality teacher in Turkey. Turkish research literature in mathematics education does not only lack achievement gap studies but also studies that examine disparities in educational opportunities. Among school-related factors, research has provided some evidence that teacher quality is a particularly important predictor of learning outcomes (Darling-Hammond, 2000; Wayne & Youngs, 2003). Research shows that teacher qualifications, such as certification and subject-matter preparation, are associated with student achievement. As a result, there have been several calls for more equitable distribution of teachers and more qualified teachers for disadvantaged students. However, studies in the US and international studies on opportunity gap in access to qualified teachers have found substantial inequalities (Akiba et al., 2007; Betts, Rueben, & Danenberg, 2000; Caceres, 2009). As the initial step to achieve equity, there was a need in Turkish literature to examine the opportunity gap in mathematics education, a main aspect of which is the distribution of qualified teachers.

The main reason of calls for equitable distribution of qualified teachers is to obtain equal student achievement outcomes. Although there has been some research on the relationship between teacher qualifications and student achievement, particularly in the US, what teacher qualifications make teachers effective in closing the achievement is still a question to be answered (Borman & Kimball, 2004). Research on teacher characteristics that are associated with better achievement outcomes for low-SES students is important for every country as they develop interventions to alleviate disparities in educational outcomes. Results of such research can inform MoNE, which maintains all the responsibility for hiring and assignment of teachers for public schools. Thus, the current study investigated the association between teacher qualifications and achievement of low-SES students.

Although because of its exploratory nature, the present study cannot help to resolve any possible problems found, knowledge obtained from the present study can have important policy implications. For example, in the course of narrowing the opportunity gap, Turkish policy-makers can explore and benefit from the policies of the countries identified in the present study that are more equitable in terms of student achievement than Turkey. The current study also illuminates the extent of inequities between low- and high-SES Turkish students in their access to qualified mathematics teachers. Moreover, by showing the relationship between teacher qualifications and student achievement, the present study shows Turkish policy-makers the importance of the equitable distribution of qualified teachers in closing the achievement gap in middle schools.

CHAPTER II

LITERATURE REVIEW

Overview

Following the foundation of Turkish Republic in 1923, substantive reforms were undertaken in Turkish education system. Further, Turkey's negotiations with the EU and desire to become a full member of the EU have urged Turkey to commit itself to a series of additional reforms including legal, social, and educational. Even though Turkey has performed significant reforms in education, including increase in compulsory education years, school enrollment (particularly for girls in rural areas), and number of teachers, equity and quality in education is still an important concern. Mathematics has a particular importance as it is applied in nearly all disciplines of science, engineering, industry, and technology. Further, proficiency in mathematics is required for technical skills needed by global economy. Thus, equity in mathematics education becomes a primary goal to be achieved.

This section starts with a brief history of the EU followed by Turkey's relationships with the EU. Subsequently, the importance of educational equity in EU's current agenda and perspectives on equity in mathematics education are discussed. Finally, research on achievement and opportunity gaps in Turkey compared to EU countries is presented.

Brief History of the European Union

The foundation of the EU dates back to 1951 when Belgium, France, Germany, Italy, Luxembourg, and the Netherlands signed the European Coal and Steel Community (ECSC) treaty. The ECSC was established to unite the European countries both politically and economically in order to end wars and achieve a steady peace in Europe (European Commission, n.d.h). The cooperation among the European countries that started with the ECSC, which constituted a joint management of coal and steel industries in member countries, extended to cover other industries and services over time with more member countries added.

The achievements of the ECSC in the development and restructuring of the steel and coal industries led to the Treaties of Rome in 1957, which established the European Economic Community (EEC) and the European Atomic Energy Community. The EEC laid the foundations for a customs union among the member countries and a common market in which labor, capital, services, and goods could move freely (European Commission, n.d.i). The legal and bureaucratic obstacles to such a common market were resolved, and the conceptualized common market was achieved in 1993 (European Commission, n.d.c). The European Atomic Energy Community, commonly known as Euratom, was formed to support and coordinate the development of nuclear industries for civilian use with a commitment to public and environmental safety (European Commission, n.d.g). These seminal treaties have been amended over time in addition to other treaties signed on various occasions. The Merger Treaty in 1965 brought together the three European Communities (i.e., the ECSC, the EEC, and the Euratom) under a single council (European Commission, n.d.i).

In 1992, a major treaty, namely the Treaty on European Union, was signed. The Treaty on European Union establishing the EU and leading to the development of Euro, moved the economic cooperation among members towards political cooperation ("Treaty on European Union," 1992). The EU is composed of three supranational and intergovernmental institutions, commonly referred to as pillars: European Communities, Common Foreign and Security Policy, and Police and Judicial Cooperation in Criminal Matters. The first pillar, European Communities, is consisted of the European Community (formerly the European Economic Community), the European Coal and Steel Community (until its expiry in 2002), and Euratom and is concerned with social, environmental, and economic policies ("Treaty on European Union"). The second pillar, Common Foreign and Security Policy, is dedicated to human rights issues, reinforcement of democracy, advancement of international security, and sustaining peace (Council of the European Union, 2008). Last of all, the third pillar, Police and Judicial Cooperation in Criminal Matters, focuses on international crime (European Commission, n.d.e). The new structure of the EU economically and politically integrates a large number of European countries.

Since its inception in 1952, the EU has continually expanded by adding new member countries. The first enlargement took place in 1973 with the addition of Denmark, Italy, and the United Kingdom. Greece entered the EU in 1981, followed by Portugal and Spain in 1986. Austria, Finland, and Sweden have been members since

1995. The largest membership cohort to date occurred in 2004 with the entry of the Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia, and Slovakia into the EU. The most recent members, Bulgaria and Romania, joined in 2007.

Turkey's Relationships with the European Union

Becoming a member of the EU is a lengthy and rigorous process for interested countries. Turkey has sought to become a full member of the EU since its first application to become an associate member of the EEC in 1959. Initially, Turkey did not satisfy the requirements for associate membership. Instead, EEC reached an agreement with Turkey in 1963, called the Ankara Agreement, to promote the improvement of Turkish people's standard of living with the aim of establishing a customs union with and an ultimate membership for Turkey (European Commission, n.d.b; Secretariat General for EU Affairs, n.d.b).

In 1970s the relations between Turkey and the EU were strained Secretariat General for EU Affairs, n.d.b). Turkey resisted the conditions of the Ankara Agreement and the additional protocols due to economical crises and political choices. As a result of Turkey's unwillingness to pursue EU membership, the EU subsequently avoided its own responsibilities under the treaty (Secretariat General for EU Affairs). Further, the military coup Turkey went through in 1980 and the political discomfort between Turkey and the EU, in part due to Greece's obtaining full membership, resulted in suspending the Turkey and the EU relations (Secretariat General for EU Affairs).

When a civilian government was restored in 1983, Turkey accelerated its foreign expansion programs, applied for full membership to the EU in 1987, and moved forward in executing its responsibilities for a customs union with the EU (Secretariat General for EU Affairs, n.d.b). In response to Turkey's application to full membership, the EU found Turkey to be eligible for membership but suggested that Turkey wait until the next EU enlargement and complete the customs union process in the meantime (Secretariat General for EU Affairs). The customs union between Turkey and the EU was achieved in 1995 and was considered an important step towards Turkey's integration with EU members.

Although the operation of customs union has been successful, Turkey's EU membership process has been interspersed with ups and downs caused at times by Turkey and at other times by the EU. Turkey was not included in the enlargement phase launched in 1993 at the Copenhagen European Council. In 1997 Turkey's eligibility to become a member was once again confirmed at the Luxembourg European Council, and a decision was made about establishing a pre-accession strategy to prepare Turkey for future membership (European Commission, n.d.b; Secretariat General for EU Affairs, n.d.b). Subsequently, the EU officially announced Turkey as a candidate country at the Helsinki European Council in 1999.

Following its acceptance as a candidate country, Turkey was provided an Accession Partnership, an essential instrument that guides Turkish authorities as they work towards meeting the accession criteria. The Accession Partnership is an evolving document that outlines the objectives Turkey is expected to achieve. These objectives include the political and economical criteria as well as embracement and implementation of EU legislation and policies (European Commission, n.d.d). The political criteria include enforcement of democracy, human rights, minority rights, rule of law, and improvement in Turkey's regional issues. The economic criteria include accomplishing privatization of public enterprises, achieving a liberal market economy, developing policies to stabilize macro economy, combating underground economy, and improving education and health (European Commission). To achieve these objectives Turkey adopted a national program, which outlines Turkey's procedures, timelines, and priority areas. Additionally, financial assistance has been provided by the EU for this purpose. The European Commission evaluates and reports on Turkey's progress towards the fulfillment of accession criteria on a regular basis. The Accession Partnership has been revised three times – in 2003, 2006, and 2008 – to maintain alignment with Turkey's progress in the accession process (European Commission).

After the adaptation of an Accession Partnership for Turkey, the next stage on the path to membership has been the start of accession negotiations. During the enlargement process, unanimous agreement of the European Council is required to formally start the negotiations between the candidate country and EU members (European Commission, n.d.a). The negotiations are based on a Negotiating Framework that outlines the procedures and principles of the negotiation process. The first step in accession negotiations is screening. During the screening process the candidate country becomes acquainted with the complete body of EU practices, rules, legislations, and regulations – commonly referred to as *acquis* - while member countries assess how prepared the candidate country is in regards to the conformation to the acquis (European Commission, n.d.f). For the accession negotiations between Turkey and the EU, the acquis is divided into 35 chapters, each of which refers to a particular policy. Turkey completed the screening process on all chapters as of October 2006.

Following the screening process, the negotiations, which are open-ended, are ongoing between Turkey and the EU. Negotiations take place chapter by chapter and are conducted at intergovernmental conferences where all EU members and the candidate country participate (European Commission, n.d.f). If the candidate meets the criteria for a specific chapter and recognizes EU’s common position on the chapter, then that chapter is provisionally closed. The benchmarks for provisional closure of a chapter, and if needed, for the opening of a chapter for negotiations are determined by the European Council (European Commission). Within Turkey’s negotiation process, the chapter on Science and Research was opened and provisionally closed in June 2006. Negotiations on the chapters of Enterprise and Industry, Financial Control, Statistics, Trans-European Networks, and Consumer and Health Protection have been open since 2007; the chapters of Intellectual Property, Company Law, Free Movement of Capital, and Information Society and Media have been open since 2008; and the chapter of Taxation have been open since 2009 (Secretariat General for EU Affairs, n.d.a).

Indeed, the European Council decided in December 2006 that unless Turkey applies the Additional Protocol to the Ankara Agreement to Cyprus and opens its ports and airports to Greek Cypriots, negotiations on none of the chapters will be provisionally closed (European Commission, n.d.b). Moreover, the chapters on Free Movement of

Goods, Right of Establishment and Freedom to Provide Services, Financial Services, Agriculture and Rural Development, Fisheries, Transport Policy, Customs Union, and External Relations will not be opened until Turkey complies with the Additional Protocol (European Commission). The conflict between Turkish and Greek Cypriots over the governing of Cyprus is long lasting and appears to be a stumbling block in the negotiation process. Efforts to improve current conditions in the Cyprus region are ongoing, and Turkey is particularly sensitive about finding a solution to conflicts in Cyprus. Successful completion of the negotiation process and eventual EU membership are prominent goals in Turkey's political agenda, and Turkey conveys its determination to move forward on this path at every chance.

European Union and Education

There exists a strong cooperation among EU members in education as in many other fields. Indeed, with the Maastricht Treaty, which established the EU, education was formally accepted as a legal area of involvement for the European Parliament and Council:

> The Community shall contribute to the development of quality education by encouraging cooperation between member states and, if necessary, by supporting and supplementing their action, while fully respecting the responsibility of the member states for the content of teaching and the organisation of education systems and their cultural and linguistic diversity. ("Treaty on European Union," 1992)

And in 1995, Directorate-General for Education and Culture, a separate department for education under the European Commission, was established. Because challenges in education are often common to different countries, the EU prioritizes collaboration among its members so that they can learn from each other in order to achieve quality education and improved outcomes for all students.

European Union's Perspectives on Equity in Education

One of the challenges that EU member states face in education is establishing equity. Providing equal opportunities to all students has been a goal of EU member states as they develop cooperative education programs. The first action plan developed and adopted by the European Council and member states' ministers of education in 1976 included equal opportunities as one of its six priorities (Council of the European Communities and the Ministers of Education, 1976). More than three decades later, the Education and Training 2010 Work Programme was launched by the European Commission to support the EU's goal of becoming "the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth, with more and better jobs and greater social cohesion," (European Parliament, 2000). The programme maintained equal opportunities in education as one of its objectives. More recently, the Commission of the European Communities (2008) concluded in a progress report that "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." (p. 119). Consequently, the strategic framework for European cooperation in education and training (ET 2020) retained the promotion of equity as an objective.

The role of equitable education in combating poverty and social exclusion has been highly emphasized in EU's recent strategic plans. In 2006 the Commission of the European Communities prepared a report, *Efficiency and Equity in European Education and Training Systems*, supported by relevant research, in which they stated that

> Education and training policies can have a significant positive impact on economic and social outcomes, including sustainable development and social cohesion, but inequities in education and training also have huge hidden costs which are rarely shown in public accounting systems. (p. 3)

Nevertheless, there is substantial research that shows the social and economical benefits of education on individuals and on society.

Research on economic and social impacts of education. Better education is not only associated with a greater likelihood of employment but also with higher income and improved fringe benefits (de la Fuente, 2003; Harmon, Oosterbeek, & Walker, 2003; OECD, 2005; Wößmann & Schütz, 2006). In the majority of EU countries, the unemployment rate for adults with below upper secondary education is, on average, at least two times as much as the unemployment rate for adults with tertiary education (OECD). Moreover, the estimated return on education for individuals, which were between 8% and 10% in most of the European countries, was 2.11% to 9.87% higher than return on alternative investments (i.e., shares and bonds) (de la Fuente). In addition to greater earnings, better educational attainment was linked to more sophisticated saving strategies (Bernheim & Scholz, 1993).

Individual economic benefits of education accrue to the society. The estimated increase in the productivity of EU countries is on average 6.2% per an additional year of educational attainment (de la Fuente, 2003). Wöβmann and Schütz (2006) identified three mediums via which education can influence economic growth: (a) education enhances human capital, (b) education improves “the innovative power of an economy” (p. 6) (e.g., development of new technologies and products), and (c) education facilitates the transfer of new knowledge. In addition, better educated people are less likely to depend on social-welfare, and higher education also facilitates the transition from welfare dependency to self-sustaining employment (London, 2006; Wöβmann & Schütz).

Besides economical benefits, better educational attainment has social advantages. As noted by McMahon (2004), “the non-economic (i.e. non-market) impacts of education are over and above the pure economic impacts on earnings or GDP per capita.” (p. 1). Years of schooling was found to be positively associated with happiness even when controlled for income (Blanchflower & Oswald, 2004). Higher levels of education have been shown to have a positive relationship with better health conditions and health behaviors (Cutler & Lleras-Muney, 2009; Grossman, 2006; Mokdad, Marks, Stroup, & Gerberding, 2004). Moreover, more educated women are more likely to have healthier infants (Chou, Liu, Grossman, & Joyce, 2007; Currie & Moretti, 2003). Education levels also make a difference in life expectancies (Kunst & Mackenbach, 1994; Meara, Richards, & Cutler, 2008). Further, more educated persons are less likely to experience divorce and more likely to have healthier and cognitively more developed children (Currie, Shields, & Price, 2007; Davis-Kean, 2005; Martin, n.d.).

At the society level, education positively affects the political conditions, civic engagement, crime rates, social cohesion, and environmental care. Education contributes to the development of democracy, the rule of law, political freedom, informed voting practices, and political stability (Dee, 2004; McMahon, 2004; Milligan, Moretti, & Oreopoulos, 2004; Rindermann, 2008). More educational attainment is associated with larger support for free speech, higher levels of civic knowledge, improved human rights, reduced inequalities, and lower crime rates (Dee; Lochner & Moretti, 2004; McMahon). There is also an indirect relationship with higher schooling and less deforestation, less water pollution but more air pollution (Godoy & Contreras, 2001; McMahon).

In light of the available research on the economical and social impact of educational attainment on both individuals and society, the European Council advised member states to accelerate their reform movements to ensure equal opportunities for all students (Council of the European Union, 2006). Recognizing the substantial amount of investments member states need to make in education towards achieving equity, the Council of the European Union and the Representatives of the Governments of the Member States (2006) concluded that

> inequities in education and training systems, resulting in outcomes such as low levels of achievement, school drop-outs and early school leaving, engender heavy hidden social costs for the future which can far outweigh the investments

> made. The development of efficient and equitable high quality education and training systems contributes significantly towards reducing the risks of unemployment, social exclusion and wasted human potential in a modern knowledge-based economy. (p. 4)

Equity in Mathematics Education

Achieving equity in mathematics education is a challenging though a paramount goal. Nevertheless, 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). Achievement levels and tertiary graduates in mathematics have been a particular area of attention in EU’s recent educational objectives. One of the five EU benchmarks for 2010 was an “increase of at least 15% in the number of tertiary graduates in Mathematics, Science and Technology (MST), with a simultaneous decrease in the gender imbalance” (Commission of the European Communities, 2009, p. 14). This benchmark was achieved before 2005 with some countries reaching the benchmark level and some coming very close to it. However, the gender imbalance is still notable as 68% of the Mathematics, Science and Technology graduates are males (Commission of the European Communities).

For 2020, the 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 courses 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 et al., 2006; Updegraff et al., 1996). Mathematics achievement history has been found to be positively associated with mathematics self-efficacy, which influences students' intentions to persist and pursue in mathematics-related courses (Navarro, Flores, & Worthington, 2007; O'Brien, Martinez-Pons, & Kopala, 1999; Updegraff et al.). Thus, improvement in students' achievement levels in mathematics can potentially lead to more interest in mathematics-related careers. More specifically 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.

Low-achieving student in mathematics are often those who come from low-income families or socially disadvantaged backgrounds and have disproportionately less access to quality educational resources (Chiu & Khoo, 2005; Wöβmann, 2007). To increase low-achieving students' achievement levels and, further, to close the achievement gap for underperforming students in mathematics, teachers, schools, and policy makers need to change practices and improve policies that impede underrepresented students' learning in mathematics and enhance quality and equity in mathematics education. As noted by NCTM (2008),

> Excellence in mathematics education rests on equity—high expectations, respect, understanding, and strong support for all students. Policies, practices, attitudes,

> and beliefs related to mathematics teaching and learning must be assessed continually to ensure that all students have equal access to the resources with the greatest potential to promote learning. (p. 1)

There are multiple perspectives through which equity in mathematics education is examined. NCTM perceives equity in terms of access to educational resources, treatment of students, and achievement outcomes. The EU shares NCTM's conceptualization of equity. The Commission of the European Communities (2006) perceives equity as "the extent to which individuals can take advantage of education and training, in terms of opportunities, access, treatment and outcomes" (p. 2). Equitable opportunities imply that students are supported in their educational endeavors and are provided with quality educational resources regardless of their socio-economic background, sex, race or ethnicity, disabilities, and minority or migration status. Equitable opportunities do not always guarantee "actual" (p. 3) equity in terms of equitable access, treatment, or student outcomes so Demeuse et al. (2007) referred to equitable opportunities as "potential" (p. 3) equity. Equitable access and treatment indicate, for example, comparable representation of students with various demographics at different levels of education and equitable access to quality curriculum, advanced courses, well-qualified teachers, or favorable school resources such as small classes and current educational materials.

Equity in student outcomes is the most commonly used indicator of equity and is usually interpreted as the closure of the achievement gap among various groups. For example, 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). However, it is important to note that measures of equitable student outcomes are not limited to achievement. Another conceptualization of equity that is concerned with student outcomes expands the notion of equity to include the equitable relations in mathematics classrooms (Boaler, 2008; Post, 2004). Boaler, based on Anderson's (1999) conception of "democratic equity", offers a relational understanding of equity, which

> concerns relations between people and … shifts the focus away from measures of achievement and on to ways of acting between people…. [T]he term 'relational equity' … draws attention to the ways students learn to treat each other and the respect they learn for people from different circumstances to their own. (p. 8)

Achievement and Opportunity Gaps in Mathematics Education in Turkey

To provide readers with a context, an overview of Turkish education system will be presented before reviewing the literature on the achievement and opportunity gap in k-12 mathematics education in Turkey.

Organization and structure of Turkish education system. The Ministry of National Education (MoNE) has organized two main education systems: formal and non-formal education. Formal education is divided into four levels: preprimary school, primary school (elementary and middle), high school, and post-secondary school.

Compulsory education consists of primary schooling, grades one through eight. Nonformal education provides alternative education and training, irrespective of age, for those who never participated in or completed the compulsory education or those who demand supplementary education or training. The MoNE provides formal and nonformal education free of charge in public schools. There are also private schools for nonformal and for each level of formal education. Formal and nonformal education, with the exception of post-secondary education, in both public and private schools is legislated and supervised by the MoNE. Post-secondary institutions are controlled by the Higher Education Council (Ozel, Yetkiner, Capraro, & Kupcu, 2009).

Preprimary education. Preprimary education is voluntary and targets three to five years olds. Gross enrollment rate in preprimary education was about 16% in 2007, which was more than twice as much as the rate in 2000 when it was only 6% (World Bank Group, 2009). Recognizing the importance of preschool education for children's social, emotional, cognitive and physical development, the MoNE has invested in the development of preschool programs in both quantity and quality (Kapci & Guler, 1999). However, Turkey is still substantially behind the average participation rates in preprimary schooling in not only EU member and but also candidate states, which were 91%[1] and 45%, respectively in 2007 (World Bank Group).

Primary education. Primary education is compulsory and is eight years (i.e., grades one through eight) from the age of 6 to 14. Compulsory education in Turkey used to be five years of elementary education (i.e., grades one through five) until 1997 when

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[1] Data for the gross enrollment rat in preprimary education in Ireland was not available in the World Bank's database. Therefore, the average was obtained for 26 EU member states.

the 8-Year Compulsory Education Law integrated the five-year elementary education with the three-year lower secondary education. Of the prominent goals in extending the length of the compulsory education were to expand educational opportunities for all students and to encourage students, particularly students from low-income families, students in rural areas, and girls, to continue their education three more years (Dulger, 2004). Thus, the eight-year compulsory education reform was “a way of enhancing social cohesion through reduction of economic disparities and social inequalities” (Dulger, p. 3). Structuring the compulsory education duration as 8 years brought Turkey to a comparable level to EU member and candidate states in that all EU member and candidate countries have at least 8 years of compulsory education (World Bank Group, 2009).

The 8-year compulsory education reform was not merely an increase in the number of years for compulsory education but included initiatives to provide students who had formerly been deprived of educational access, such as students, particularly girls, from rural areas, families of low SES, with access to primary education. The program was supported by funding from the MoNE, EU, UNICEF, private sector, and various nonprofit organizations, to invest in additional school infrastructure, educational materials, and human resources including teachers, as well as incentives to encourage families to enroll their children of compulsory school age in primary schools. The total annual spending on the implementation of the new compulsory education program was estimated to be more than $3 billion in the first years (Dulger, 2004). Approximately 104,000 new classrooms were constructed to accommodate the increase in the number of primary school students, and more than 70,000 primary-school teachers were recruited (Dulger). To supply the transportation of students in rural areas, busing systems were broadened. For students who live in more distant rural areas, the MoNE opened boarding schools. Students from low-income families were provided with free uniforms and free school meals (Dulger). All primary students in public schools receive free textbooks and practice workbooks from the MoNE since the 2003-2004 academic year.

To supply the need for additional teachers, the MoNE not only recruited teachers graduated from education programs in universities but also university graduates from other programs. Teachers who did not complete an education program received brief teacher training programs. Some of the teachers acquired only temporary licenses and were required to complete their training subsequently (Dulger, 2004). Thus, the high demand in teachers resulted in a compromise of quality for quantity in the recruitment process.

The new compulsory education program resulted in striking increases in the enrollment rates in 8-year primary education, particularly for girls in rural areas. Primary schooling rate increased from 85.63% in 1997-1998 academic year to 96.30% in 2002-2003 academic year (Dulger, 2004). In the program's first implementation year, the increase in the number of girls in the rural areas who were enrolled in the sixth grade was 162%, and substantial increases were sustained in the following years. In the World Bank's (2005b) report on Turkey it was concluded that "Few cases in the history of any national education system have produced such striking improvement so quickly; Turkey's leadership has earned the right to be proud of its accomplishment" (p. 6).

Secondary education. Secondary school education is voluntary and lasts at least 4 years in general or vocational schools. Indeed, secondary schooling was extended from 3 to 4 years in 2005. Since the 2006-2007 academic year, the MoNE has been providing secondary school students in public schools with free textbooks.

There are various types of high schools in Turkey some of which used to require an entrance examination, namely Secondary School Student Selection and Placement Examination (Turkish acronym OKS) at the end of eighth grade. Secondary School Student Selection and Placement Examination was voluntary but was required and highly competitive for students who wanted to attend prestigious public and private high schools. Due largely to concerns about the high stakes nature of the Secondary School Student Selection and Placement Examination, MoNE has established a new system for transition from primary to secondary schooling since 2008.

In the new system, admission to select high schools does not depend on one single test. Instead, the MoNE administers optional Academic Proficiency Examinations (Turkish acronym SBS) at the end of sixth, seventh, and eighth grades. Academic Proficiency Examinations assess students on the grade-level national curriculum objectives. When students are placed into selective high schools, a composite score obtained from students' performances on Academic Proficiency Examinations for three years, their grade point average (GPA), and their discipline scores is considered. Primary school graduates who wish to undertake their secondary school studies at high-quality and well-resourced high schools must attain scores required for admission by the schools of their choice. The high schools that are considered prestigious include Science High

Schools and general and vocational Anatolian High Schools, which are public, and some private high schools. Students whose scores do not suffice to attend these schools can enroll in public general and vocational high schools as well as many other private schools.

Achievement gap in mathematics education in Turkey compared to EU countries. A literature search was conducted to locate studies that were carried out in Turkey to investigate the achievement and opportunity in mathematics among various groups (e.g., boys and girls, students from low and high income families, rural and urban students) in k-12 education. First, the databases Academic Search Complete (Ebsco), Education Full Text (Wilson), Education Resources Information Center (ERIC), PsycINFO, Social Sciences Full Text (Wilson), Sociological Abstracts, and Directory of Open Access Journals (DOAJ) were searched using the following keywords in combination with Turkey: achievement gap, mathematics achievement, math achievement, mathematics education, math education, primary education, elementary education, urban education, rural education, gender gap, gender inequality, gender difference, gender equity, gender inequity, equity, inequity, educational opportunities, and teacher quality. Second, references of the located studies were reviewed to identify relevant studies. The literature search suggested that research on gap analysis in mathematics education in Turkey is in its nascent stage. In this section, study findings related to achievement gap are summarized. Results of studies on opportunity gap are presented in the next section.

Results of national and international studies that Turkey had participated in, namely Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA), reflected gaps in students' mathematics achievement. What follows is a summary of the findings of small and large scale studies that were conducted exclusively in Turkey to examine the disparities in mathematics achievement. Subsequently, results from TIMSS and PISA for Turkey compared to the EU countries are presented.

Every three years, a national study is conducted in Turkey – Examination of Student Achievement – to identify achievement levels of fourth, fifth, sixth, seventh, and eighth graders' in various disciplines such as Turkish Language, Mathematics, Science and Technology, and Social Studies. The last study for which final report is available was conducted in 2005 in randomly selected 829 public and private primary schools. The fourth, fifth, sixth, seventh, and eighth graders participating in the OBBS were presented with mathematics achievement tests of 15, 15, 20, 20, 25 items, respectively (EARGED, 2005). Domains covered in the tests were identified as number, geometry, and the other. Achievement results were reported as absolute percentage scores. The average absolute percentage scores for fourth, fifth, sixth, seventh, and eighth grades were 46.2%, 50.7%, 41.5%, 38.6%, and 41%, respectively. Students achieved the lowest in geometry although their achievement in none of the domains was satisfactory.

In the final reports of OBBS, relationships between students' achievement in mathematics and their gender, geographical location, parents' educational levels, and families' socioeconomic backgrounds were examined. Investigation of gender gaps in mathematics achievement yielded inconsistent results. Whereas boys achieved better than girls at the fourth and eighth grade levels, girls achieved better than boys at sixth and seventh grades. There were no gender differences at fifth grade. Across all grades, students in east and southeast regions of Turkey scored lower than their counterparts in other regions. Students' achievement increased with their parents' educational attainment as well as their families' SES in all grades (EARGED, 2005).

In another study with a less representative sample of Turkish eighth-grade students, Isiksal and Cakiroglu (2008) examined gender differences in mathematics achievement on high school entrance examination. Isiksal and Cakiroglu used a random sample 2647 students from cities with a range of economic development. The researchers concluded that the difference between boys' and girls' mathematics performance was small enough to be negligible in cities with both high and low levels of economic development. The authors also could not find a recognizable difference in mathematics achievements of students among cities of different economic levels. Although Isiksal and Cakiroglu's sample was randomly selected from high school entrance examination attendees, it is important to consider that students who took the high school entrance test were likely to be fundamentally different (e.g., more motivated) than students who did not. Thus, Isiksal and Cakiroglu's sample was not as representative of Turkish eighth-grade students as was OBBS' sample.

Another study on the high school entrance examination data was conducted by Yavuz (2009) to examine the relationship between parental education levels and eighth-grade students' mathematics achievement. Yavuz used the high school examination data only from students who took the test in Konya, a city in Turkey. His results suggested that there was 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.

Engin-Demir (2009) conducted a study in which she investigated the academic achievement of Turkish urban poor primary-school students who worked outside of school. Engin-Demir's participants were sixth, seventh, and eighth graders from *gecekondu* neighborhoods of the Greater Ankara Municipality. Engin-Demir included students' mathematics grades within the composite measure of academic achievement. The mean achievement score of students was the pass/fail borderline score. Her results showed that students' parents' educational levels, household size and possessions, and home ownership together explained 5% of the variation in academic achievement.

Dursun and Dede (2004) investigated the factors that primary-school mathematics teachers' perceived to be affecting students' achievement in mathematics. Among the 38 teachers in Dursun and Dede's sample, 57% thought gender had a small effect, and the remaining 43% did not think gender had any effect on mathematics achievement. All the teachers in the sample deemed parents' educational levels and SES had an effect on students' mathematics achievement. Percentages of teachers who thought the effects of parental education levels and SES as being large were 71 and 57, respectively. Teachers also thought teacher quality as a factor impacting students' achievement in mathematics, and 86% believed this impact was large.

TIMSS results. TIMSS is an international study that assesses fourth- and eighth-grade students' achievement in mathematics and science. TIMSS also collects data on educational and social contexts via questionnaires completed by students, their teachers, and their school principals. Turkey participated in TIMSS 1999, which was administered only to eighth graders, and ranked 31st in mathematics achievement among the 38 participating countries. The average achievement of Turkish students was below both the international average and averages of all of the participating EU countries. Yayan and Berberoglu (2004) in their secondary analysis of TIMSS 1999 data found differences in the latent variable "home-family background characteristics" (p. 91), representing students' parents' highest education levels and number of books at their homes, was among the variables that had the largest association with mathematics achievement scores.

More recently, Turkey participated in the 2007 cycle of TIMSS at the eighth-grade level. As can be seen in Table 1, in TIMSS 2007 Turkish students' achievement in mathematics overall and in all cognitive and content domains still fell below the international average of 500 and, except for data and chance, the averages of students from EU countries. In the content domain of data and chance Turkish students performed better than students from Romania and Bulgaria. Indeed, Turkish students performed relatively better in data and chance than in mathematics overall, whereas they performed less well in geometry (Martin et al., 2008).

Table 1

TIMSS 2007 Average Mathematics Achievement by Content and Cognitive Domains in Turkey and Participating EU Countries

Country	Mathematics Average Scale Score (*SE*)	Average Scale Scores for Mathematics Content Domains				Average Scale Scores for Mathematics Cognitive Domains		
		Number (*SE*)	Algebra (*SE*)	Geometry (*SE*)	Data and Chance (*SE*)	Knowing (*SE*)	Applying (*SE*)	Reasoning (*SE*)
Bulgaria	464 (5.0)	458 (4.7)	476 (5.1)	468 (5.0)	440 (4.7)	477 (4.7)	458 (4.8)	455 (4.7)
Cyprus	465 (1.6)	464 (1.6)	468 (2.0)	458 (2.7)	464 (1.6)	468 (1.6)	465 (1.8)	461 (2.1)
Czech Republic	504 (2.4)	511 (2.5)	484 (2.4)	498 (2.7)	512 (2.8)	502 (2.5)	504 (2.7)	500 (2.6)
England	513 (4.8)	510 (5.0)	492 (4.6)	510 (4.4)	547 (5.0)	503 (4.0)	514 (4.9)	518 (4.3)
Hungary	517 (3.5)	517 (3.6)	503 (3.6)	508 (3.6)	524 (3.3)	518 (3.3)	513 (3.1)	513 (3.2)

Table 1

Continued

Country	Mathematics Average Scale Score (*SE*)	Average Scale Scores for Mathematics Content Domains				Average Scale Scores for Mathematics Cognitive Domains		
		Number (*SE*)	Algebra (*SE*)	Geometry (*SE*)	Data and Chance (*SE*)	Knowing (*SE*)	Applying (*SE*)	Reasoning (*SE*)
Italy	480 (3.0)	478 (2.8)	460 (3.2)	490 (3.1)	491 (3.1)	476 (3.0)	483 (2.9)	483 (2.8)
Lithuania	506 (2.3)	506 (2.7)	483 (2.7)	507 (2.6)	523 (2.3)	508 (2.5)	511 (2.4)	486 (2.5)
Malta	488 (1.2)	496 (1.3)	473 (1.4)	495 (1.1)	487 (1.4)	490 (1.6)	492 (1.0)	475 (1.3)
Romania	461 (4.1)	457 (3.5)	478 (4.6)	466 (4.0)	429 (3.7)	470 (4.2)	462 (4.0)	449 (4.6)
Scotland	487 (3.7)	489 (3.7)	467 (3.7)	485 (3.9)	517 (3.5)	481 (3.3)	489 (3.7)	495 (3.3)

Table 1

Continued

Country	Mathematics Average Scale Score (*SE*)	Average Scale Scores for Mathematics Content Domains				Average Scale Scores for Mathematics Cognitive Domains		
		Number (*SE*)	Algebra (*SE*)	Geometry (*SE*)	Data and Chance (*SE*)	Knowing (*SE*)	Applying (*SE*)	Reasoning (*SE*)
Slovenia	501 (2.1)	502 (2.3)	488 (2.4)	499 (2.4)	511 (2.3)	500 (2.2)	503 (2.0)	496 (2.5)
Sweden	491 (2.3)	507 (1.8)	456 (2.4)	472 (2.5)	526 (3.0)	478 (2.0)	497 (2.0)	490 (2.6)
Turkey	432 (4.8)	429 (4.0)	440 (5.1)	411 (5.1)	445 (4.4)	439 (4.8)	425 (4.5)	441 (4.2)

TIMSS 2007 identified four international benchmarks, from low to advanced, and described the knowledge and skills students at each benchmark demonstrated. Sixty-seven percent of Turkish students achieved at or below the low international benchmark, suggesting that those students possessed only “some knowledge of whole numbers and decimals, operation, and basic graphs” (Martin et al., 2008, p. 69) but could not apply their basic knowledge even in straightforward situations. With such a large percent of low-performing students Turkey ranked lower than Romania, which had the largest percentage of students – 54% - who performed at or below the low benchmark among the participating EU countries. On the other hand, 5% of Turkish students performed at or above the advanced international benchmark, which was identified with students' ability to “organize and draw conclusions from information, make generalizations, and solve non-routine problems” (Martin et al., p. 69). Among the EU countries, only Hungary, England, Lithuania, and Czech Republic had larger percentages of students than Turkey who reached the advanced benchmark. The fact that Turkey, when compared to the EU countries, had the largest percentage of students who performed at the lowest level whereas Turkey ranked among the highest regarding the percentage of student who reached the advanced level reflected disparities in Turkish educational system. As suggested by the World Bank (2005b)

> Turkey's challenge is to transform a school system that succeeds in educating a small number of students to the highest international standards into one that does a good job at educating all students. If the education system does not move in

> this direction, the vast majority of students will develop few skills and inadequate competencies, a result that is neither equitable nor sustainable. (p. 18)

Else-Quest, Hyde, and Linn (2010) investigated the gender differences in mathematics achievement across nations that participated in TIMSS 2003 and found virtually no difference between boys' and girls' performances (i.e., Cohen's $d = 0.01$, in favor of boys) across nations. Among the EU countries Belgium had the largest gender gap favoring boys (Cohen's $d = 0.14$) followed by Netherlands (Cohen's $d = 0.10$). Cyprus, on the other hand, had the largest difference in mathematics achievement between boys and girls favoring girls (Cohen's $d = 0.19$). Because Turkey did not participate in TIMSS 2003, Else-Quest's study did not provide information on how gender difference in mathematics achievement in Turkey at the middle-school level was compared to other nations, in general, or to EU countries, in particular.

When the cross-national gender difference on TIMSS 2003 was disaggregated by content domains, there were virtually no gender differences in Data (Cohen's $d = 0.00$), Geometry (Cohen's $d = 0.01$, in favor of girls), and Number (Cohen's $d = 0.01$, in favor of girls) (Else-Quest et al., 2010). Although the gender difference in Measurement (i.e., Cohen's $d = 0.07$, in favor of boys) was larger than the difference in other content domains, it was still small. The largest gender difference, which was favoring girls, was observed in Algebra (Cohen's $d = 0.11$). Disaggregated results at the content level for EU countries showed that in Cyprus girls achieved better than boys in all content domains and even more so in Algebra (Cohen's $d = 0.31$). In Belgium, on the other hand, the gender gap was always in favor of boys, including Algebra on which girls achieved better than boys in all other EU countries included in Else-Quest et al.'s study. In Latvia, Lithuania, Romania, Slovak Republic, and Slovenia, differences in boys' and girls achievement, in favor of girls, were more pronounced in Algebra compared to differences in overall mathematics.

In a secondary analysis of TIMSS 2003 data, Akiba et al. (2007) examined the mathematics achievement gap between eighth-grade low and high-SES students in the US as compared to the other participating countries. Although Akiba et al.'s study did not include Turkey, it provided useful information on the extent of equity in mathematics education in some EU countries. Akiba et al. found variations across the sample EU countries in the size of the achievement gap between low- and high-SES students. Whereas Hungary, Romania, and Slovak Republic were among the ten countries where the difference between the national averages of low- and high-SES students' mathematics achievements was the largest, in Latvia this difference was relatively smaller.

PISA results. PISA is another international study, implemented by OECD, that Turkey has participated in 2003, 2006, and 2009. PISA assesses the extent to which 15-year olds have the knowledge and skills for informed participation in adult life and society in terms of reading, mathematical, and scientific literacy. The grade level of PISA participants is different than that of TIMSS participants because in Turkey 15-year olds are usually ninth graders at high schools whereas TIMSS is administered to eight graders at lower secondary schools. TIMSS and PISA also differ in terms of the features of student learning they assess. TIMSS has a more curricular focus and assesses what students have learned (attained curriculum) in relation to the intended and implemented curricula, whereas PISA has a more functional focus and assesses how well students can utilize and apply their mathematics knowledge to situations encountered in adult life (de Lange, 2006).

In each cycle of PISA one of the domains (i.e., reading, mathematical, and science literacy) is emphasized as the focus of the assessment and is allotted more time than the other domains. Mathematics was the focus domain in 2003 administration. Within the framework of PISA, mathematical literacy is “concerned with the capacity of students to analyse, reason and communicate effectively as they pose, solve and interpret mathematical problems in a variety of situations involving quantitative, spatial, probabilistic or other mathematical concepts” (OECD, 2007, p. 51). The emphasis in PISA’s mathematics assessment is on applications of mathematics to real-life situations, mathematical modeling, and interpreting unfamiliar contexts and complex data.

Table 2

PISA 2003 Mathematics Achievement by Gender and Content Area in Turkey and Participating EU Countries

Country	Mathematics						Space and Shape		Change and Relationships		Quantity		Uncertainty	
	Mean		Male mean		Female mean		Mean		Mean		Mean		Mean	
	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE
Finland	544.3	1.9	548.0	2.5	540.6	2.1	539.0	2.0	548.5	1.8	543.0	2.2	544.8	2.1
Netherlands	537.8	3.1	540.3	4.1	535.2	3.5	526.2	2.9	528.3	3.1	551.0	3.1	549.3	3.0
Belgium	529.3	2.3	532.9	3.4	525.4	3.2	529.6	2.3	529.6	2.3	535.0	2.4	525.7	2.2
Czech Republic	516.5	3.6	523.8	4.3	508.9	4.4	527.4	4.1	528.0	3.5	515.0	3.5	500.3	3.1
Denmark	514.3	2.7	522.7	3.4	506.2	3.0	512.4	2.8	515.6	2.6	509.0	3.0	515.6	2.8
France	510.8	2.5	515.3	3.6	506.8	2.9	507.6	3.0	506.9	2.5	520.0	2.6	506.1	2.4

Table 2

Continued

Country	Mathematics						Space and Shape		Change and Relationships		Quantity		Uncertainty	
	Mean		Male mean		Female mean		Mean		Mean		Mean		Mean	
	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE
Sweden	509.0	2.6	512.3	3.0	505.8	3.1	498.3	2.6	513.6	2.5	505.0	2.9	510.8	2.7
Austria	505.6	3.3	509.4	4.0	501.8	4.0	515.2	3.5	513.2	3.0	500.0	3.6	493.8	3.1
Germany	503.0	3.3	507.9	4.0	498.9	3.9	499.6	3.3	513.8	3.4	507.0	3.7	492.5	3.3
Ireland	502.8	2.4	510.2	3.0	495.4	3.4	476.2	2.4	501.7	2.5	506.0	2.4	517.2	2.6
OECD Average	**500.0**	**0.6**	**505.5**	**0.8**	**494.4**	**0.8**	**496.3**	**0.6**	**500.7**	**0.6**	**499.0**	**0.7**	**502.0**	**0.6**
Slovak Republic	498.2	3.4	507.3	3.9	488.6	3.6	505.4	4.0	512.5	3.4	494.0	3.5	475.8	3.2

Table 2

Continued

Country	Mathematics						Space and Shape		Change and Relationships		Quantity		Uncertainty	
	Mean		Male mean		Female mean		Mean		Mean		Mean		Mean	
	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE
Luxembourg	493.2	1.0	501.9	1.9	484.8	1.5	488.2	1.4	501.5	1.1	487.0	1.2	492.1	1.1
Poland	490.2	2.5	493.0	3.0	487.4	3.0	490.3	2.7	491.8	2.5	484.0	2.7	493.5	2.4
Hungary	490.0	2.8	493.7	3.3	485.9	3.3	479.1	3.3	496.3	2.7	495.0	3.1	489.0	2.6
Spain	485.1	2.4	489.6	3.4	480.7	2.2	476.5	2.6	492.4	2.5	481.0	2.8	489.0	2.4
Latvia	483.4	3.7	484.8	4.8	482.0	3.6	486.4	4.0	481.7	3.6	487.0	4.4	473.8	3.3
Portugal	466.0	3.4	472.4	4.2	460.2	3.4	450.2	3.4	465.4	3.5	468.0	4.0	470.6	3.4

Table 2

Continued

Country	Mathematics						Space and Shape		Change and Relationships		Quantity		Uncertainty	
	Mean		Male mean		Female mean		Mean		Mean		Mean		Mean	
	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE
Italy	465.7	3.1	474.9	4.6	457.1	3.8	470.3	3.1	474.8	3.4	452.0	3.2	462.6	3.0
Greece	444.9	3.9	455.0	4.8	435.6	3.8	437.1	3.8	445.9	4.0	436.0	4.3	458.4	3.5
Turkey	*423.4*	*6.7*	*430.2*	*7.9*	*415.1*	*6.7*	*417.4*	*6.4*	*413.2*	*6.8*	*423.0*	*7.6*	*442.6*	*6.2*

In 2003 administration of PISA, Turkish students' mean achievements in mathematics overall and in mathematics subdomains of space and shape, change and relationships, quantity, and uncertainty were below both the OECD average and averages of all of the participating EU countries (see Table 2) (OECD, n.d.b). PISA identified six levels of proficiency in mathematics. Students at Level 1 can answer only clearly defined questions that present all the needed information distinctly, involve familiar situations, and require routine procedures. Students at Level 6, on the other hand, "can conceptualise, generalize, and utilize information based on their investigations and modelling of complex problem situations. They can link different information sources and representations and flexibly translate among them" (OECD, 2004, p. 47).

In overall mathematics on PISA 2003, more than 50% of Turkish students could perform only at or below level 1, which was substantially larger than the OECD average of 21.41% and was larger than the percentage of students who achieved at or below Level 1 in any of the participating EU countries. The percentage of Turkish students achieving at Level 6 was 2.38, which was lower than the OECD average of 4.01% but was larger than the percentages of students achieving at Level 6 in some of the participating EU countries such as Latvia (1.64%), Portugal (0.82%), Italy (1.55%), and Greece (0.62%) (OECD, n.d.b). Given the relatively large percentage of students achieving at the highest level, the World Bank (2005b) report concluded that "These results indicate that enough knowledge exists in the education system regarding how to produce high quality learning outcomes" (p. 18). However,

> The challenge for policymakers in Turkey is to better align resources with a strategy to improve quality of all schools, so that students everywhere in Turkey can, at a minimum, learn basic numeracy and literacy skills, as well as develop broader competencies (e.g., critical thinking and problem-solving skills) needed for global competitiveness and the knowledge economy. (World Bank, p. 17)

PISA 2003 results showed the variation in Turkish students' mathematics achievement was the largest among both EU and OECD countries. Looking at the EU countries, in Belgium, Germany, Italy, Sweden, Greece, and Hungary, variances in students' mathematics performance on PISA 2003 were larger than the average within-country variance among OECD countries. On the other hand, the within-country variation in mathematics achievement in Finland was smaller than the OECD average and was the smallest among EU countries.

PISA 2003 results also revealed substantial variation in Turkish students' mathematics performances by socio-economic status, school, and to some degree by gender. Boys achieved better than girls (Cohen's $d = 0.14$), and the magnitude of the difference was larger than the average difference (i.e., Cohen's $d = 0.11$, in favor of boys) in the countries participated in PISA 2003 (Else-Quest et al. 2010). In Czech Republic (Cohen's $d = 0.16$), Denmark (Cohen's $d = 0.18$), Greece (Cohen's $d = 0.21$), Ireland (Cohen's $d = 0.17$), Italy (Cohen's $d = 0.19$), Luxembourg (Cohen's $d = 0.19$), and Slovak Republic (Cohen's $d = 0.20$), the gender gap, in favor of boys, was larger than the gap in Turkey (Else-Quest et al.). In none of the EU countries was the gender gap in favor of girls in mathematics achievement.

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.b). Demir, Kilic, and Depren (2009), in his 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 (β = 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. 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 on PISA 2003 than it was for Turkey. Among the EU countries, socio-economic status had the smallest effect on 15 year olds' mathematics achievement in Latvia (r^2 = 6.0), followed by Finland (r^2 = 7.2).

In a secondary analysis of PISA 2003 data, Martins and Veiga (2010) found that among the 15 EU countries in their study, Germany, Greece, Great Britain, Portugal, and Belgium had the largest SES-related inequity in mathematics education, in favor of high-SES students, whereas Finland and Sweden had the smallest. Further, Martins and Veiga identified some relationship between SES-based inequity in mathematics performance and the overall level of socioeconomic inequality in the sample countries. In other words, to some extent, countries that had higher socioeconomic inequality tended to have higher levels of SES-based inequity in mathematics achievement. However, such a conclusion was not valid for all the countries in Martins and Veiga's study. For example, Germany had a larger estimated SES-based inequity in mathematics performance than one would have expected based on its socioeconomic inequity measure.

The variation among schools in Turkey was the largest among the OECD countries on PISA 2003 mathematics scale. Indeed, the between-school variation in students' mathematics performances was larger than the within-school variance in Turkey. One main reason for this striking between-school variation in Turkey could be the selective nature of Turkish educational system. In Turkey, there are various types of high schools that enroll students based on national high-stakes examinations. Not surprisingly, students in the most selective public and private high schools performed recognizably better than their counterparts in other schools. For example, all students in prestigious Science and Police high schools scored above the OECD mathematics average of 500, whereas more than 75% of the students in vocational high schools scored below 500 on PISA 2003 (EARGED, 2005).

The proportion of between-school variation on PISA 2003 mathematics test 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, n.d.b). 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. 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.

Martins and Veiga (2010) investigated contributions of students' socio-economic background versus the socio-economic compositions of the schools to the SES-based inequity in mathematics achievement in 15 EU countries on PISA 2003. In Finland, schools' socio-economic composition had virtually no relationship with the SES-based inequity. Other countries where school composition had relatively smaller association with the SES-related inequity compared to the students' individual SES were Denmark, Great Britain, Greece, Ireland, Portual, Spain, and Sweden. In Austria, Belgium, France, Germany, Italy, Luxembourg, and Netherlands, on the other hand, socio-economic composition of schools explained larger percentage of the SES-based inequity in mathematics achievement than did students' socio-economic backgrounds.

Mathematics results obtained for Turkey in 2006 administration of PISA were similar to the results obtained in 2003 cycle. Turkish students' mean mathematics achievement level continued to be far below the OECD average, and it was higher than the mean achievement of only two EU countries, namely Romania and Bulgaria (see Table 3) (OECD, n.d.b). More than 52.1% of Turkish students still performed at or below Level 1 in mathematics, which was substantially larger than the OECD average of 21.3% (OECD). Among participating EU member states and candidates, only Bulgaria (53.3%) and Romania (52.7) had percentages of students achieving at or below Level 1 that were as high as Turkey. However, the percentage of Turkish students who performed at the highest level in mathematics, 1.20%, was larger than that of some EU countries and candidates, namely Latvia (1.11%), Spain (1.17%), Croatia (0.75%), Portugal (0.80%), Greece (0.86), Romania (0.14%), and Bulgaria (0.60%). Students in east and southeast regions of Turkey, on average, achieved lower in mathematics than their peers in other regions on PISA 2006 as they did on the previous PISA administration (EARGED, 2007).

Table 3

PISA 2006 Mathematics Achievement by Gender in Turkey and Participating EU Countries

Country	5th Percentile		Mean		95th Percentile		Male Mean		Female Mean	
	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE
Finland	411.4	5.0	548.4	2.3	677.9	3.0	554.2	2.3	542.6	2.7
Netherlands	382.0	6.0	530.6	2.6	671.8	4.3	536.9	2.6	524.1	3.1
Belgium	336.6	8.9	520.4	3.0	677.9	2.7	523.7	3.0	516.7	4.1
Estonia	381.2	5.9	514.6	2.8	645.6	4.1	515.3	2.8	513.8	3.3
Denmark	371.2	5.0	513.0	2.6	648.8	4.3	518.2	2.6	507.9	3.0
Czech Republic	340.3	5.2	509.9	3.6	677.1	6.0	514.4	3.6	503.9	4.2
Austria	338.0	6.8	505.5	3.7	657.1	4.0	516.6	3.7	494.0	4.4
Slovenia	361.4	2.7	504.5	1.0	653.7	3.8	506.9	1.0	502.1	1.8
Germany	339.1	8.5	503.8	3.9	663.9	4.6	513.2	3.9	493.7	4.6
Sweden	354.1	5.6	502.4	2.4	649.0	4.2	504.9	2.4	499.7	2.7
Ireland	366.0	4.6	501.5	2.8	634.1	2.9	507.3	2.8	495.8	3.7

Table 3

Continued

Country	5th Percentile		Mean		95th Percentile		Male Mean		Female Mean	
	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE
OECD Average	**345.6**	**1.1**	**497.7**	**0.5**	**645.3**	**0.9**	**503.2**	**0.5**	**492.0**	**0.7**
France	333.6	5.5	495.5	3.2	645.7	4.0	498.9	3.2	492.4	4.0
United Kingdom	351.2	5.0	495.4	2.1	643.0	3.8	503.9	2.1	487.2	2.6
Poland	352.8	3.3	495.4	2.4	638.2	3.6	500.0	2.4	490.9	2.8
Slovak Republic	332.5	7.0	492.1	2.8	640.3	4.8	499.1	2.8	484.7	3.7
Hungary	343.3	5.6	490.9	2.9	642.7	5.8	495.8	2.9	485.6	3.5
Luxembourg	331.9	4.4	490.0	1.1	640.6	3.6	498.2	1.1	481.6	1.7
Lithuania	337.9	5.0	486.4	2.9	631.9	4.6	487.5	2.9	485.3	3.3
Latvia	347.0	5.6	486.2	3.0	619.4	4.2	488.8	3.0	483.6	3.6
Spain	332.0	4.4	480.0	2.3	621.9	3.3	484.2	2.3	475.6	2.6
Croatia	331.6	4.3	467.2	2.4	604.7	3.8	474.0	2.4	460.5	3.2
Portugal	314.8	6.5	466.2	3.1	612.0	3.8	473.9	3.1	459.0	3.7
Italy	305.3	4.4	461.7	2.3	616.1	3.8	470.1	2.3	453.5	2.9

Table 3

Continued

Country	5th Percentile		Mean		95th Percentile		Male Mean		Female Mean	
	Score	SE	Score	SE	Score	SE	Score	SE	Score	SE
Greece	303.6	7.3	459.2	3.0	607.0	4.5	461.5	3.0	456.8	4.3
Turkey	*286.6*	*6.1*	*423.9*	*4.9*	*595.0*	*15.8*	*426.6*	*4.9*	*420.7*	*5.6*
Romania	277.6	6.5	414.8	4.2	557.1	7.7	418.1	4.2	411.5	4.2
Bulgaria	251.0	8.3	413.4	6.1	582.6	11.0	411.7	6.1	415.4	6.7

Students' SES levels were still an important factor in Turkish students' mathematics performances on PISA 2006 (OECD, n.d.b) . 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%.

Among the EU countries that participated in PISA 2006, in Hungary, Bulgaria, 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. 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.b).

Dramatic variation among Turkish schools in terms of students' mathematics achievement was still apparent on PISA 2006 (EARGED, 2007). Alacaci and Erbas (2010) analyzed PISA 2006 data using hierarchical linear modeling to investigate the sources of variation in mathematics achievement among schools. Alacaci and Erbas 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.

Summary of studies on gender- and SES-based achievement gaps in Turkey compared to the EU countries. Research on the gender gap in mathematics achievement of Turkish students is pretty limited, particularly at the middle-school level, and present somewhat mixed findings. On OBBS, the direction and size of the gender gap varied by grade (EARGED, 2005) from fourth through eighth grades. Because, OBBS reports did not include effect sizes, it was not possible to evaluate the magnitude of the differences or compare them to other studies' findings. Isiksal and Cakiroglu (2008) found only a negligible amount of difference between boys' and girls' achievement on the high school examination exam. Although comparative information for some EU countries on TIMSS 2003 was available (Else-Quest et al., 2010), because Turkey did not participate in TIMSS 2003, we could not compare the gender difference in Turkey at the middle-school level to differences in EU countries. On the other hand, PISA studies, whose sample was mainly high-school students in Turkey, provided helpful information about the gender gap in Turkey compared to EU countries. Turkish male students outperformed their female peers by a small margin on PISA 2003 although the magnitude of the difference was larger than that of in the majority of the participating EU countries.

Studies on the SES-related inequity in mathematics achievement among Turkish students mainly focused on the relationship between socio-economic factors and achievement but very rarely examined the size of the achievement gap between students from low- and high-SES families. On the national study OBBS in Turkey, 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. Lack of effect sizes in OBBS reports precluded comparing the SES-based achievement gaps in Turkey with gaps in other nations. At middle-school level, our literature search did not locate any comparative studies about Turkey and EU countries on SES-related achievement gap. However, some information about how differences in average mathematics achievement between low- and high-SES students varied across EU countries came from a secondary analysis of TIMSS 2003 data (Akiba et al., 2007).

Hungary, Romania, and Slovak Republic had the largest SES-related achievement gaps, whereas the gap in Latvia was relatively smaller (Akiba et al.).

At the high-school level, PISA 2003 and 2006 studies revealed strong the relationship between students' SES and their mathematics achievement. Large between-school variations in mathematics achievement on PISA studies, and the comparatively large contribution of students' SES to between-school variation compared to within-school variation suggested Turkish high schools differed in their social intake, whereas within high schools students were homogeneous in terms of their socioeconomic backgrounds. Relationships between students' SES and their achievement in mathematics were larger in some EU countries, such as Hungary, Germany, and Belgium on PISA 2003 and Hungary, Bulgaria, Slovak Republic, and Slovenia on PISA 2006, than it was in Turkey. Finland was consistently found to have the smallest SES-related inequity in mathematics achievement.

Opportunity gaps in mathematics education in Turkey. Although the primary education reform provided students, particularly girls, from rural areas and low-income families with access to primary schooling, gaps in educational opportunities between students from high and low income families or boys and girls still exist. The report prepared by the World Bank in 2006 concluded that Turkish education system is failing in providing "equitable learning opportunities to all youth through an efficient and effective service delivery system" (p. 5). Notwithstanding highly centralized education system in Turkey, where the MoNE is responsible for 94% of the educational decisions such as construction and renovation of school buildings, hiring, salaries, and firing of teachers and principals, and selection and distribution of textbooks (OECD, 1998), there are considerable inequities in the distribution of teachers and physical resources (e.g., infrastructure, number of classrooms, and education materials) across schools. Unfortunately, students who need the most get the least resources (Mete, 2004). Families whose children are in rural and low-income schools are more likely to report complaints about schools, teaching quality, shortage of teachers, or lack of educational resources (Mete).

There have been studies that focused on inequalities in Turkish education system. Some of these studies focused on regional differences. Cingi, Kadilar, and Kocberber (2007) investigated the educational opportunities, such as number of students per teacher and per classroom, number of science laboratories per school, and number of libraries per school, provided to primary students in each district in Turkey. The regional distances Cingi et al. found were striking. Whereas there were no districts in Istanbul that was considered in poor condition, in the southeast region of Turkey 97.4% of the districts were in poor condition in terms of the educational opportunities they provided. Overall, districts in Marmara and Aegean regions had considerably less percentage of districts that were in poor condition as compared to the 10 remaining regions identified. Cingi et al. also compared educational opportunities provided in public and private primary schools. The authors concluded that private schools had more favorable conditions in terms of the number of students per classroom, number of students per teacher, number of science laboratories per school, and number of computer laboratories per school.

Some studies examined inequalities in Turkish education system using data on education expenditures. The expenditure on education in Turkey accounted for 6.97% of its GDP (World Bank, 2005a). Although Turkey's total expenditure on education is 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. Thus, Turkey's public expenditures on education as a percentage of GDP was low among other OECD countries and was lower than EU countries such as Germany, Hungary, Finland, and France. The World Bank (2005b) concluded that "with respect to equity of education, private spending in Turkey is a more challenge than a benefit" (p. 34) because analyses of educational expenditures suggest that "public schools serving children from better-off families receive significant additional subsidies for educational materials, equipment, and activities" (p. 34).

Primary education received 40.3% of the total expenditures on education, which was the largest percent when compared to other levels of education. 95% of the allocated amount to primary schooling went to public primary schools, and the remaining was shared by the private primary schools (World Bank, 2005a). The 8-year compulsory education program resulted in a more equitable distribution of the public expenditures on primary education. In 2001, the poorest 20% of households received 21.7% of the public expenditure on primary education, which was substantially larger than their share of 15.8% in 1994 (World Bank).

Despite the importance of teacher quality crucial importance in improving student achievement in mathematics, the literature search did not locate studies conducted in Turkey on opportunity gaps in access to qualified teachers, specifically mathematics teachers or on mathematics teacher quality. Thus, in this section recent literature in the EU countries and the US on teacher quality, its impact on student achievement, and differential access to qualified teachers will be summarized.

Defining and measuring teacher quality is not an easy task, and there has not been an agreement on a definition of teacher quality or aspects of teacher quality (Goe, 2007). Research has also shown the complexity of assessing the relationship between teacher quality and student achievement. However, research in the US and in various other countries has mainly shown positive relationships between the teacher characteristics and student achievement although with varying magnitudes (Caceres, 2009).

Various empirical studies and meta-analytic reviews of these studies on teacher quality and student outcomes have shown that teacher certification, teachers' major areas of study, their subject matter knowledge, and experience were associated with student outcomes in mathematics (e.g., Clotfelter, Ladd, & Vigdor, 2005; Darling-Hammond, 2000; Darling-Hammond & Youngs, 2002; Rice, 2003). In a meta-analysis of 21 studies on the relationship between teacher characteristics and student achievement, Wayne and Youngs (2003) concluded that teachers' coursework and degrees in mathematics and mathematics-specific certification were associated with better student achievement in mathematics. Rice, in another meta-analytic review of teacher quality research with more studies than Wayne and Youngs', found that whether teachers obtained advanced degrees in mathematics, held certification in mathematics, and took both mathematics-and pedagogy-related coursework were related to students' mathematics achievement. However, the effects of these teacher characteristics on student achievement varied by grade level. Teacher quality studies also consistently showed the positive effect of teachers' subject-matter preparation on student achievement in mathematics although the measures used to mathematics knowledge varied (Caceres, 2009). Teaching experience is another teacher characteristic that has been shown to be related to student achievement. However, the relationship between teaching experience and student achievement has not been linear. In other words, more years of experience does not always translate into better student achievement (Darling-Hammond; Hanushek, Kain, & Rivkin, 1998).

Despite the consensus among researchers and policy makers in the US on the importance of teacher quality to better student achievement outcomes, research has continuously shown the access to qualified mathematics teachers is not needs-based. Students from higher SES backgrounds or white students are more likely to be taught by teachers with better qualifications as compared to students from lower SES backgrounds or non-white students (e.g., Clotfelter et al., 2005; Hanushek, Kain, & Rivkin, 1999). Such an unequal distribution of teacher qualification among schools based on the schools' poverty levels was also found in the US (e.g., Betts et al., 2000).

Recently two secondary analyses of TIMSS 2003 data, by Akiba et al. (2007) and Caceres (2009), cross-nationally examined the relationship between student SES and teacher quality and explored the association between teacher quality and students' mathematics achievement. In one of these studies, Akiba et al. found that in all of the EU countries in their study, more than 90% of eighth-grade students were taught by mathematics teachers who were fully certified. Indeed, in Bulgaria, Italy, Lithuania, and Sweden all of the eighth-grade students had teachers with full certification. The percentage of students taught by teachers with at least three years of experience ranged from 83.7% in Sweden to 100% in Latvia. There was considerable variation among EU countries in percentages of eighth-grade students who were taught mathematics by teachers without a degree in mathematics or mathematics education. In Latvia and Lithuania, none of the eighth-grade students had mathematics teachers without a mathematics or mathematics education major, whereas in Italy 79.2% of the eighth graders had teachers who did not have a degree in mathematics or mathematics education. Sweden (19.1%), Netherlands (18.2%), and England (17.2%) followed Italy with large percentages of students taught by mathematics teachers who did not hold a mathematics or mathematics education major.

Akiba et al.'s (2007) study identified opportunity gaps in access to qualified mathematics teacher in Romania, Slovenia, Slovak Republic, Estonia, Lithuania, and Bulgaria; that is, in these countries high-SES students had greater access to better qualified mathematics teachers. On the other hand, in Sweden and to a smaller extent in Italy, there was a more "needs-based" access to qualified mathematics teachers (Akiba et al., p. 378), that is, low-SES students were more likely than their high-SES peers to have access to better qualified mathematics teachers. Caceres (2009) also used TIMSS 2003 data and examined the relationships between student SES and mathematics teacher quality at the teacher level. In Caceres' study, the relationship between mean classroom parental education level, as the proxy for SES, and mathematics teacher quality was the strongest in Slovakia (Pearson *r* = 0.20) among the sample EU countries. In Romania (Pearson *r* = 0.07) and Sweden (Pearson *r* = 0.06), mathematics teacher quality was marginally related to mean classroom parental education level. The fact that Akiba et al. and Caceres seemed to find contradictory results regarding the opportunity gap in access to qualified mathematics teachers in Romania may be due to two major reasons. One of them is Akiba et al.'s study was conducted at the national level, whereas Caceres conducted her study at the teacher level. Secondly, Akiba et al. and Caceres used different items on TIMSS teacher questionnaires to measure teacher quality.

Akiba et al. (2007) also examined the relationship between teacher quality and national achievement and found a positive association between their sample countries' mean mathematics achievement and percentages of students in these countries whose teachers were certified, majored in mathematics education, had at least three years of teaching experience, or held all three qualifications. In other words, larger percentages of students with access to better qualified teachers were linked to higher national achievement. On the other hand, achievement gaps between low- and high-SES students was found to be positively related to opportunity gaps in access to teachers with a major in mathematics or with high overall teacher quality.

Using a different perspective than Akiba et al.'s (2007), Caceres investigated how much of the variation among classroom mean mathematics achievement on TIMSS 2003 was explained by teacher quality in her sample countries. Teacher quality explained the largest variation in mean classroom mathematics achievement in Sweden

(R^2 = 5%) followed by Romania (R^2 = 3%). However, when mean classroom parental education level was used together with teacher quality to explain the variation in mean classroom mathematics achievement, the effect of teacher quality on average classroom achievement got smaller. In Slovak Republic, teacher quality, even when used as the only predictor, was not related to average classroom mathematics achievement.

Conclusion

This literature review has highlighted what is known and what is not known about achievement and opportunity gaps among Turkish SES students and how these gaps compared to those in EU countries. An important finding was that achievement gap studies were very rare in Turkey, particularly at the middle-school level. In fact, the OBBS study by the MoNE (EARGED, 2007) was the only study found that examined gender- and SES-related achievement gaps with a representative national sample at the middle-school level. Results of MoNE's study indicated that low-SES students were behind their high-SES peers in mathematics achievement, and findings regarding gender-gap were inconsistent across grades. However, lack of effect sizes in OBBS reports prevented a meaningful interpretation of the results or comparisons of achievement gaps among Turkish students to gaps in other countries. Further, researchers have argued about the importance of the interaction between SES and gender on mathematics achievement, which was missing in the Turkish literature (McGraw et al., 2006). This literature review also identified the lack of cross-national studies that used consistent assessment and variables to measure the level of gender- and SES-related achievement gaps in Turkey and the EU countries at the middle-school level.

Thus, this dissertation fills a gap by examining gender- and SES-related achievement gaps in mathematics at the middle-school level in Turkey compared to achievement gaps in EU countries, with particular attention to the interaction between gender and SES (i.e., if any potential gender differences endured across SES groups). In addition to identifying under-achieving groups, this study also highlights the mathematics content domains in which achievement gaps are larger.

In addition to the achievement disparities, this study contributes to Turkish literature by examining the opportunity gap in access to qualified mathematics teachers in Turkey. Teacher quality is among school-related factors that have been found to be important predictor of learning outcomes (Darling-Hammond, 2000; Wayne & Youngs, 2003). Research has shown that teacher qualifications, such as certification and subject-matter preparation, are associated with student achievement. As a result, there have been several calls in the US, for example, for more equitable distribution of teachers and more qualified teachers for disadvantaged students. As the initial step to achieve equity, this study identifies any potential opportunity gaps in access to qualified mathematics teachers.

In addition to examining the extent of differential access to qualified mathematics teachers, this study provides initial findings on the relationship between Turkish mathematics teachers' characteristics and student achievement outcomes at the eighth-grade level. In addition to overall impact of teacher quality on student achievement, the current study investigates the association between teacher qualifications and achievement of low-SES students. Research on teacher characteristics that are associated with better achievement outcomes for low-SES students is particularly important for Turkey as policy-makers develop interventions to alleviate disparities in educational outcomes.

CHAPTER III

METHODOLOGY

Trends in International Mathematics and Science Study

Trends in International Mathematics and Science Study (TIMSS) is a cross-national achievement study conducted by International Association for the Evaluation of Educational Achievement (IEA) every four years since 1995. TIMSS assesses fourth- and eighth-grade students' achievement in mathematics and science. To contextualize the social and educational environment in which mathematics and science learning occurs, TIMSS collects detailed information via questionnaires completed by students, their teachers, and their school principals. In addition, information about the intended mathematics and science curricula is gathered for each country. Thus, TIMSS results provide a broad picture of mathematics and science education in the participating countries. Such in-depth information allows each of the participating countries to (a) monitor changes in their mathematics and science educational practices, (b) analyze relationships between these practices and student achievement, (c) compare themselves to other participating countries worldwide, and (d) track students' progress over time.

The most recent TIMSS, conducted in 2007, collected data in 57 countries at the eighth-grade level, seven of which were benchmarking participants. The TIMSS 2007 assessment included student achievement tests in mathematics and science and student, teacher, school, and curriculum questionnaires to gather contextual information about mathematics and science teaching and learning. This dissertation focused on the mathematics achievement test and student and teacher questionnaires.

Participants

Sample Countries

The sample countries were Turkey and the EU countries that provided the required variables for the current study. Thus, among the participating EU countries Bulgaria, Cyprus, Czech Republic, Hungary, Italy, Lithuania, Malta, Romania, and Slovenia were included in the present study. As can be seen in Table 4, the sample countries varied in terms of overall quality of life (measured by life expectancy at birth), economic power (measured by gross national income (GNI) per capita), investment in education (measured by percentage of gross domestic product (GDP) spent on education), and enrollment rates in primary and secondary education.

Table 4

Selected Characteristics of Sample Countries

Country	Life Expectancy at Birth	GNI per capita (in US dollars)	% of GDP Spent on Education	Enrollment Rate	
				Primary Education	Secondary Education
Bulgaria	73	3,990	3	93	89
Cyprus	79	23,270	6	100	94
Czech Republic	77	12,790	4	93	NA
Hungary	73	10,870	5	89	90
Italy	81	31,990	5	99	92
Lithuania	71	7,930	5	88	94
Malta	79	15,310	NA	86	84
Romania	72	4,830	3	91	81
Slovenia	78	18,660	6	96	91
Turkey	72	5,400	4	90	66

Note. The data reported in this table were taken from *TIMSS 2007 Encyclopedia* (Mullis, Martin, Olson, Berger, Milne, & Stanco, 2007).

Participant Selection

TIMSS 2007 participants were selected using a two-stage probability proportional to size design in the participating countries. The first step for selecting participants in the two-stage probability proportional to size design was sampling schools using systematic, random sampling with probability proportional to size. In sampling with probability proportional to size, the probability of sampling a school was set proportional to the school size. This sampling method is particularly useful when the sizes of the units sampled, in this case the schools, are substantially different. Using probability proportional to size design sampling at the first stages of a multi-stage sample allows for the potential end participants in larger schools, in our case students, to be sampled with the same probability as the potential participants in smaller schools (Chromy, 2006). The second step was sampling intact eighth-grade classrooms in these schools using systematic random sampling. All of the students in a sampled class, except for the ones who belonged to an excluded group (i.e., students with intellectual or functional disabilities or non-native students who cannot read or speak the language of the test) or who were absent, participated in the study. Table 5 presents numbers of schools, teachers, and students at eighth grade for each country included in the present study.

Table 5

Numbers of Schools, Teachers, and Students by Country

Country	Number of Schools	Number of Teachers	Number of Students	Students	
				Female (%)	Male (%)
Bulgaria	163	207	4019	50.0	50.0
Cyprus	67	194	4399	50.1	49.9
Czech Republic	147	190	4845	48.4	51.6
Hungary	144	263	4111	49.5	50.5
Italy	170	287	4408	48.1	51.9
Lithuania	142	209	3991	49.7	50.3
Malta	59	116	4670	50.8	49.2
Romania	149	236	4198	49.2	50.8
Slovenia	148	459	4043	50.3	49.7
Turkey	146	146	4498	46.6	53.4

Target Populations

International desired target populations were all of the eighth graders in each participating country. However, each participating country determined their national desired target populations that excluded some subpopulations/school types and regions due to different languages spoken or geographical limitations. Among the countries included in the present study only Lithuania had a more limited nationally desired target population than the international target population at eighth grade. In Lithuania, national target population was restricted to students who were taught in Lithuanian.

The national desired target populations were met to a large extent in the majority of participating countries, and students excluded from the study accounted for less than five percent of the total national desired target populations. Although schools that served exclusively students with special needs were included in the first pool of schools, these schools were excluded if they were sampled. Students with intellectual or functional disabilities or non-native students who could not read or speak the language of the test were excluded within schools. Exclusions at the school level or within schools for each participating country can be found in TIMSS 2007 technical report.

Procedures

Students in the participating countries took TIMSS 2007 close to the end of their school year. Thus, 2007 TIMSS was administered in April, May, or June of 2007 in the countries included in the present study. The administration procedures for the achievement tests and background questionnaires were internationally standardized. A test administrator was assigned by TIMSS for each class to administer the achievement tests and student questionnaires. The total mathematics achievement testing time was 45 minutes for eighth grades. In TIMSS 2007, eighth graders were allowed to use calculators. However, the items were developed in a way that calculator use would not make any difference in student achievement. Student questionnaires were designed to take about 30 minutes, and each student who took the TIMSS student achievement test completed the student questionnaire.

Measures

The instruments used in TIMSS 2007 to collect information on fourth- and eighth-grade students' achievement was an achievement test for each grade that consisted of mathematics and science items. In the present study, the focus is on only the mathematics items on the eighth-grade achievement test. The instruments used to gather contextual information about educational and social context were as follows: Student questionnaire, teacher questionnaire, school questionnaire, and curriculum questionnaire. In the present study, student and teacher questionnaires were used. Administering the questionnaires to students, teachers, and school principals, both allowed to gather information about different aspects of the educational contexts and enabled measuring the same constructs in different questionnaires, thereby gathering information on the same constructs from different resources. All of the instruments, that is, the achievement test and the questionnaires, were created in English and were subsequently translated into different languages. Rigorous translation validation procedures, details of which can be found in TIMSS technical reports, were used to ensure equivalency of the instruments in various languages. The questionnaires, except for the curriculum questionnaire, were pilot tested with representative samples in the majority of the participating countries, and necessary changes were made based on the results of the pilot tests.

Mathematics Achievement Test

Mathematics achievement test framework. The TIMSS achievement test frameworks were developed with the contribution of educators from around the world to assure the frameworks were suitable for use in the participating countries. The frameworks included both the curricula content and mathematics education expectations/objectives across the participating countries. The framework for mathematics assessment had two dimensions: a content dimension and a cognitive dimension.

Content dimension. The content dimension laid out the subject matter assessed, which was categorized under different content domains. The eighth-grade content domains were (a) number, (b) algebra, (c) geometry, and (d) data-and-chance. For each content domain, related topic areas and target understandings and abilities associated with the topic areas were specified. The topics included in each content domain are presented in Table 6. Objectives for each topic area can be found in TIMSS assessment framework documents.

Cognitive dimension. The cognitive dimension classified thinking processes assessed under different cognitive domains. The cognitive domains were (a) knowing, (b) applying, and (c) reasoning. Knowing involved knowledge of facts and procedures, applying referred to the application of knowledge to solve routine problems, and reasoning embodied transferring knowledge and applying mathematical thinking to novel and complex problems.

Table 6

Topics for Each Content Domain on Mathematics Achievement Test for Eighth Grade

Content Domains (% of score points allotted for the content domain)	Topic Areas
Number (30%)	Whole numbers Fractions and decimals Integers Ratio, proportion, and percent
Algebra (29%)	Patterns Algebraic expressions Equations/formulas and functions
Geometry (21%)	Geometric shapes Geometric measurement Location and movement
Data and Chance (20%)	Data organization and representation Data interpretation Chance

Mathematics achievement test booklets. There were 14 achievement test booklets, each of which contained two mathematics item blocks. TIMSS 2007 used matrix-sampling approach for the creation of achievement test booklets. As the first step in this approach, items were first grouped into 14 mathematics item blocks. Each item block contained 11-18 items at eighth grade. Seven of the 14 item blocks for eighth grades used in TIMSS 2007 were the blocks secured (i.e., were not released for public use) from 1999 and 2003 administrations of TIMSS. Thus, for 2007 TIMSS only seven blocks of new items were created. Having the same item blocks in different administrations of TIMSS allows for measuring trends over time.

The second step in the creation of the achievement test booklets was constructing 14 student achievement test booklets using different combinations of the item blocks. Each booklet contained two mathematics item blocks, one of which was from 2003 TIMSS administration. In the arrangement of the booklets special attention was given to ensure that each booklet covered the assessment framework and contained adequate number of items to reliably measure achievement trends. In seven of the booklets, mathematics items were placed before science items, and in the remaining, mathematics items were placed after science items.

Each student completed one achievement test booklet. The minimum sample size in each country and the distribution of booklets in each classroom were determined to ensure that each item was answered by sufficient number of students.

Mathematics items. The TIMSS mathematics achievement test consisted of multiple-choice and constructed-response items. The total number of mathematics items on the eighth grade test was 215: 117 multiple choice items and 98 constructed-response items. Multiple-choice items presented students with four options one of which was correct. A correct answer to a multiple-choice item was scored as 1, and an incorrect answer was scored as 0. Instructions to answer multiple-choice items provided students with an example multiple-choice item illustrating the selection and marking of a correct answer.

Constructed-response items required a written response. Constructed-response items were scored using a rubric that gave partial credit for partially correct answers and full credit to completely correct answers. Rubrics described main characteristics of correct and partially correct responses. Specific correct solution strategies and common error/misconception patterns were listed in the rubrics, and each of them was given a code. Each student answer was assigned such a code, in addition to a score, to identify the particular correct solution strategy used or the error/misconception that led to the incorrect response. If an answer included a correct/incorrect solution strategy that was not specified in the rubric, the answer was coded as 9. To ensure consistent scoring of constructed-response items across countries, scorers were trained with sample student responses from previous TIMSS administrations. Most of the constructed-response items were worth 1 or 2 points, and some constructed-response items that assessed reasoning skills were worth up to 6 points.

Scaling of the mathematics achievement data. Because of the constraints such as time and cost to test every student on all items, TIMSS 2007 used matrix-sampling approach. However, at the end, we would like to know how the students would have performed if all the items had been administered to all students. Item response theory (IRT) together with multiple imputation, also known as plausible value, technique allowed for making reliable estimates of students' abilities. IRT is a probabilistic measurement method in which the probability of producing a correct response depends on item characteristics and examinee's ability. For example, students with high ability have high probabilities to correctly answer easy items, whereas students with low ability have low probabilities to correctly answer difficult items. An advantage of IRT is IRT produces ability estimates that are independent from item characteristics. Thus, even when students are not administered the same items, which was the case for TIMSS 2007, their abilities can be summarized on a common scale.

Plausible values were obtained by combining IRT proficiency estimates with student background data to generate a distribution of possible scores for each student (Foy, Galia, & Li, 2008). Five scores were randomly drawn from each student's distribution, and each of these five scores constituted a plausible value. Statistical analyses with TIMSS data needed to be conducted on each of the plausible values, and obtained statistics were averaged. The variance for each statistic was the combination of both sampling and imputation variances. 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, which took sample and test design into account, was used.

Score reliability. TIMSS 2007 technical reports included the internal consistency reliability coefficient of mathematics scores for each country (see Table 7). The reliability coefficient for each country was calculated as the median Cronbach's alpha coefficient of mathematics scores across the 14 achievement test booklets. Reliability coefficients for the countries included in the present study were sufficiently large (Nunnally & Bernstein, 1994).

TIMSS 2007 technical reports also included inter-rater reliability estimates for constructed-response mathematics items within each country. The inter-rater reliability estimates were reported for the raters' agreements on the correctness of the student answers as well as on the diagnostics of the answers, which included the types of strategies used, errors, and misconceptions. To determine inter-rater reliability estimates, for each country, two raters scored a minimum of randomly selected 200 student answers to each item. Table 7 displays the average percentage of exact agreement for the correctness and diagnostic scores across all constructed-response mathematics items for each country in the present study.

For an international study like TIMSS, in addition to within-country inter-rater reliabilities, it was important to provide an estimate of cross-country inter-rater reliability. Because of the large number of different languages in which the achievement tests were administered, inter-rater reliabilities across all participating countries could not be determined. However, a cross-country inter-rater reliability study was conducted with the English proficient raters in the Northern Hemisphere countries for a sample of constructed-response items at both fourth- and eighth-grade levels. Average percentages of exact agreement on the correctness and diagnostic scores across the 20 mathematics items included in the cross-country inter-reliability study at the eighth-grade level were 91 and 90, respectively.

Table 7

Reliability Coefficients of Mathematics Scores by Country

Country	Cronbach's Alpha Reliability Coefficient	Inter-Rater Reliability: Average percentage of exact agreement on the Correctness Scores	Inter-Rater Reliability: Average percentage of exact agreement on the Diagnostic Scores
Bulgaria	0.90	96	94
Cyprus	0.88	-	-
Czech Republic	0.88	98	96
Hungary	0.90	98	97
Italy	0.87	99	98
Lithuania	0.89	98	97
Malta	0.89	97	95
Romania	0.90	99	99
Slovenia	0.88	100	99
Turkey	0.91	100	99

Validity. Being an international study it was important for TIMSS to establish comparative validity, which refers to the comparability of the data across countries to be able to make meaningful comparisons among different countries' achievement levels. TIMSS & PIRLS International Study Center collaborated with an international committee of mathematics experts who reviewed and revised the items to ensure that the items fit the mathematics achievement frameworks. TIMSS items were also field tested, and items that covered a range of difficulty levels and that had high discriminatory powers across countries were chosen.

Contextual Questionnaires

Student questionnaire framework. The student questionnaire framework covered information about students’ demographics and attitudes, their home background, their school, experiences in their mathematics classrooms, their mathematics homework and extracurricular activities, and their computer use - both in and out-of school. Student questionnaires included items pertaining to science education; however, science-education related questions were not used in the present study.

Teacher questionnaire framework. The teacher questionnaire framework addressed information about teachers, classroom characteristics and activities as well as schools. Information about teachers included characteristics of teachers, their preparation to teach, and professional development opportunities. Information about classrooms included the implemented curriculum, class size, instructional time and activities, assessment and homework, and technology, more specifically computer, internet, and calculator use. Teacher questionnaires for eighth-grade teachers were subject-specific. In other words, the mathematics teacher questionnaire did not include questions related to science. Teacher questionnaires were designed to take about 30-45 minutes and were completed by the teachers whose students took the TIMSS student-achievement test.

Analysis

This section presents variables and analytical methods used to answer each research question.

Research Question 1

The first research question asked: How does Turkey compare to other EU countries in terms of the SES-based achievement gap in mathematics, overall, and in various content (i.e., number, algebra, geometry, and data-and-chance) and cognitive (i.e., knowing, applying, and reasoning) domains in middle schools?

Variables used for research question 1. In the present study, parental education was used as the SES measure. Parental education is among the nonschool factors that impact educational outcomes and that international studies such as TIMSS and PISA collect information on. In his meta-analysis on the relationship between SES and academic achievement, Sirin (2005) found that parental education was the most common SES measure in academic achievement studies in the US. As stated by Sirin, “parental education, is considered one of the most stable aspects of SES because it is typically established at an early age and tends to remain the same over time” (p. 419). Parental education is commonly correlated with parental income. Further, in a study conducted by Hampden-Thompson and Johnston (2006) to address “the concern that differences between countries on nonschool factors hinder cross-national comparisons of achievement outcomes,” (p. 2) parental education was found to be a consistent indicator of mathematics achievement across countries.

The following items on the TIMSS student questionnaire asked about students' parents' educational levels:

- What is the highest level of education completed by your mother (or stepmother or female guardian)?
- What is the highest level of education completed by your father (or stepmother or female guardian)?

The students could choose one of the following options for each question:

- Some <ISCED Level 1 or 2> or did not go to school
- <ISCED 2>
- <ISCED 3>
- <ISCED 4>
- <ISCED 5B>
- <ISCED 5A, first degree>
- Beyond <ISCED 5A, first degree>
- I don't know

ISCED 1, ISCED 2, ISCED 3 refer to primary, lower secondary, and upper secondary education, respectively. ISCED 4 is defined as the "post-secondary non-tertiary education" and covers the programs that straddle the "boundary between upper secondary and post-secondary education" (OECD, n.d.a). ISCED 5A and 5B correspond to post-secondary education with ISCED 5A programs to be more theory-based. In original TIMSS data files, the above options were coded on a 7-point scale, where *Some*

<ISCED Level 1 or 2> or did not go to school corresponded to 1 and *Beyond <ISCED 5A, first degree>* corresponded to 7.

In a study on the effectiveness of the International Standard Classification of Education (ISCED) framework to measure the skills of workers in the EU, Steedman and McIntosh (2001) concluded that ISCED was "identified as the most suitable means of measuring skills over time and space" (p. 564). Steedman and McIntosh further showed there were considerable differences in the employment rates and earnings among ISCED 0/1/2, ISCED3, and ISCED 5/6/7 groups. For some of the analyses in the present study, three levels of parental educational attainment and corresponding SES levels were identified: (a) low level of parental education (ISCED 1/2 or no education) ~ low-SES students, (b) medium level of parental education (ISCED 3/4) ~ medium-SES students, and (c) high level of parental education (ISCED 5B/5A first degree or beyond ISCED 5A first degree) ~ high SES students (cf. European Centre for the Development of Vocational Training, 2009; Luxembourg Income Study, n.d.). When recoding the SES levels as low, medium, and high, the education level of the parent who had the highest educational attainment was used. The parental education level was recoded as missing for those students who chose the "I don't know" option.

As it is often the case in social science research, some students left one or both of the parental education variables blank. As can be seen in Table 8, percentages of missing data on questions about the highest education levels of the parents differed across countries. In Lithuania, Malta, and Slovenia missing data were larger than 30%, whereas in Turkey the missing data were smaller than 5%. EU countries England and Scotland did not administer the items about parental education so England and Scotland were not included in the present study. Another EU country, Sweden, was excluded because the percentage of missing data on each item about parental education was larger than 50%. Schafer and Olsen (1998) suggested that ordinal variables could be imputed under normality assumption as long as they are not highly skewed. An examination of distributions of parental education variables showed they were heavily skewed in some countries. Thus, missing data were handled using the multiple imputation procedure for categorical variables within SPSS.

Multiple imputation for the missing data on SES variables resulted in five imputed datasets for each country. All the analyses to answer the first research question were conducted on each of the imputed data files for each country using the IDB analyzer. Subsequently, results from the five imputed data sets were aggregated for each country. Final point estimates (e.g., percentages, means, SDs) were simply the averages of the point estimates obtained from each imputed data file. Final standard errors of point estimates were calculated using Rubin's formula: Standard error = $\sqrt{(1-1/M)B+W}$, where M is the number of imputed files, B is the variance of the point estimates across imputations, and W is the average within-variance of the point estimates (Pickles, 2005).

Table 8

Percentages of Missing Data on Parental Education Variables for Each Sample Country

Country	Highest Education Level - Mother	Highest Education Level - Father
Bulgaria	12.96	16.46
Cyprus	11.35	12.20
Czech Republic	16.28	22.03
Hungary	9.18	10.93
Italy	13.32	14.63
Lithuania	29.84	38.70
Malta	35.77	38.70
Romania	23.40	28.18
Slovenia	31.20	33.28
Turkey	4.45	4.22

Analyses used for research question 1. Three different approaches were used to answer this research question:

First approach. 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. 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.

Confidence intervals for correlation coefficients were calculated and also graphed to ease comparisons. The American Psychological Association (2001), the American Educational Research Association (2006), and the working group on statistics in mathematics education research (American Statistical Association, 2007) all recommended reporting confidence intervals (CIs) for point estimates. The APA *Publication Manual* stated that

> The reporting of confidence intervals (for estimates of parameters, for functions of parameters such as differences in means, and for effect sizes) can be an extremely effective way of reporting results. Because confidence intervals combine information on location and precision and can often be directly used to infer significance levels, they are, in general, the best reporting strategy. (p. 22)

Because the sampling distribution for Pearson *r* is not normally distributed, computations of CIs were relatively complicated. First, all Pearson *r* correlation coefficients were converted to Fisher's *z*, and CIs for these Fisher's *z* values were calculated. Subsequently, upper and lower confidence limits for the Fisher's *z* were converted back to Pearson *r* (Fan & Thompson, 2003).

Second approach. 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 approach. 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.

Research Question 2

The second research question asked: How does Turkey compare to other EU countries in terms of the gender-based achievement gap in mathematics, overall, and in various content (i.e., number, algebra, geometry, and data-and-chance) and cognitive (i.e., knowing, applying, and reasoning) domains, with attention to the interaction between SES and gender, in middle school?

Analyses used for research question 2. To answer this research question, first, achievement differences between boys and girls were examined using CIs around mean achievement scores and Cohen's *d* effect sizes. For all effect size calculations, girls' achievement scores were subtracted from those of boys. After examining gender-based differences in mathematics achievement within each country, results were disaggregated by SES levels. In other words, gender-based differences at low-, medium-, and high-SES strata were examined separately using 95% CIs and Cohen's *d* effect sizes. Because the SES variable was multiply imputed, analyses to examine gender differences in mathematics achievement among low-, medium-, and high-SES students were conducted on each of the five imputed data files for each country using the IDB analyzer. Subsequently, results from the five imputed data sets were aggregated for each country.

Research Question 3

The third research question asked: In Turkey if and to what extent is there differential access to qualified mathematics teachers based on students' SES in middle school?

Variables used for research question 3. TIMSS 2007 teacher questionnaire included items on teachers' preparation to teach that could be used as proxies for teacher quality. Among those teacher quality indicators, teachers' years of experience, majors in post-secondary education, and their self-reported preparedness in content domains of number, algebra, geometry, and data and chance were used in the present study. Table 9 displays the variables used to answer this research question. Although teaching certification status has been shown to be an important aspect of teacher quality (Darling-Hammond, 2000), the item on the teacher questionnaire that asked if teachers held teaching licenses or certificates was not included here because more than 99% of all students in the Turkish sample were taught by teachers who held teaching licenses or certificates. The interval-scale item on the teacher questionnaire regarding teachers' years of experience was transformed into a dichotomous variable, where one category consisted of teachers with less than 3 years of experience and the other category included teachers with 3 or more years of experience.

Table 9

Teacher Questionnaire Items Used to Answer Research Question 3

Teacher Questionnaire Item	Item Scale
By the end of this school year, how many years will you have been teaching altogether?	interval
During your post-secondary education, what was your major or main area(s) of study?	
a) Mathematics	dichotomous
b) Education - Mathematics	dichotomous
How well prepared do you feel you are to teach the following mathematics topics?	
Number	
a) Computing, estimating or approximating with whole numbers	Three-level ordinal
b) Representing decimals and fractions using words, numbers, or models (including number lines)	Three-level ordinal
c) Computing with fractions and decimals	Three-level ordinal
d) Representing, comparing, ordering, and computing with integers	Three-level ordinal
e) Problem solving involving percents and proportions	Three-level ordinal

Table 9

Continued

Teacher Questionnaire Item	Item Scale
Algebra	
a) Numeric, algebraic, and geometric patterns or sequences (extension, missing terms, generalization of patterns)	Three-level ordinal
b) Simplifying and evaluating the algebraic expressions	Three-level ordinal
c) Simple linear equations and inequalities, and simultaneous (two variables) equations	Three-level ordinal
d) Equivalent representations of functions as ordered pairs, tables, graphs, words, or equations	Three-level ordinal
Geometry	
a) Geometric properties of angles and geometric shapes (triangles, quadrilaterals, and other common polygons)	Three-level ordinal
b) Congruent figures and similar triangles	Three-level ordinal
c) Relationship between three–dimensional shapes and their two-dimensional representation	Three-level ordinal
d) Using appropriate measurement formulas for perimeters, circumferences, areas of circles, surface areas and volumes	Three-level ordinal
e) Cartesian plane - ordered pairs, equations, intercepts, intersections, and gradient	Three-level ordinal
f) Translation, reflection, and rotation	Three-level ordinal

Table 9

Continued

Teacher Questionnaire Item	Item Scale
Data and Chance	
a) Reading and displaying data using tables, pictographs, bar graphs, pie charts and line graphs	Three-level ordinal
b) Interpreting data sets (e.g., draw conclusions, make predictions, and estimate values between and beyond given data points)	Three-level ordinal
c) Judging, predicting, and determining the chances of possible outcomes	Three-level ordinal

Analyses used for research question 3. TIMSS data sampling were random at the student but not the teacher level. Thus, analyses for this question were conducted at the student level to allow for generalization. Percentages of low-, medium-, and high-SES students taught by mathematics teachers who had 3 or more years of experience, who had a major in mathematics or mathematics education, and who felt confident about their subject-matter preparation were calculated in IDB analyzer. Percentages were obtained using five imputed data files, and results were aggregated subsequently. Percentages of students whose teachers had missing data were less than 3% on all the teacher quality indicator variables used in the present study, except for years of experience. For teachers of 8.3% of all students, data on years of teaching experience were missing.

Research Question 4

The fourth research question asked: In Turkey, what is the relationship between mathematics teacher quality and student achievement and, more specifically, if and to what extent mathematics teacher quality is associated with the achievement of low-SES students?

Variables used for research question 4. Teacher quality indicators in Table 9 were used for research question 4 as well as research question 3. However, there were some recoding of the variables and imputation involved. Questionnaire items about how well prepared teachers felt to teach various mathematics concepts provided teachers with four answer options: not applicable, not well prepared, somewhat prepared, and very well prepared. For analysis purposes to answer research question 4, the *not applicable* choice was recoded as missing data, and the remaining three options were recoded on a three-point ordinal scale, where not well prepared was 0, somewhat prepared was 1, and very well prepared was 2. Missing data on teachers' preparedness levels were imputed using the EM algorithm in SPSS 19. Subsequently, an overall teacher preparedness variable, *TEACHPREP*, was created for each teacher by adding his or her scores on each questionnaire item about how prepared teachers felt to teach the various mathematics concepts.

The interval-scale item on the teacher questionnaire regarding teachers' years of experience was transformed into a dichotomous variable, namely *YEARS_EXP*, where one category (coded as 0) consisted of teachers with less than 3 years of experience and the other category (coded as 1) included teachers with 3 or more years of experience. The variable that showed teachers' majors were named as *MAJOR*. Teachers who had a 1 on the variable *MAJOR* held either a mathematics or mathematics education major, whereas teachers with a 0 on *MAJOR* did not hold a mathematics or mathematics education major.

The SES variable was the same three level ordinal variable (i.e., low, medium, and high) used in the first three research questions. However, unlike analyses for prior research questions, multiple imputation was not used for the SES variable. For those students who had missing data on only one of their parents' education, the SES level was coded based on the parent for whom education level was provided. If both parents' education levels were missing, then these students (i.e., 2.3% of all students) were deleted when running the analyses for research question 4.

Analyses used for research question 4. Two-level hierarchical linear modeling was used to examine the relationship between mathematics teacher quality and student achievement and, further, to explore if and to what extent mathematics teacher quality made a difference on the achievement of low-SES students. In the present study, HLM 6 software (Raudenbush, Bryk, and Congdon, 2004) was used for multilevel analyses. Hierarchical linear modeling techniques take into account the nested structure of the data, which was the case for TIMSS 2007 data, where students were grouped within teachers (Raudenbush & Bryk, 2002). The HLM 6 software also allowed for running the multilevel models using the five plausible values and applying the sampling weights.

The multilevel model development took place in three steps. In the first step, an unconditional two-level model was run to examine proportions of total variance in mathematics achievement that were between and within teachers. In the next model, teacher-level predictors were included to explain the between-teacher variance. In other words, this second model examined the relationship between classroom mean achievement and teacher quality indicators. The third HLM model, building on the previous model with level-2 predictors, also included parental education level to investigate if and to what extent students' SES levels explained the within-teacher variance in mathematics achievement. This final HLM model also explored the extent to which quality of the mathematics teachers was associated with the achievement of low-SES students.

Unconditional model. The preliminary step involved the estimation of the *unconditional* or *null* model, that is, a model containing no predictors. The unconditional model decomposed the total mathematics achievement variance into two components: between-teacher and within-teacher variances. The unconditional model revealed an intraclass correlation coefficient, which represented the proportion of the total mathematics achievement present between teachers. Student level (i.e., level 1) (Equation 3.1), teacher level (i.e., level 2) (Equation 3.2), and mixed model (Equation 3.3) equations for the unconditional model are presented below.

Level 1: $$y_{ij} = \beta_{0j} + e_{ij} \qquad (3.1)$$

Level 2: $$\beta_{0j} = \gamma_{00} + u_{0j} \qquad (3.2)$$

Mixed model: $$y_{ij} = \gamma_{00} + u_{0j} + e_{ij} \qquad (3.3)$$

- i is for individuals and j is for teachers
- γ_{00} is the grand mean mathematics achievement score (in this case the average mathematics achievement for the country)
- e_{ij} is the random effect associated with student i in teacher j's class (in this case the deviation of student i's achievement from the mean achievement of teacher j's class)
- u_{0j} is the random effect associated with teacher j's class (in this case the deviation of the mean achievement of teacher j's class from the country mean)

Hierarchical linear model including only level-2 predictors. In this step, following teacher quality indicators were entered as a level-2 predictor to explain the between-teacher variance: (a) how well teachers felt to teach various mathematics concepts, *TEACHPREP*, (b) years of experience, *YEARS_EXP*, and (c) teachers' majors, *MAJOR*. In examining the relationship between student achievement and teacher quality, classroom median SES level was used as the control variable to more clearly determine effects of teacher quality on student achievement holding classroom SES levels constant.

Student level (i.e., level 1) (Equation 3.4), teacher level (i.e., level 2) (Equation 3.5), and mixed model (Equation 3.6) equations for the model with only level-2 predictors are presented below.

Level 1: $$y_{ij} = \beta_{0j} + e_{ij} \quad (3.4)$$

Level 2: $$\beta_{0j} = \gamma_{00} + \gamma_{01}\, \mathit{TEACHPREP} + \gamma_{02}\, \mathit{YEARS\_EXP} + \gamma_{03}\, \mathit{MAJOR} + \gamma_{04}\, \mathrm{MEDIANSES} + u_{0j} \quad (3.5)$$

Mixed model: $y_{ij} = \gamma_{00} + \gamma_{01}$ *TEACHPREP* $+ \gamma_{02}$ *YEARS_EXP*

$+ \gamma_{03}$ *MAJOR* $+ \gamma_{04}$ MEDIANSES $+ u_{0j} + e_{ij}$ (3.6)

- γ_{01} is the main effect of *TEACHPREP*
- γ_{02} is the main effect of *YEARS_EXP*
- γ_{03} is the main effect of *MAJOR*
- γ_{04} is the main effect of MEDIANSES
- e_{ij} is the level-1 random effect
- u_{0j} is the level-2 random effect

Hierarchical linear model with level-1 and level-2 predictors. In this final model, while remaining the teacher-level predictors in the previous model, parental education (i.e., low, medium, and high), the proxy for students' SES levels, was entered as the level-1 predictor. Because parental education was an ordinal variable with three categories, two dummy variables, MEDSES and HIGHSES, were coded and used in HLM analyses.

Student level (i.e., level 1) (Equation 3.7), teacher level (i.e., level 2) (Equation 3.8), and mixed model (Equation 3.9) equations for the current model are presented below.

Level 1: $y_{ij} = \beta_{0j} + \beta_{1j}$ MEDSES $+ \beta_{2j}$ HIGHSES $+ e_{ij}$ (3.7)

Level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01}$ *TEACHPREP* $+ \gamma_{02}$ *YEARS_EXP*

$+ \gamma_{03}$ *MAJOR* $+ \gamma_{04}$ MEDIANSES $+ u_{0j}$ (3.8)

$\beta_{1j} = \gamma_{10} + u_{1j}$

$$\beta_{2j} = \gamma_{20} + u_{2j}$$

Mixed model: $y_{ij} = \gamma_{00} + \gamma_{01}\, TEACHPREP + \gamma_{02}\, YEARS\_EXP$

$+ \gamma_{03}\, MAJOR + \gamma_{04}\, MEDIANSES + u_{0j}$

$+ \gamma_{10}\, MEDSES + u_{1j}\, MEDSES + \gamma_{20}\, HIGHSES$

$+ u_{2j}\, \mathrm{HIGH}SES + e_{ij}$ (3.9)

- γ_{10} is the main effect of *MEDSES*
- γ_{20} is the main effect of *HIGHSES*

CHAPTER IV

RESULTS

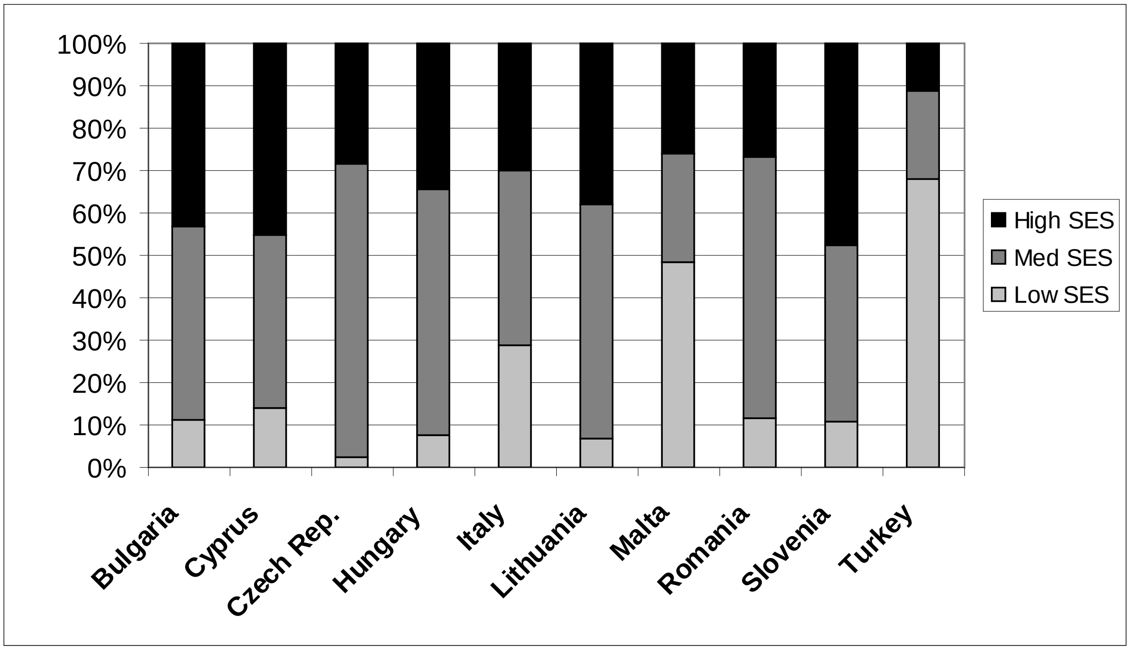

Figure 1. Percentages of students from low-, medium-, and high-SES families in each sample country.

As shown in Figure 1, sample countries differed in terms of the percentages of students who came from low-, medium-, and high-SES families (see also Table A.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.

Findings for Research Question 1

Results of Correlation Analyses

Three different correlation analyses (i.e., Pearson *r* correlations between the parental education level and achievement scores, Pearson *r* correlations between the parental education level and achievement scores transformed to ranks, and Spearman rank correlations between the parental education level and achievement scores) conducted for triangulation revealed very similar results in mathematics, overall, and in content and cognitive domains (see Tables B.1 through B.8). Therefore, in this section, results from the first set of correlation analyses, that is, Pearson *r* correlations between the parental education level and achievement scores, are reported.

As shown in Figure 2, 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 also Table C.1). 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. As can be seen in Figures C.1 through C.7 and Tables C.1 through C.8 in Appendix C, Turkey had the largest correlation between SES and achievement in all of the content and cognitive domains, followed, in order, by Hungary and Bulgaria.

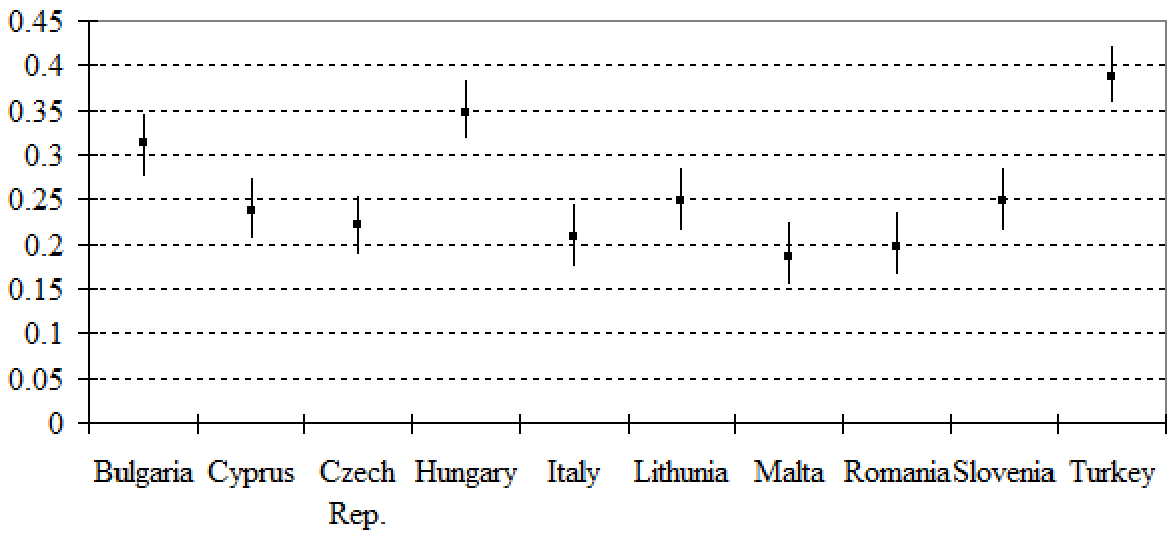

Figure 2. Pearson r correlations between SES and achievement scores in mathematics in each sample country.

In addition to comparing effect sizes across the countries in the present study, 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 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 the average effect size obtained by Sirin. 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., $r = 0.35$).

Comparison of Achievement Levels Between Low- and High-SES Groups

As shown in Table 10, 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 $d = 1.45$). 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 10

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]	
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).

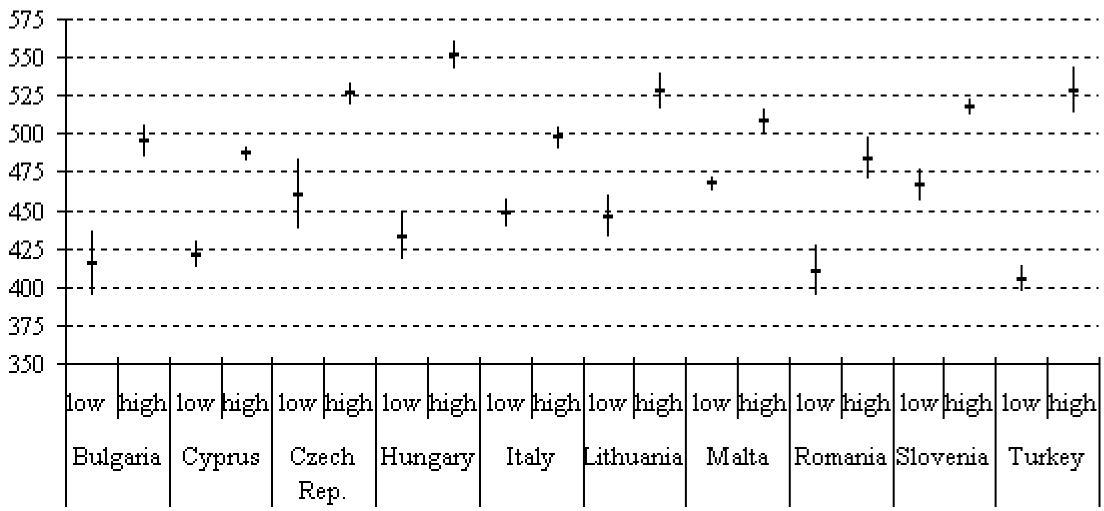

Figure 3. 95% CIs around means for achievement differences between low- and high-SES students in mathematics in each sample country.

After examining differences between low- and high-SES students in overall mathematics achievement, results were disaggregated by content and cognitive domains (see Appendix D, Figures D.1 through D.7 and Tables D.1 through D.8). 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 (see Figures D.1 through D.7). 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 (see Figure D.4).

Average achievement scores of Turkish high-SES students in all content and cognitive domains were above the TIMSS scale average of 500 (see Tables D.1 through D.8). In algebra, Turkish high-SES students, together with Hungarian high-SES peers, performed better than their peers in other countries (see Figure D.1). 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 (see Figure D.6). 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 (see Figures D.2, D.3, D.4, D.5, and D.7).

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 (see Table E.1). 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 (see Tables E.2 through E.8).

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,

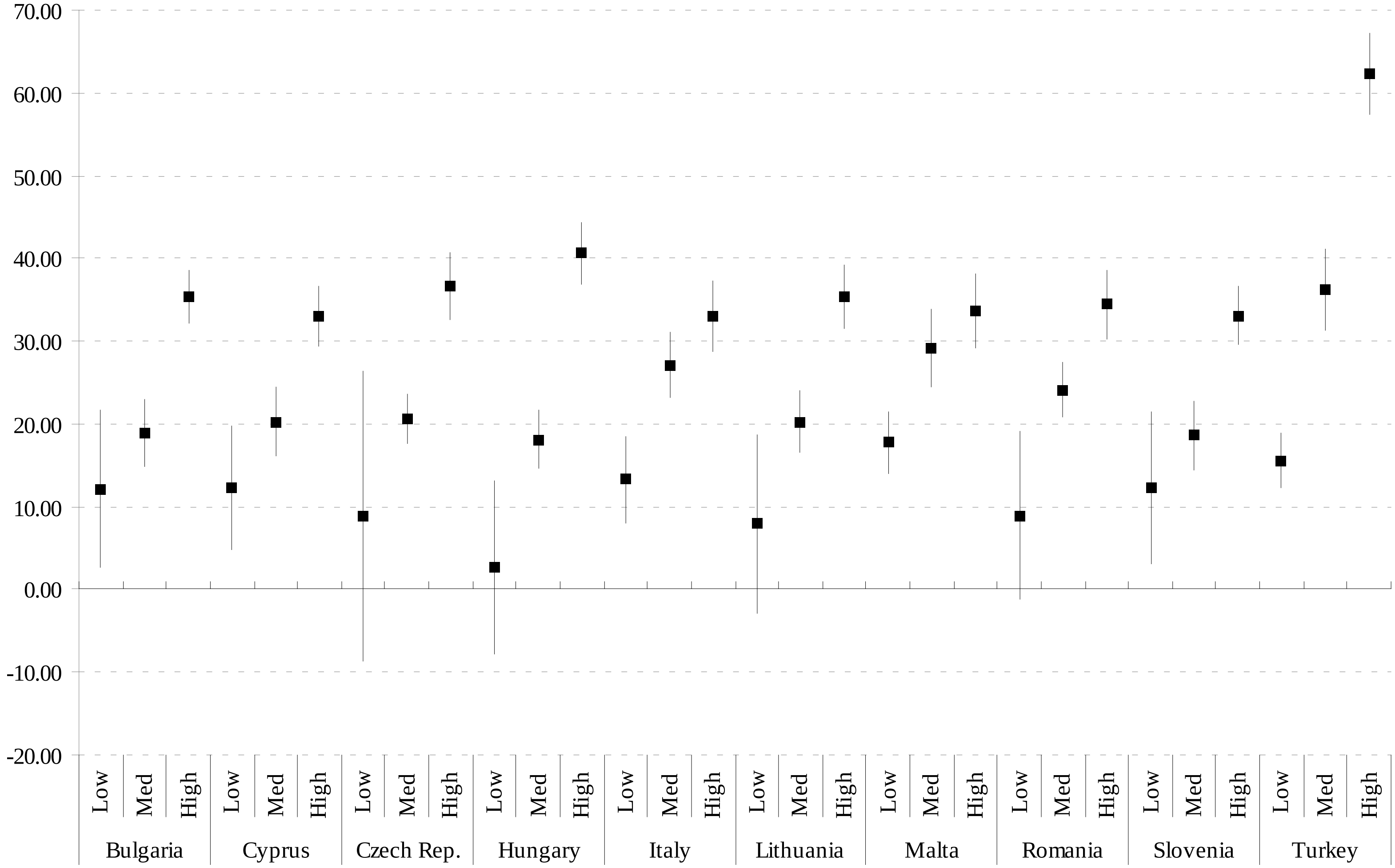

Figure 4. 95% CIs around percentages of low-, medium, and high-SES students performing in the upper quartile and above in mathematics.

respectively (see Tables E.1 through E.8). 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 (see Tables E.1 through E.8).

Findings for Research Question 2

Achievement Differences Between Boys and Girls

As shown in Table 11, the size and direction of the gender gap in mathematics differed across countries. Gender differences favoring girls in mathematics were most evident in Cyprus, Romania and Bulgaria and to a small extent in Lithuania. On average, girls achieved 0.23, 0.18, 0.14, and 0.08 standard deviations higher than boys in Cyprus Romania, Bulgaria, and Lithuania, respectively. In Italy, boys outperformed girls by a small amount in mathematics (Cohen's d = 0.08). In the remaining countries (i.e., the Czech Republic, Turkey, Malta, Hungary, and Slovenia), gender gap in mathematics was either nonexistent or negligible.

After examining differences between boys and girls in overall mathematics achievement, results were disaggregated by content and cognitive domains (see Figures F.2 through F.8 and Tables F.1 through F.7). Both the direction and the size of the gender gap differed substantially across domains. As displayed in Figure F.2 and Table F.1, gender gap in favor of girls was the most evident in almost all of the countries in the content domain of algebra. In Cyprus (Cohen's d = -0.31), Romania (Cohen's d = -0.28), Bulgaria (Cohen's d = -0.23), and Lithuania (Cohen's d = -0.20), gender gaps favoring girls in overall mathematics became wider in algebra. Girls also outperformed boys in

Table 11

Cohen's d Effect Sizes and 95% CIs Around Means for Achievement Differences Between Boys and Girls in Mathematics in Each Sample Country

Country	Gender	*n*	Mean	*SD*	95% CI	Cohen's *d*
Bulgaria	Girl	2045	470.9	97.0	[461.86, 479.97]	-0.14
	Boy	1974	456.3	105.5	[443.97, 468.72]	
Cyprus	Girl	2196	475.7	83.6	[471.30, 480.06]	-0.23
	Boy	2203	455.2	93.6	[450.62, 459.87]	
Czech Republic	Girl	2335	505.1	72.8	[500.07, 510.04]	-0.03
	Boy	2510	502.6	74.4	[497.14, 508.13]	
Hungary	Girl	2051	516.1	83.0	[508.15, 524.08]	0.01
	Boy	2060	517.0	86.1	[509.69, 524.24]	
Italy	Girl	2114	476.5	74.6	[469.99, 483.06]	0.08
	Boy	2294	482.5	77.6	[475.60, 489.41]	
Lithuania	Girl	2016	509.2	77.9	[503.29, 515.08]	-0.08
	Boy	1975	502.5	81.4	[498.02, 506.95]	
Malta	Girl	2374	487.3	87.9	[484.36, 490.30]	0.00
	Boy	2296	487.7	95.9	[484.29, 491.02]	
Romania	Girl	2094	470.5	95.3	[462.29, 478.65]	-0.18
	Boy	2104	452.5	103.1	[443.45, 461.46]	
Slovenia	Girl	2022	500.3	69.4	[494.95, 505.61]	0.03
	Boy	2021	502.7	73.8	[497.59, 507.74]	
Turkey	Girl	2093	432.1	106.8	[421.74, 442.46]	0.00
	Boy	2405	431.6	110.4	[421.77, 441.35]	

algebra in the Czech Republic (Cohen's *d* = -0.22), and by a small amount in Slovenia (Cohen's *d* = -0.14), Hungary (Cohen's d = -0.13), and Turkey (Cohen's d = -0.11), where gender gap was not observed in overall mathematics. In Italy, where the gender gap favored boys in overall mathematics, the gender gap changed direction in algebra although the gap was small enough to be negligible (Cohen's d = -0.04).

Gender gaps favoring girls in algebra narrowed in Cyprus (Cohen's *d* = -0.08) and Romania (Cohen's *d* = -0.07), and became virtually nonexistent in Bulgaria (Cohen's *d* = -0.02) and Lithuania (Cohen's *d* = 0.03) in the content domain of number (see Figure F.3 and Table F.2). Boys achieved better than girls in number in Italy (Cohen's *d* = 0.22) and to a smaller extent in the Czech Republic (Cohen's *d* = 0.11), Turkey (Cohen's *d* = 0.12), Hungary (Cohen's *d* = 0.14), and Slovenia (Cohen's *d* = 0.16), where the direction of the gender gap was in the opposite direction in algebra (see Appendix F, Figure F.3 and Table F.2).

In geometry, sizes and the direction of the gender gap in Cyprus (Cohen's *d* = -0.26), Romania (Cohen's *d* = -0.16), Bulgaria (Cohen's *d* = -0.16), and Lithuania (Cohen's *d* = -0.09) reflected the findings for overall mathematics, in which girls achieved better than boys (see Figure F.4 and Table F.3). In Turkey, there was a gender gap favoring girls (Cohen's *d* = -0.07) in geometry although the effect size was smaller than it was for algebra (i.e., Cohen's *d* = -0.11). In Hungary (Cohen's *d* = -0.02), the Czech Republic (Cohen's *d* = 0.00), and Italy (Cohen's *d* = 0.03), there was virtually no gender gap in geometry. In Slovenia and Malta, boys outperformed girls by a trivial amount (i.e.; Cohen's *d* = 0.05).

In data-and-chance, a gender gap favoring girls was the most evident in Cyprus (Cohen's *d* = -0.23) and to a lesser degree in Bulgaria (Cohen's *d* = -0.18) (see Figure F.5 and Table F.4). In Turkey, Lithuania, and Romania, on average, girls achieved 0.05 standard deviations higher than boys in data-and-chance. In Slovenia and Italy, boys out-performed girls with Cohen's *d* effect sizes of 0.12 and 0.05, respectively.

In all cognitive domains, girls achieved better than boys in Cyprus, Romania, and Bulgaria (see Figures F.6 through F.8 and Tables F.5 through F.7). In knowing, gender gap was in favor of boys in Italy and Slovenia (Cohen's *d* = 0.15), and, to a small extent, in the Czech Republic (Cohen's *d* = 0.07) and Hungary (Cohen's *d* = 0.07) (see Table F.5). In applying and reasoning, all observed gender gaps were in favor of girls. In applying, girls, on average, achieved 0.17, 0.10, and 0.06 standard deviations higher than boys in Lithuania, the Czech Republic, and Hungary respectively. In reasoning, boys' scores were on average 0.12, 0.08, and 0.07 standard deviations lower than girls' scores in the Czech Republic, Lithuania, and Slovenia, respectively.

Achievement Differences Between Boys and Girls Disaggregated by SES Levels

There was no gender gap at any SES level among Turkish students in overall mathematics (see Figures G.1 through G.3, Tables G.1 through G.3) and in any of the cognitive domains (see Figures G.4 through G.24 and Tables G.4 through G.24). Although there was some evidence of gender gap in content domains in Turkey, the size of the achievement gap was relatively similar across SES levels, except for number (see Figures G.4 through G.24 and Tables G.4 through G.24). The gender gap in favor of Turkish boys among medium-SES students (Cohen's *d* = 0.2) was more evident compared to gender gaps among low- and high-SES students in number. Similar to

Turkey, magnitudes of achievement gaps in mathematics, overall, and in all content and cognitive domains in Malta and, except for knowing, in Italy were stable across different SES levels. In knowing, the gender gap favoring boys among medium-SES Italian students was larger compared to gender gaps among low- and high-SES Italian students. In Lithuania, although boys and girls achieved similarly in mathematics, overall, and in the majority of the content and cognitive domains, in reasoning and data-and-chance gender gaps favoring girls among low-SES students were more recognizable.

In Bulgaria, gender gaps favoring girls in mathematics, overall, algebra, geometry, knowing, applying and reasoning among medium- and/or high-SES students were not existent among low-SES students. However, in number, there appeared a gender gap favoring Bulgarian boys among only low-SES students (Cohen's $d = 0.2$). Somewhat comparable to results in Bulgaria, in Romania gender gaps in favor of girls tended to be smaller among high-SES students compared to gender gaps among low- and medium-SES students in mathematics, overall, and in algebra, applying, and knowing. In number, the gender gap favorable to boys was also less evident among high-SES Romanian students relative to gender gaps among medium- and high-SES students. In Cyprus, on the other hand, gender gaps favoring girls were larger among low-SES students compared to gender gaps among medium-and high-SES students in mathematics, overall, and in algebra, number, data, knowing, applying, and reasoning (see Figures and Tables in Appendix G).

In the Czech Republic and Hungary, although gender gaps were relatively the same across SES levels in some domains, in others, gender gaps favoring boys were larger among low-SES students. Although there was virtually no gender gap among medium- and high-SES students in the Czech Republic in number, data-and-chance, geometry, and knowing, there were recognizable gender gaps favoring boys among low-SES students. Likewise, gender gaps in favor of boys were existent only among low-SES Hungarian students in mathematics, overall, and in all content and cognitive domains, except for algebra and applying. In algebra and applying, gender gaps in favor of girls among medium- and/or high-SES Hungarian students disappeared among low-SES students (see Figures and Tables in Appendix G).

In Slovenia, similar to the Czech Republic and Hungary, gender gaps favoring boys were larger among low-SES students compared to gender gaps among high- and/or medium-SES students in mathematics, overall, and in knowing although there was virtually no gender gap for any SES levels in other cognitive domains. In data-and-chance and geometry, gender gaps in favor of Slovenian boys were more evident for low-SES students. In algebra, gender gaps in favor of girls among medium- and high-SES Slovenian students narrowed among low-SES students (see Figures and Tables in Appendix G).

Findings for Research Question 3

Results revealed disparities between low- and high-SES Turkish students in their access to qualified mathematics teachers. Almost one fourth of low-SES eighth-grade students (23.4%) were taught by teachers with less than 3 years of experience compared to 4.6% of high-SES students (see Table 12). Although more than 90% of both low- and high-SES students had teachers who majored in mathematics or mathematics education, the percentage of low-SES students whose teachers did not hold a mathematics or mathematics education (i.e., 6.8%) major was larger than that of high-SES students (i.e., 0.8%) (see Table 12).

Table 12

Percentages of Low-, Medium-, and High-SES Students Taught by Teachers with at Least 3 Years of Experience or with a Mathematics/Mathematics Education Major

Teachers	SES Levels					
	Low		Medium		High	
	%	*SE*	%	*SE*	%	*SE*
Teachers With at Least 3 Years of Experience	76.6	3.8	90.2	2.9	95.4	1.4
Teachers with Mathematics or Mathematics Education Major	93.2	2.9	97.9	1.3	99.2	0.5

When teachers' subject matter preparation was considered, there were varying differences between low- and high-SES students' access to qualified teachers by mathematical domains. Percentages of low-SES students taught by teachers who did not feel well prepared to teach numbers were two to three times as much as percentages of high-SES students whose teachers felt not well prepared across the various number concepts (see Table 13). In algebra, more than 20% of students across the different SES levels had teachers who thought teaching representations of functions was not applicable in eighth-grade algebra classes (see Table 14). Also Turkish eighth-grade students, and particularly those who were from low-SES families, were more likely to be taught by teachers who did not feel prepared enough to teach patterns and sequences than they were to have teachers who felt confident about their preparation in algebraic expressions or equations and inequalities (see Table 14).

In data-and-chance, approximately 10% of low-SES students were taught by teachers who felt not well prepared to teach the basic concept of reading and displaying data (see Table 15). In relatively more complex data-and-chance concepts, namely interpreting datasets and chances of possible outcomes, percentages of low-SES students whose teachers did not feel confident about their preparation to teach (13.3% and 17.1%, respectively) were approximately twice as much as percentages of high-SES students whose teachers felt not well prepared to teach. When we looked at across geometric concepts, Turkish students, overall, were less likely to have teachers who felt very well prepared to teach three-dimensional shapes and their representations than they were to have teachers very well prepared in the other geometry concepts included in the questionnaire (see Table 16). Only 35.7% of low-SES students and a little over 50% of high-SES Turkish eighth-grade students had teachers who felt very well prepared to teach three-dimensional shapes, which is a complex geometry concept to communicate to students.

Table 13

Percentages of Low-, Medium-, and High-SES Students Taught by Teachers Who Felt Not Well Prepared, Somewhat Prepared, Very Well Prepared, or Not Applicable to Teach Number Concepts

Number Concepts	Not Applicable						Not Well Prepared						Somewhat Prepared						Very Well Prepared					
	SES Level						SES Level						SES Level						SES Level					
	Low		Medium		High		Low		Medium		High		Low		Medium		High		Low		Medium		High	
	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*
Computing, estimating or approximating with whole numbers	3.5	1.8	75.4	4.5	1.3	0.9	13.1	3.7	7.9	2.9	5.7	2.9	8.1	2.6	10.7	3.7	8.2	3.3	75.4	4.5	79.4	4.6	84.8	4.6
Representing decimals and fractions	0.5	0.6	0.8	0.8	0.8	0.8	15.0	3.8	10.6	3.4	5.0	2.4	17.1	3.6	16.2	4.2	14.3	5.5	67.4	4.1	72.3	5.0	80.0	6.0

Table 13

Continued

Number Concepts	Not Applicable						Not Well Prepared						Somewhat Prepared						Very Well Prepared					
	SES Level						SES Level						SES Level						SES Level					
	Low		Medium		High		Low		Medium		High		Low		Medium		High		Low		Medium		High	
	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*
Computing with fractions and decimals	0.6	0.6	0.8	0.9	0.8	0.8	12.4	3.6	6.5	2.7	4.0	2.3	7.8	1.9	8.2	2.6	5.3	2.6	79.2	4.0	84.5	3.7	89.9	3.6
Representing, comparing, ordering, and computing with integers	3.2	1.7	2.2	1.2	1.0	0.8	8.5	3.0	5.5	2.6	3.8	2.3	5.4	2.4	5.3	2.3	5.4	2.8	82.8	3.9	87.1	3.6	89.8	3.7

Table 13

Continued

Number Concepts	Not Applicable						Not Well Prepared						Somewhat Prepared						Very Well Prepared					
	SES Level						SES Level						SES Level						SES Level					
	Low		Medium		High		Low		Medium		High		Low		Medium		High		Low		Medium		High	
	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*
Problem solving involving percents and proportions	2.7	1.6	1.0	0.7	0.1	0.1	13.8	3.6	10.2	3.2	6.7	2.9	15.5	3.8	13.0	3.5	10.9	3.7	68.0	5.1	75.9	4.7	82.3	4.7

Table 14

Percentages of Low-, Medium-, and High-SES Students Taught by Teachers Who Felt Not Well Prepared, Somewhat Prepared, Very Well Prepared, or Not Applicable to Teach Algebra Concepts

Algebra Concepts	Not Applicable						Not Well Prepared						Somewhat Prepared						Very Well Prepared					
	SES Level						SES Level						SES Level						SES Level					
	Low		Medium		High		Low		Medium		High		Low		Medium		High		Low		Medium		High	
	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*
Patterns and sequences	11.6	3.1	8.7	2.4	6.1	2.3	14	3.5	10.7	3.4	7.6	3.4	26.8	3.9	26.8	4.4	27.8	6	47.6	4.8	53.7	4.9	58.5	6.2
Algebraic expressions	0.0		0.0		0.0		9.9	3	7.1	2.8	7.1	3.3	11.7	3.4	11.8	3.7	7.9	3	78.4	4.5	81.1	4.4	85	4.6
Equations and inequalities	0.0		0.0		0.0		9.8	3.1	7.9	3.1	6.1	3	15.5	3.2	17.3	4.7	15.8	4.9	74.7	4.4	74.8	5.4	78.1	5.9
Representations of functions	29.9	4.4	24.7	4.3	21.4	6.6	8.4	2.3	10	3.4	7.5	3.4	27.8	3.8	29.7	5.5	25.9	6.6	33.9	4	35.5	5.4	45.2	7

Table 15

Percentages of Low-, Medium-, and High-SES Students Taught by Teachers Who Felt Not Well Prepared, Somewhat Prepared, Very Well Prepared, or Not Applicable to Teach Data-and-Chance Concepts

Data-and-Chance Concepts	Not Applicable						Not Well Prepared						Somewhat Prepared						Very Well Prepared					
	SES Level						SES Level						SES Level						SES Level					
	Low		Medium		High		Low		Medium		High		Low		Medium		High		Low		Medium		High	
	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*
Reading and displaying data	10.1	2.8	7.5	1.9	6.8	2.4	9.6	3.3	6.6	2.4	3.7	2.2	21.2	3.4	23.2	4.9	15.9	4.5	59.2	4.3	62.6	5.2	73.6	5.8
Interpreting datasets	5	2.0	5.1	2	10.5	5.7	13.3	3.6	7.8	2.8	6	2.8	24.4	4.2	24.7	5.1	16.8	4.9	57.3	4.8	62.4	5.4	66.7	6.5
Chances of possible outcomes	1	0.3	1.7	0.8	1.5	1	17.1	3.4	14.5	3.7	9.6	3.7	29.6	3.9	25.4	4.7	17.7	4.3	52.3	3.8	58.4	5	71.1	6

Table 16

Percentages of Low-, Medium-, and High-SES Students Taught by Teachers Who Felt Not Well Prepared, Somewhat Prepared, Very Well Prepared, or Not Applicable to Teach Geometry Concepts

Geometry Concepts	Not Applicable						Not Well Prepared						Somewhat Prepared						Very Well Prepared					
	SES Level						SES Level						SES Level						SES Level					
	Low		Medium		High		Low		Medium		High		Low		Medium		High		Low		Medium		High	
	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*
Properties of angles and shapes	0.8	0.8	0.3	0.3	0.0		7.6	2.6	5.8	2.6	4.1	2.6	10.2	2.6	14	3.7	16.4	5.3	81.3	3.6	80	4.4	79.4	5.9
Congruent figures and similar triangles	0.0		0.0		0.0		9.7	2.9	8.9	3.1	6.3	3.2	11	3.1	9.4	2.7	10.3	3.6	79.3	4.2	81.7	4	83.4	5

Table 16

Continued

Geometry Concepts	Not Applicable						Not Well Prepared						Somewhat Prepared						Very Well Prepared					
	SES Level						SES Level						SES Level						SES Level					
	Low		Medium		High		Low		Medium		High		Low		Medium		High		Low		Medium		High	
	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*
Three-dimensional shapes and their representations	6.3	1.9	7.2	3.1	5.2	3.0	14.1	3.7	13.4	3.8	6.3	3	43.9	4.4	41.2	5.4	36.6	6.9	35.7	4.4	38.2	5.7	51.9	7.9
Measurement formulas	1.1	1.1	0.6	0.6	0.0		8.6	2.8	9.5	3.4	5.8	3	20.9	4.4	15.6	3.3	12.9	3.5	69.3	5	74.3	4.7	81.3	4.8
Cartesian plane	5.2	1.4	7.5	2.3	8.8	5.5	8.6	2.9	7.2	3	3	2.2	22.5	3.8	19.9	4.6	17.3	5.1	63.7	4.8	65.4	5.6	70.9	6.5
Translation, reflection, and rotation	13.8	2.9	14.5	3.5	12.1	5.6	7	2.5	4.4	1.9	1.5	0.9	31.6	4.6	28.8	4.7	23.4	5.8	47.6	5	52.3	5.5	63	6.5

Findings for Research Question 4

Unconditional Model

Unconditional model analysis showed 38% (i.e., 4480.67/(4480.67+7443.60)) of the total variation in Turkish 8th-grade students' mathematics achievement was between teachers (see Table 17). The reliability estimate for this model was 0.94 indicating that a reasonable proportion of the between-teacher variance was reliable and could be modeled using between-teacher variables. These results suggested there was considerable variation in 8th-grade students' mathematics performances in Turkey that can be explained by both student- and teacher-related characteristics.

Table 17

Fixed and Random Effects of the Unconditional Model

Fixed effect	Coefficient	*SE*		*df*	*p* value
Intercept (γ_{00})	430.22	5.85		131	< 0.001
Random effects	Variance	*SD*	χ^2	*df*	*p* value
Intercept, u_{0j}	4480.67	66.94	2404.63	131	< 0.001
Level-1 effect, e_{ij}	7443.60	86.28			

Hierarchical Linear Model Including Only Level-2 Predictors

Results of this multilevel model are presented in Table 18. The estimated effect of being taught by a teacher with 3 or more years of experience was statistically significant in the model. On average, holding other predictors constant, we would expect the average achievement of a class taught by a teacher with 3 or more years of experience to be 20.95 (γ_{02}) ($p = 0.03$) points higher than the mean achievement of a class whose teacher had less than 3 years of experience. Although the coefficient of teachers' major area of study was not statistically significant at the 0.05 level, it suggested that, holding other predictors constant, a class taught by a teacher who did not hold a mathematics or mathematics education major would achieve 27.81(γ_{03}) ($p = 0.08$) points lower than a class whose teacher majored in mathematics or mathematics education. Teachers' feelings about how prepared they were to teach various mathematics concepts were not found to have a relationship with the class mean achievement at the presence of the current predictors in the model.

When variance components were examined, the residual variance between schools in the current model, 1905.87, was substantially smaller than the residual variance in the null model, which was 4480.67. The estimated proportion of between-teacher variance that this model, which included the teacher quality indicators and classroom median SES, explained was 57.5%. However, it is important to note that when classroom median SES was entered as the single teacher-level predictor, it explained 54.6% of the between-teacher variance. When classroom median SES was removed and only teacher quality indicators were remained in the model, the proportion of between-teacher variance that was explained (i.e., 14.4%) was smaller but still important. The statistically significant residual variance of the intercept (i.e., $u_{0j} = 1905.87$ ($p < 0.001$)

indicated that there was significant variation among mean classroom mathematics achievement to be explained.

Table 18

Fixed and Random Effects of the Model with Level-2 Predictors Only

Fixed effect	Coefficient	*SE*		*df*	*p* value
Intercept (γ_{00})	344.44	31.00		127	< 0.001
TEACHPREP(γ_{01})	0.46	0.56		127	0.41
YEARS_EXP(γ_{02})	20.95	9.32		127	0.03
MAJOR(γ_{03})	27.81	15.72		127	0.08
MEDIANSES(γ_{04})	85.50	8.61		127	< 0.001
Random effects	Variance	*SD*	χ^2	*df*	*p* value
Intercept, u_{0j}	1905.87	43.66	2404.63	127	< 0.001
Level-1 effect, e_{ij}	7443.53	86.28			

Hierarchical Linear Model with Level-1 and Level-2 Predictors

Among the teacher quality indicators, years of teaching experience was still statistically significant when level-1 predictors included. On average, low-SES students taught by a teacher who had at least 3 years of experience achieved 18.41 points (approximately one fifth of a standard deviation) higher than low-SES students whose teachers had less than 3 years of experience. Teachers' major was not statistically significant at 0.05 level but this model suggested that, on average, low-SES students taught by a teacher without mathematics or mathematics education major would score 25.53 points (a little over one fifth of a standard deviation) lower than low-SES students whose teacher held a mathematics or mathematics education major.

Turning to the variance components in the final model, the residual variance in students' mathematics achievement dropped to 7190.52 from approximately 7444 when student SES variables were included in the model (see Table 19). In other words, students' SES levels explained only 3.3% of the variation in mathematics achievement. This result suggested Turkish middle-school classes were homogeneous in terms of students' SES levels. There was statistically significant variance (i.e., 1779.62, $p < 0.001$) left in the variance of low-SES students' mean mathematics achievement by teacher once teacher quality indicators and classroom median SES were controlled.

Table 19

Fixed and Random Effects of the Model with Level-1 and Level-2 Predictors

Fixed effect	Coefficient	*SE*		*df*	*p* value
Intercept (γ_{00})	341.92	29.02		127	< 0.001
TEACHPREP(γ_{01})	0.47	0.52		127	0.366
YEARS_EXP(γ_{02})	18.41	8.88		127	0.04
MAJOR(γ_{03})	25.53	15.11		127	0.09
MEDIANSES(γ_{04})	67.29	8.91		127	< 0.001
MEDSES(γ_{10})	26.25	4.18		131	< 0.001
HIGHSES(γ_{20})	57.37	6.79		131	< 0.001
Random effects	Variance	*SD*	χ^2	*df*	*p* value
Intercept, u_{0j}	1779.62	42.18	476.48	72	< 0.001
u_{1j}	121.15	11.01	85.86	76	0.21
u_{2j}	418.43	20.46	108.61	76	0.01
Level-1 effect, e_{ij}	7190.52	84.80			

CHAPTER V

DISCUSSION AND CONCLUSION

Summary of the Current Study's Results

The current study found virtually none or only negligible gender differences in Turkish students' achievement in mathematics, overall, or in various content and cognitive domains. However, there were substantial achievement gaps between low-SES students and their high-SES peers in Turkey. Indeed, 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. In overall mathematics and in all content and cognitive domains, the correlation between students' SES levels and their achievement was the largest in Turkey, followed, in order, by Hungary and Bulgaria. The EU country that had as large or even somewhat larger SES-related achievement gaps as those identified in Turkey was Hungary. Average achievement levels of high-SES students were at approximately 93rd and 88th percentiles of the low-SES students in Hungary and Turkey, respectively. Although low-SES Turkish students' performances in mathematics were among the lowest across sample countries, Turkish students from high-SES families performed comparably to their high-SES peers in countries whose average mathematics achievement levels were above TIMSS scale average of 500 (i.e., the Czech Republic, Lithuania, and Slovenia).

In addition to achievement gaps, the current study identified SES-related inequities in access to qualified mathematics teachers in Turkey. Low-SES students were more likely to be taught by mathematics teachers who had less than 3 years of experience or who did not hold a degree in mathematics or mathematics education. On the other hand, years of experience and a degree in mathematics or mathematics education were found to be substantially related to students' mathematics achievement. Low-SES students' mathematics teachers were also more likely to report lack of confidence in their preparation to teach various mathematics contents.

SES-Related Mathematics Achievement Gap in Turkey and in the Sample EU Countries

The current study's results highlighted important achievement gaps between low- and high-SES Turkish eighth-grade students' in mathematics, overall, and in various content and cognitive domains. 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 achievement in mathematics, overall, and in content and cognitive domains. The current study's results were similar to Akiba et al.'s (2007) findings regarding Hungary's standing among EU countries in terms of SES-related achievement gaps in mathematics although each study used different measures of SES. 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 education systems. In Turkey, students' placements into high schools are mainly based on students' scores on national high-stakes tests, which include mathematics sections, administered during primary school years. Students with high enough scores on these tests attend prestigious public and private high schools. Students whose scores do not suffice for acceptance to these schools attend open-enrollment public and private high schools. High-stakes testing for acceptance to prestigious high-schools, and in later years of schooling to enter universities, 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. SES levels of middle- and high-school students become an indicator for receiving private tutoring (Tansel & Bircan, 2008). Thus, upper and the middle SES students become more privileged than lower SES students. The SES-related achievement gap that is identified among eighth-grade students in the current study suggested that economical reasons of access to private tutoring sessions may be contributing to the inequity among middle-school students.

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.

The selective nature of both 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. Due mainly to the streaming system at the high-school level, PISA 2003 and 2006 results suggested that Turkish high schools were homogeneous in terms of both students' ability levels and socioeconomic statuses. Unlike the larger between-school variation compared to the within-school variation in Turkish high-school students' mathematics achievement PISA studies, the current study's results showed that 38% of the variation in eighth-grade students' mathematics achievement was between schools. In other words, Turkish middle schools were not found to be as homogenous as Turkish high schools in terms of student ability levels. This finding suggests that although there is some variation among Turkish primary schools, this variation becomes substantially larger with the start of the tracking in Turkish education system, which is at the high-school level. This finding also supports the policy recommendations against early tracking as early tracking often interferes with equitable outcomes (Field, Kuczera, & Pont, 2007). Despite the smaller between-school variation in mathematics achievement at the middle-school level, still more than half of the between-school variation was explained by students' SES levels indicating some homogeneity in terms of students' SES levels in Turkish middle schools.

Given the similarly large SES-based achievement gaps in Turkey and Hungary, a major difference between these two countries was the percentages of low-SES students included in their samples. Whereas 68.08% of the Turkish sample was from low-SES families, only 7.68% of the Hungarian sample was low-SES students. This comparison suggested that the influence of the Hungarian low-SES students' achievement levels on the average achievement of Hungary was probably smaller than the influence of Turkish low-SES students' achievement on average achievement of Turkey on TIMSS 2007. Further, low-SES Turkish students' average achievement in mathematics was lower than Hungarian low-SES students' mathematics achievement.

Indeed, Turkish low-SES students were among the lowest achieving students when compared cross-nationally with EU countries. The two EU countries in which low-SES students achieved similar to Turkish low-SES students were Romania and Bulgaria. However, like Hungary, Romania and Bulgaria also had substantially lower percentages of low-SES students than Turkey. The percentage of students from low-SES families were 11.19% and 11.68% in Bulgaria and Romania, respectively. 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 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 EU countries included in the current study. In Maltese education system, streaming starts at the secondary education level, which starts after 6 years of primary schooling. Students can attend three types of public secondary schools, namely junior lyceums, area secondary schools, and schools for very low achievers, in addition to church and independent private secondary schools (Malta Ministry of Education, Employment and the Family, n.d.). Admission to junior lyceums and to some church schools is based on an entrance examination, and students who cannot pass this exam can attend area secondary schools. However, students who are considered very low achievers at the end of the sixth grade are admitted to the secondary schools for very low achievers. After the current study's results were obtained, in a personal communication with the TIMSS 2007 national research coordinator for Malta, the author was 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 low- and high-SES students' achievement levels based on TIMSS 2007 results.

Italy was another EU country that had relatively a larger percentage of low-SES students than the other sample EU countries but a smaller SES-related achievement gap. As most of the EU countries, Italian education system has a tracking system, which occurs at the upper secondary level at age 14. The main difference between the tracking systems in Turkey and Italy is whereas tracking in Turkish education system is based on high-stakes national tests, in Italian education system parents choose which track their students will attend (Scalmato & Angotti, 2009). Although the influence of parental education on which upper secondary schools students attend is still substantial in Italy, the situation is not as acute as it is in the Turkish education system.

To summarize, the current study highlighted the substantial influence of eighth-grade students' socioeconomic backgrounds on their mathematics achievement. Such a powerful influence of socioeconomic backgrounds on 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 (2005a) 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.

Gender Gap in Mathematics Achievement in Turkey and in the Sample EU Countries

Although the SES-related achievement gap in mathematics among Turkish eighth-grade students was substantial, the gender-gap was virtually negligible in mathematics, overall, and in content and cognitive domains. In overall mathematics achievement, no gender gap was observed among Turkish students, and across the sample EU countries gender gap was either in favor of girls (i.e., Bulgaria, Cyprus, and Romania) or virtually not existent. In Turkey, magnitudes of gender gaps were relatively stable across SES levels although there were some variations across SES levels within EU countries. The current study's results regarding gender gaps in the sample EU countries are similar to the results obtained on TIMSS 2003 (Else-Quest et al., 2010) with the exception of results for Romania, where the gender gap in favor of girls became larger on TIMSS 2007 (i.e., Cohen's $d = 0.04$ on TIMSS 2003 versus Cohen's $d = 0.18$).

When gender gaps in mathematics achievement were disaggregated by content and cognitive domains, Turkish boys' and girls' achievement levels were similar in all domains, except for algebra and number. In algebra, girls achieved slightly better than boys, but the difference was smaller than that of in the majority of the EU countries. In number, boys' slightly outperformed girls but the effect size was larger than effect sizes obtained for most of the EU countries. When gender gaps across the sample countries in the current study are considered, largest gender gaps in mathematics, overall, and in all cognitive and content domains, except for number, were in favor of girls.

The current study's results revealed some differences between gender gaps identified on PISA 2003 and TIMSS 2007. There was a small gender gap in favor of boys (Cohen's $d = 0.14$) (Else-Quest et al., 2010) in Turkey on PISA 2003, whereas no gender difference was identified on TIMSS 2007. The difference between sizes of gender gaps on PISA and TIMSS may be because these studies differ in terms of the features of student learning they assess. In a study of achievement gaps on TIMSS and PISA, Else-Quest et al. also found slightly larger gender gaps on PISA and concluded that "PISA, with its focus on real-world applications, may be more sensitive to societal gender inequity" (p. 124). Also, TIMSS is administered at an earlier grade than PISA, and previous research has suggested an increase in gender difference with age (Leahey & Guo, 2001).

The largest gender gap among Turkish students in favor of girls was in algebra on TIMSS 2007 (Cohen's $d = 0.11$), where as on a comparable content domain, namely change, on PISA 2003, the gender gap was negligible (Cohen's $d = 0.05$, in favor of boys. On the other hand, on TIMSS 2007, the largest gender gap among Turkish students in favor of boys was in number (Cohen's $d = 0.12$), which was similar to the achievement gap identified on PISA 2003 in the content domain of quantity (Cohen's $d = 0.16$, in favor of boys). Achievement gaps identified in geometry and data-and-chance on TIMSS 2007 in Turkey were negligible although on PISA 2003 boys achieved somewhat better than girls in content domains of space (comparable to geometry on TIMSS) and uncertainty (comparable to data-and-chance on TIMSS).

In short, the current study did not find any substantial gender gaps among eighth-grade Turkish students on TIMSS 2007. Further research is needed in Turkey to examine if and to what extent gender differences increase or decrease at the high-school level. Further, as of 2008, share of female graduates in mathematics, science, and technology in Turkey is very low (i.e., 7.6%) although it is better than the situation in some of the EU countries, such as Cyprus (4%), Luxembourg (1.8%), and Hungary (6.1%) (European Commission, n.d.j). Thus, initiatives to attract females to STEM fields need to be undertaken in Turkey to achieve a decrease in the gender imbalance.

Mathematics Teacher Quality in Turkey

In the current study, teachers' years of experience, majors in post-secondary education, and their self-reported preparedness in content domains of number, algebra, geometry, and data-and-chance were used as teacher quality indicator. Approximately 19% more Turkish low-SES students than high-SES students were taught by teachers with less than 3 years of experience. This finding revealed an important opportunity gap between low- and high-SES Turkish eighth-grade students in their access to more experienced mathematics teachers. Among the EU countries that participated on TIMSS 2003, the largest opportunity gap in access to more experienced mathematics teachers was identified in Flemish Belgium, however, the gap was substantially smaller than it was in Turkey (Akiba et al., 2007). In Italy, Romania, Slovenia, Bulgaria, Lithuania, and Latvia, percentages of high-SES were less than 2% more than percentages of low-SES students whose mathematics teachers had at least 3 years of teaching experience. On the other hand, in Netherland, Estonia, Hungary, and Sweden, there was a more needs-based access to experienced mathematics teachers, in other words, more percentages of low-SES students than high-SES students were taught by teachers with three or more years of experience. Indeed, in Sweden approximately 11% more low-SES students than high-SES students were taught by mathematics teachers with at least three years of experience.

In Turkey, there was a lack of research on disparities in access to qualified mathematics teachers and the relationship between mathematics teacher characteristics and student achievement. However, a commonly known problem with the teacher assignment process of the MoNE, which holds the responsibility for hiring and assignment of teachers, is that every year thousands of new teachers are hired and students who need the most get indeed the least. Thus, teacher quality research can have important impact as to informing policymakers. The current study contributed to Turkish literature not only in identifying opportunity gaps but also in examining how different aspects of mathematics teacher quality were related to student achievement outcomes.

Among the teacher quality indicators included in the current study, teaching experience had a strong relationship with Turkish eighth-grade students' mathematics achievement (cf. Akiba et al., 2007; Darling-Hammond, 2000). Controlling for classroom median SES and other teacher quality indicators, the average achievement of a class taught by a mathematics teacher with 3 or more years of experience was found to be 20.95 points higher than the mean achievement of a class whose mathematics teacher had less than 3 years of experience. Further, considering the relationship between teaching experience and achievement levels of low-SES students, results showed that a low-SES student taught by a teacher who had at least 3 years of experience achieved on average, 18.41 points (approximately one fifth of a standard deviation) higher than a low-SES student whose teacher had less than 3 years of experience. These findings have important implications in practice as the MoNE develops policies to assign new teachers to public schools in various parts of Turkey and to effectively and efficiently improve the mobility of experienced teachers.

In addition to teaching experience, the current study's results suggested teachers' major area of study was related to students' mathematics achievement. Controlling for the classroom median SES and other teacher quality indicators, a class taught by a teacher who did not hold a mathematics or mathematics education major achieved, on average, 27.81 points lower than a class whose teacher majored in mathematics or mathematics education. Indeed, a large percentage of Turkish eighth-grade students (i.e., more than 90%) were found to have been taught by mathematics teachers who held a degree in mathematics or mathematics education. When compared to EU countries such as England, Italy, Netherlands, and Sweden, a larger portion of Turkish eighth-grade students had mathematics teachers with a major in mathematics or mathematics education (Akiba et al., 2007). However, to a small extent there appeared to be a disparity between low- and high-SES students in their access to mathematics teachers who had a major in mathematics or mathematics education. Given that being taught by a teacher with mathematics or mathematics education major was found to be associated with 25.53 points difference (a little over one fifth of a standard deviation) in low-SES students' mathematics achievement, teachers' majors in post-secondary education is another important aspect to consider for mathematics teacher assignment.

In the current study, teachers' self-reported preparedness in content domains of number, algebra, geometry, and data and chance was not found to be related to eighth-grade students' mathematics achievement on TIMSS 2007. However, in various mathematics concepts low-SES students were more likely to be taught by mathematics teachers who were less confident about their abilities to teach. It is important to note that relying on mathematics teachers' self-reported perceptions to identify their readiness to teach, which encompasses their content or pedagogical content knowledge for teaching mathematics, can only provide some preliminary findings. Given the importance of teacher knowledge, a critical area of future research in Turkey is teachers' knowledge for teaching mathematics.

There were particular concepts that mathematics teachers either felt not confident to teach or considered not applicable. For example, a large percentage of mathematics teachers considered representations of functions inapplicable to teach although in the TIMSS 2007 curriculum survey equivalent representations of functions were stated to be taught mostly at seventh- and eighth-grade to all or almost all students. In a current analysis of the algebraic tasks in the Turkish national curriculum guidebook for primary schools, Ubuz, Erbas, Cetinkaya, and Ozgeldi (2010) categorized multiple representations within higher-level cognitive concepts and found that approximately 60% of algebraic tasks for grades sixth through eighth required higher-level cognition. This finding suggested that multiple representations are indeed in the current mathematics curriculum. However, it is important to note that there has been a curriculum reform in Turkey, and the current mathematics curriculum is in use only since 2004. Future studies on the comparison of the old and the new curricula and their impact on teacher practices can help us understand better the emphasis of representations in the old curriculum and to what extent teachers' practices have changed with the new curriculum. In another algebraic concept, patterns and sequences, mathematics teachers felt less confident about their preparation to teach compared to other algebraic concepts. An examination of the TIMSS 2007 curriculum survey revealed that patterns and sequences were not included in the mathematics curriculum anywhere from the first to the eighth grade. Future studies need to investigate the Turkish primary school mathematics curriculum to see when and how students are given opportunities to learn and identify regularities in, for example, shapes or number sequences or to use inductive reasoning to formulate rules to describe patterns and, further, to make generalizations.

In various data-and-chance concepts, percentages of low-SES students whose teachers did not feel confident about their preparation to teach were relatively large. Indeed, the curriculum survey revealed that interpretations of datasets, inappropriate data display or scales, or predicting chances of future events using available data were not included in Turkish primary school mathematics curriculum. On the other hand, more basic concepts about data analysis such as reading data from tables or charts, data display, or general characteristics of data sets (e.g., mean, median) were in the mathematics curriculum. Although the new curriculum includes a learning strand named probability and statistics, future research needs to examine what this learning strand entails. Given the amount of the available statistical information today, students need to learn how to interpret that information and use it to make future predictions.

Limitations of the Current Study

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 for the current study. In some other countries, the portion of missing data on parental education was still high, and multiple imputation was used to overcome this limitation.

The teacher quality indicators used in the current study were restricted to those in TIMSS 2007 data set, which were mainly measurable characteristics. Also for teachers' readiness to teach various concepts, the current study relied on teachers' self-reported preparedness levels. Other teacher quality indicators that have been shown to be related to students' mathematics achievement, such as content knowledge or pedagogical content knowledge to teach mathematics, were not included in the current study.

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APPENDIX A

Table A.1

Percentages of Students From Low-, Medium-, and High-SES Families in Each Sample Country

Country	Students		
	Low SES (%)	Med SES (%)	High SES (%)
Bulgaria	11.19	45.69	43.12
Cyprus	14.00	40.63	45.37
Czech Rep.	2.36	69.19	28.44
Hungary	7.68	57.86	34.47
Italy	28.78	41.03	30.18
Lithuania	6.97	54.88	38.15
Malta	48.49	25.60	25.91
Romania	11.68	61.40	26.92
Slovenia	10.79	41.49	47.71
Turkey	68.08	20.87	11.05

APPENDIX B

Table B.1

Triangulation of Correlation Coefficients Between SES and Achievement Scores in Mathematics in Each Sample Country

Country	*n*	[a]Pearson *r*	[b]Pearson *r*	Spearman rho
Bulgaria	4019	0.31	0.31	0.31
Cyprus	4399	0.24	0.24	0.24
Czech Republic	4845	0.22	0.21	0.22
Hungary	4111	0.35	0.35	0.35
Italy	4408	0.21	0.21	0.21
Lithuania	3991	0.25	0.25	0.25
Malta	4670	0.19	0.19	0.19
Romania	4198	0.20	0.20	0.20
Slovenia	4043	0.25	0.24	0.25
Turkey	4498	0.39	0.36	0.39

Note. [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.

Table B.2

Triangulation of Correlation Coefficients Between SES and Achievement Scores in Algebra in Each Sample Country

Country	*n*	[a]Pearson *r*	[b]Pearson *r*	Spearman rho
Bulgaria	4019	0.29	0.29	0.29
Cyprus	4399	0.19	0.19	0.19
Czech Republic	4845	0.19	0.19	0.19
Hungary	4111	0.32	0.32	0.32
Italy	4408	0.19	0.19	0.19
Lithuania	3991	0.22	0.22	0.22
Malta	4670	0.18	0.19	0.18
Romania	4198	0.18	0.18	0.18
Slovenia	4043	0.24	0.24	0.24
Turkey	4498	0.39	0.36	0.39

Note. [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.

Table B.3

Triangulation of Correlation Coefficients Between SES and Achievement Scores in Number in Each Sample Country

Country	*n*	[a]Pearson *r*	[b]Pearson *r*	Spearman rho
Bulgaria	4019	0.31	0.31	0.31
Cyprus	4399	0.24	0.24	0.24
Czech Republic	4845	0.21	0.20	0.21
Hungary	4111	0.32	0.32	0.32
Italy	4408	0.19	0.19	0.19
Lithuania	3991	0.25	0.25	0.25
Malta	4670	0.17	0.17	0.17
Romania	4198	0.18	0.18	0.18
Slovenia	4043	0.26	0.25	0.26
Turkey	4498	0.36	0.34	0.36

Note. [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.

Table B.4

Triangulation of Correlation Coefficients Between SES and Achievement Scores in Data-and-Chance in Each Sample Country

Country	*n*	[a]Pearson *r*	[b]Pearson *r*	Spearman rho
Bulgaria	4019	0.27	0.26	0.27
Cyprus	4399	0.19	0.20	0.19
Czech Republic	4845	0.16	0.16	0.16
Hungary	4111	0.30	0.30	0.30
Italy	4408	0.20	0.19	0.20
Lithuania	3991	0.18	0.18	0.18
Malta	4670	0.19	0.19	0.19
Romania	4198	0.17	0.18	0.17
Slovenia	4043	0.19	0.18	0.19
Turkey	4498	0.34	0.33	0.34

Note. [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.

Table B.5

Triangulation of Correlation Coefficients Between SES and Achievement Scores in Geometry in Each Sample Country

Country	*n*	[a]Pearson *r*	[b]Pearson *r*	Spearman rho
Bulgaria	4019	0.27	0.26	0.27
Cyprus	4399	0.23	0.23	0.23
Czech Republic	4845	0.20	0.20	0.20
Hungary	4111	0.33	0.33	0.33
Italy	4408	0.17	0.17	0.17
Lithuania	3991	0.26	0.26	0.26
Malta	4670	0.18	0.18	0.18
Romania	4198	0.17	0.18	0.17
Slovenia	4043	0.21	0.20	0.21
Turkey	4498	0.37	0.35	0.37

Note. [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.

Table B.6

Triangulation of Correlation Coefficients Between SES and Achievement Scores in Knowing in Each Sample Country

Country	*n*	[a]Pearson *r*	[b]Pearson *r*	Spearman rho
Bulgaria	4019	0.30	0.29	0.30
Cyprus	4399	0.24	0.24	0.24
Czech Republic	4845	0.21	0.21	0.21
Hungary	4111	0.34	0.34	0.34
Italy	4408	0.19	0.19	0.19
Lithuania	3991	0.25	0.25	0.25
Malta	4670	0.18	0.19	0.18
Romania	4198	0.18	0.19	0.18
Slovenia	4043	0.24	0.24	0.24
Turkey	4498	0.39	0.36	0.39

Note. [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.

Table B.7

Triangulation of Correlation Coefficients Between SES and Achievement Scores in Applying in Each Sample Country

Country	*n*	[a]Pearson *r*	[b]Pearson *r*	Spearman rho
Bulgaria	4019	0.32	0.32	0.32
Cyprus	4399	0.23	0.23	0.23
Czech Republic	4845	0.21	0.20	0.21
Hungary	4111	0.35	0.35	0.35
Italy	4408	0.22	0.22	0.22
Lithuania	3991	0.23	0.23	0.23
Malta	4670	0.19	0.19	0.19
Romania	4198	0.20	0.21	0.20
Slovenia	4043	0.26	0.25	0.26
Turkey	4498	0.40	0.37	0.40

Note. [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.

Table B.8

Triangulation of Correlation Coefficients Between SES and Achievement Scores in Reasoning in Each Sample Country

Country	*n*	[a]Pearson *r*	[b]Pearson *r*	Spearman rho
Bulgaria	4019	0.27	0.27	0.27
Cyprus	4399	0.18	0.18	0.18
Czech Republic	4845	0.18	0.17	0.18
Hungary	4111	0.30	0.30	0.30
Italy	4408	0.18	0.18	0.18
Lithuania	3991	0.20	0.20	0.20
Malta	4670	0.16	0.16	0.16
Romania	4198	0.17	0.17	0.17
Slovenia	4043	0.22	0.22	0.22
Turkey	4498	0.33	0.32	0.33

Note. [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.

APPENDIX C

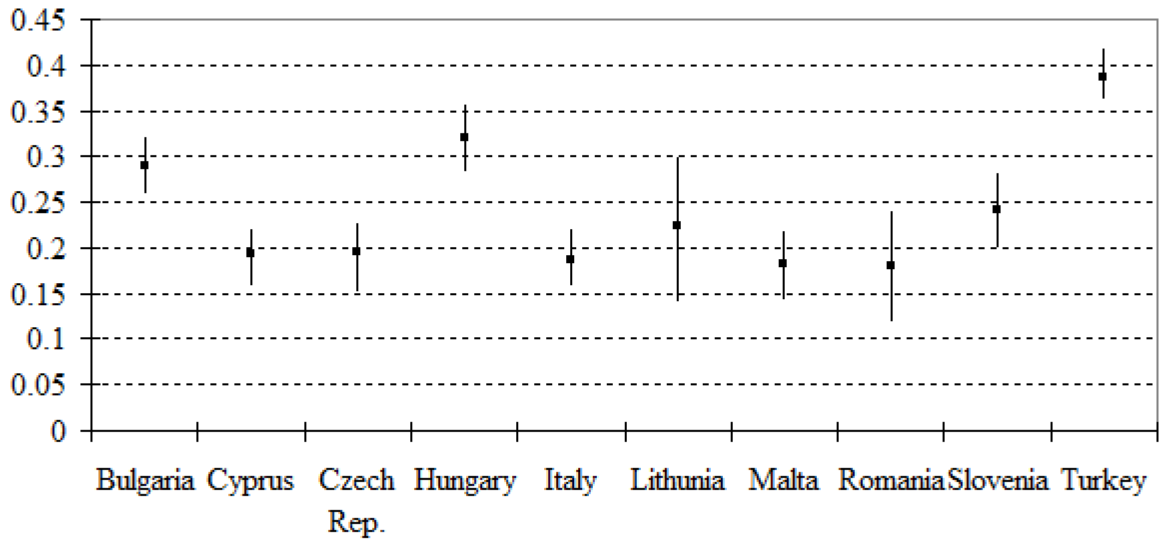

Figure C.1. Pearson *r* correlations between SES and achievement scores in algebra in each sample country.

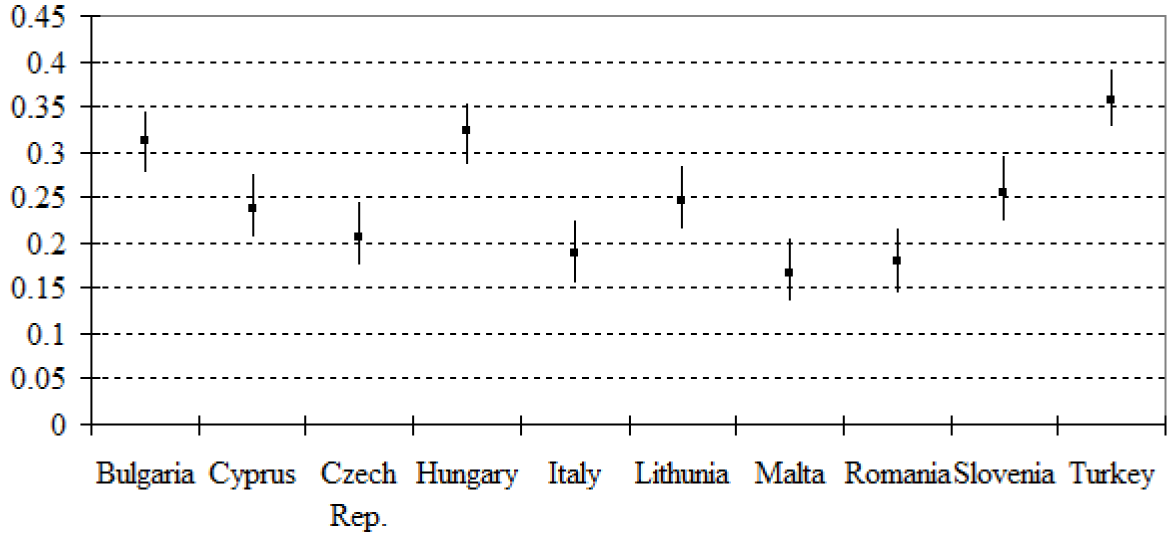

Figure C.2. Pearson *r* correlations between SES and achievement scores in number in each sample country.

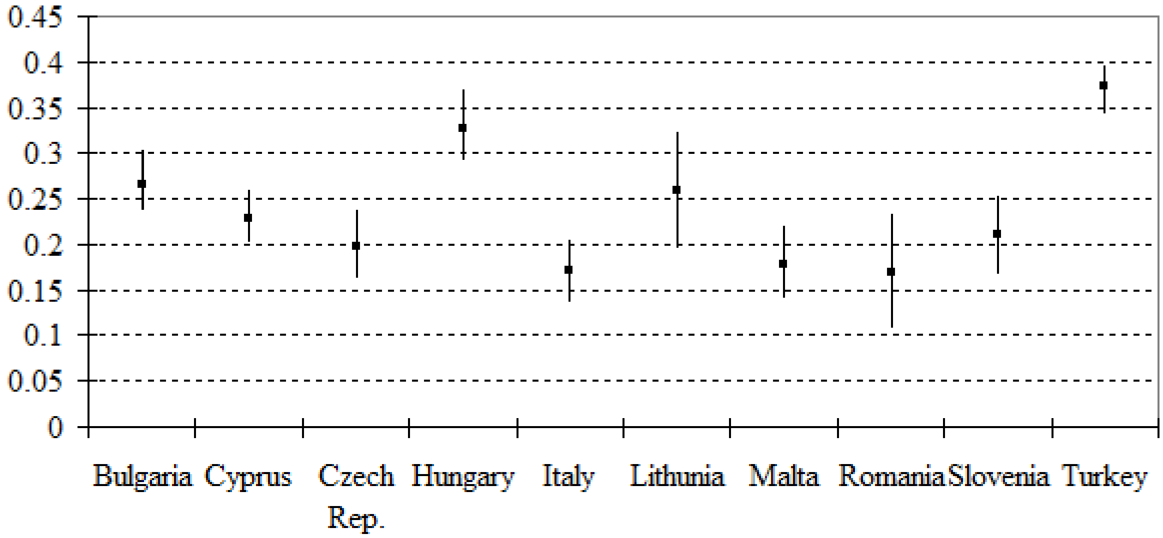

Figure C.3. Pearson *r* correlations between SES and achievement scores in geometry in each sample country.

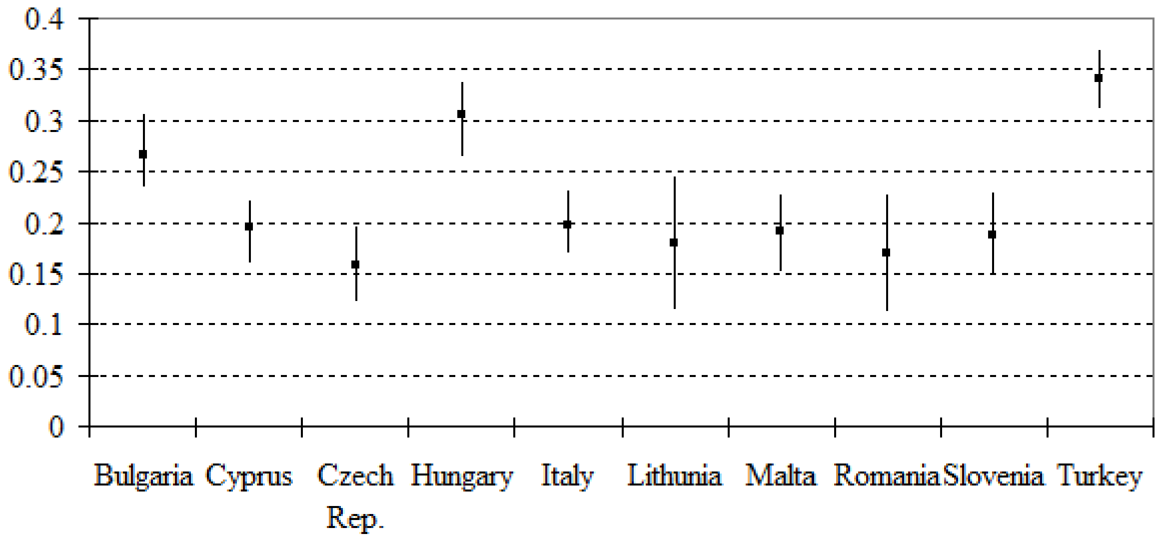

Figure C.4. Pearson *r* correlations between SES and achievement scores in data-and-chance in each sample country.

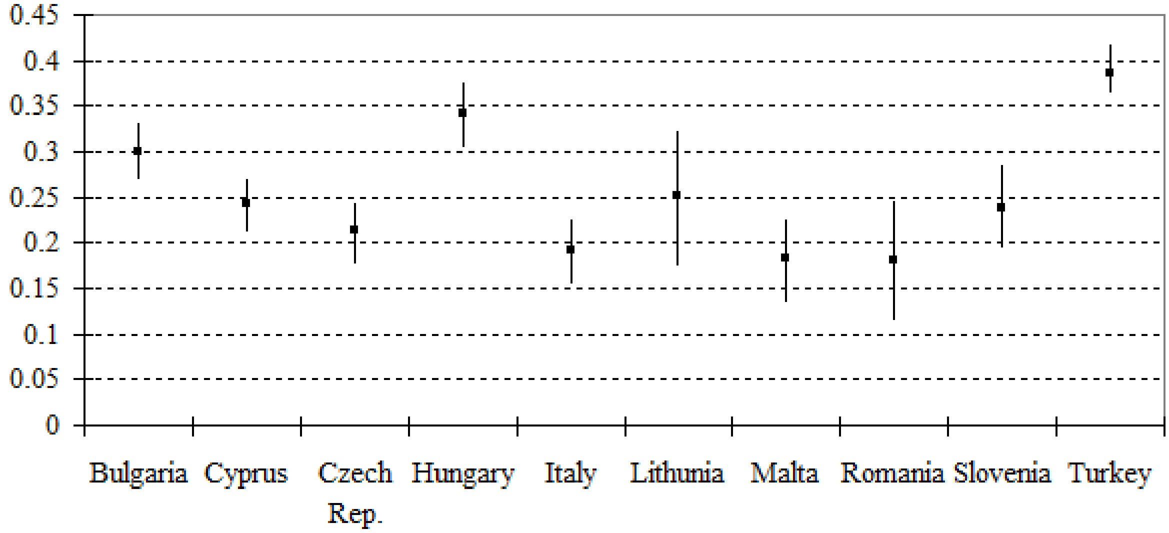

Figure C.5. Pearson *r* correlations between SES and achievement scores in knowing in each sample country.

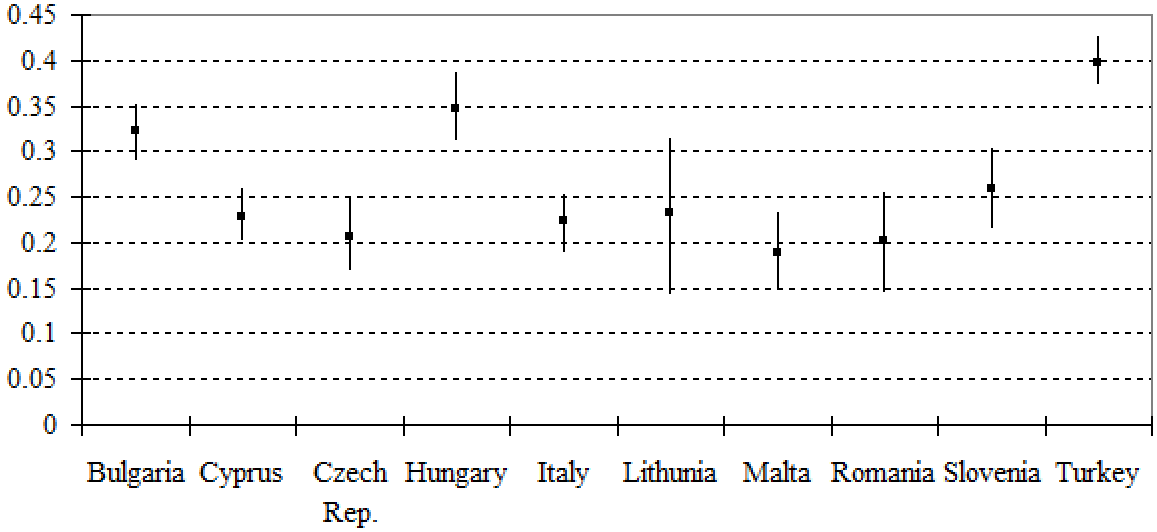

Figure C.6. Pearson *r* correlations between SES and achievement scores in applying in each sample country.

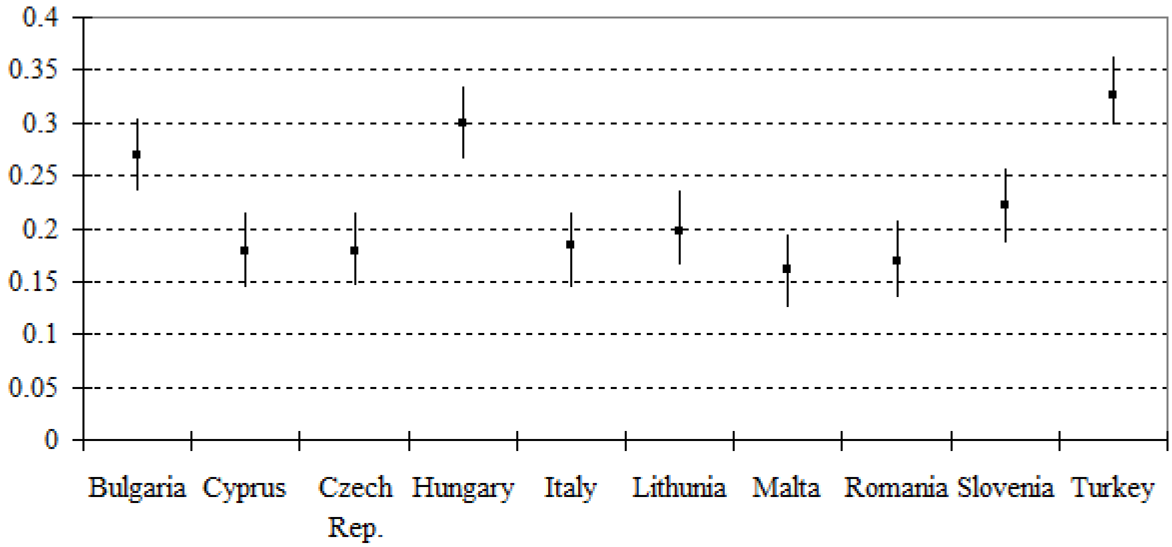

Figure C.7. Pearson *r* correlations between SES and achievement scores in reasoning in each sample country.

Table C.1

Pearson r Correlations Between SES and Mathematics Achievement Scores in Each Sample Country

Country	*n*	Correlations	*SE*	CI
Bulgaria	4019	0.31	0.03	[0.28, 0.34]
Cyprus	4399	0.24	0.02	[0.21, 0.27]
Czech Rep.	4845	0.22	0.02	[0.19, 0.25]
Hungary	4111	0.35	0.03	[0.32, 0.38]
Italy	4408	0.21	0.02	[0.18, 0.24]
Lithuania	3991	0.25	0.04	[0.21, 0.28]
Malta	4670	0.19	0.02	[0.16, 0.22]
Romania	4198	0.20	0.04	[0.17, 0.24]
Slovenia	4043	0.25	0.03	[0.21, 0.28]
Turkey	4498	0.39	0.02	[0.36, 0.42]

Table C.2

Pearson r Correlations Between SES and Achievement Scores in Algebra in Each Sample Country

Country	*n*	Correlations	*SE*	CI
Bulgaria	4019	0.29	0.03	[0.26, 0.32]
Cyprus	4399	0.19	0.02	[0.16, 0.22]
Czech Rep.	4845	0.19	0.03	[0.15, 0.23]
Hungary	4111	0.32	0.03	[0.28, 0.36]
Italy	4408	0.19	0.02	[0.16, 0.22]
Lithuania	3991	0.22	0.04	[0.14, 0.30]
Malta	4670	0.18	0.03	[0.14, 0.22]
Romania	4198	0.18	0.04	[0.12, 0.24]
Slovenia	4043	0.24	0.03	[0.20, 0.28]
Turkey	4498	0.39	0.03	[0.36, 0.42]

Table C.3

Pearson r Correlations Between SES and Achievement Scores in Number in Each Sample Country

Country	*n*	Correlations	*SE*	CI
Bulgaria	4019	0.31	0.03	[0.28, 0.34]
Cyprus	4399	0.24	0.02	[0.21, 0.27]
Czech Rep.	4845	0.21	0.03	[0.18, 0.24]
Hungary	4111	0.32	0.03	[0.29, 0.35]
Italy	4408	0.19	0.02	[0.16, 0.22]
Lithuania	3991	0.25	0.04	[0.21, 0.28]
Malta	4670	0.17	0.02	[0.14, 0.21]
Romania	4198	0.18	0.04	[0.14, 0.22]
Slovenia	4043	0.26	0.03	[0.23, 0.29]
Turkey	4498	0.36	0.02	[0.33, 0.39]

Table C.4

Pearson r Correlations Between SES and Achievement Scores in Geometry in Each Sample Country

Country	*n*	Correlations	*SE*	CI
Bulgaria	4019	0.27	0.03	[0.24, 0.30]
Cyprus	4399	0.23	0.02	[0.20, 0.26]
Czech Rep.	4845	0.20	0.02	[0.16, 0.24]
Hungary	4111	0.33	0.03	[0.29, 0.37]
Italy	4408	0.17	0.02	[0.14, 0.21]
Lithuania	3991	0.26	0.04	[0.20, 0.32]
Malta	4670	0.18	0.02	[0.14, 0.22]
Romania	4198	0.17	0.04	[0.11, 0.23]
Slovenia	4043	0.21	0.03	[0.17, 0.25]
Turkey	4498	0.37	0.03	[0.34, 0.40]

Table C.5

Pearson r Correlations Between SES and Achievement Scores in Data-and-Chance in Each Sample Country

Country	*n*	Correlations	*SE*	CI
Bulgaria	4019	0.27	0.03	[0.24, 0.31]
Cyprus	4399	0.19	0.02	[0.16, 0.22]
Czech Rep.	4845	0.16	0.02	[0.12, 0.20]
Hungary	4111	0.30	0.03	[0.26, 0.34]
Italy	4408	0.20	0.02	[0.17, 0.23]
Lithuania	3991	0.18	0.04	[0.11, 0.24]
Malta	4670	0.19	0.02	[0.15, 0.23]
Romania	4198	0.17	0.04	[0.11, 0.23]
Slovenia	4043	0.19	0.03	[0.15, 0.23]
Turkey	4498	0.34	0.03	[0.31, 0.37]

Table C.6

Pearson r Correlations Between SES and Achievement Scores in Knowing in Each Sample Country

Country	*n*	Correlations	*SE*	CI
Bulgaria	4019	0.30	0.03	[0.27, 0.33]
Cyprus	4399	0.24	0.02	[0.21, 0.27]
Czech Rep.	4845	0.21	0.02	[0.18, 0.24]
Hungary	4111	0.34	0.03	[0.31, 0.37]
Italy	4408	0.19	0.02	[0.16, 0.22]
Lithuania	3991	0.25	0.04	[0.17, 0.32]
Malta	4670	0.18	0.02	[0.13, 0.23]
Romania	4198	0.18	0.04	[0.12, 0.24]
Slovenia	4043	0.24	0.03	[0.20, 0.28]
Turkey	4498	0.39	0.02	[0.36, 0.42]

Table C.7

Pearson r Correlations Between SES and Achievement Scores in Applying in Each Sample Country

Country	*n*	Correlations	*SE*	CI
Bulgaria	4019	0.32	0.03	[0.29, 0.35]
Cyprus	4399	0.23	0.02	[0.20, 0.26]
Czech Rep.	4845	0.21	0.02	[0.17, 0.25]
Hungary	4111	0.35	0.03	[0.31, 0.39]
Italy	4408	0.22	0.02	[0.19, 0.25]
Lithuania	3991	0.23	0.05	[0.14, 0.31]
Malta	4670	0.19	0.02	[0.15, 0.23]
Romania	4198	0.20	0.04	[0.15, 0.25]
Slovenia	4043	0.26	0.03	[0.22, 0.30]
Turkey	4498	0.40	0.02	[0.37, 0.43]

Table C.8

Pearson r Correlations Between SES and Achievement Scores in Reasoning in Each Sample Country

Country	*n*	Correlations	*SE*	CI
Bulgaria	4019	0.27	0.03	[0.24, 0.30]
Cyprus	4399	0.18	0.02	[0.15, 0.22]
Czech Rep.	4845	0.18	0.02	[0.15, 0.21]
Hungary	4111	0.30	0.03	[0.27, 0.33]
Italy	4408	0.18	0.02	[0.15, 0.22]
Lithuania	3991	0.20	0.04	[0.16, 0.24]
Malta	4670	0.16	0.02	[0.13, 0.19]
Romania	4198	0.17	0.04	[0.13, 0.21]
Slovenia	4043	0.22	0.03	[0.19, 0.26]
Turkey	4498	0.33	0.02	[0.30, 0.36]

APPENDIX D

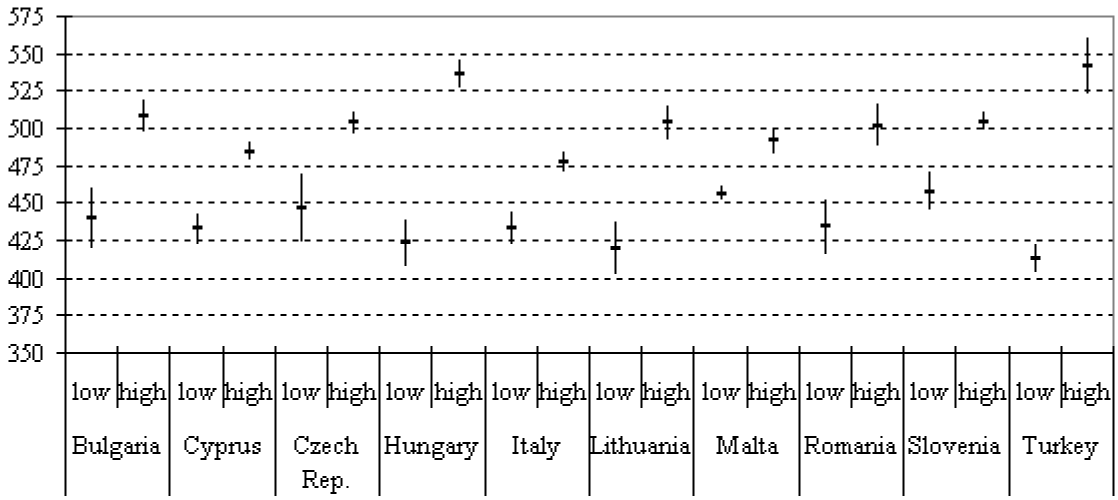

Figure D.1. 95% CIs around means for achievement differences between low- and high-SES students in algebra in each sample country.

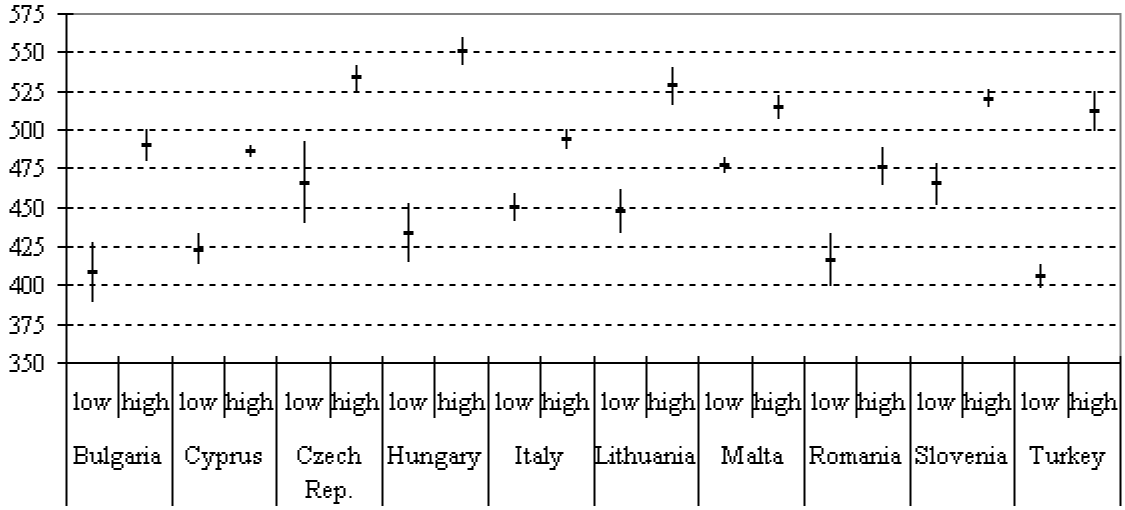

Figure D.2. 95% CIs around means for achievement differences between low- and high-SES students in number in each sample country.

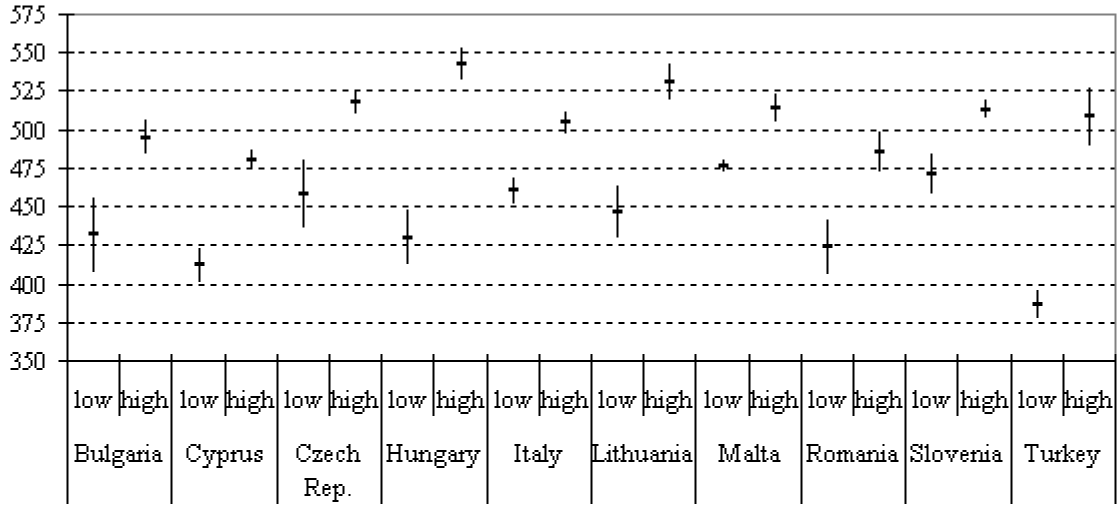

Figure D.3. 95% CIs around means for achievement differences between low- and high-SES students in geometry in each sample country.

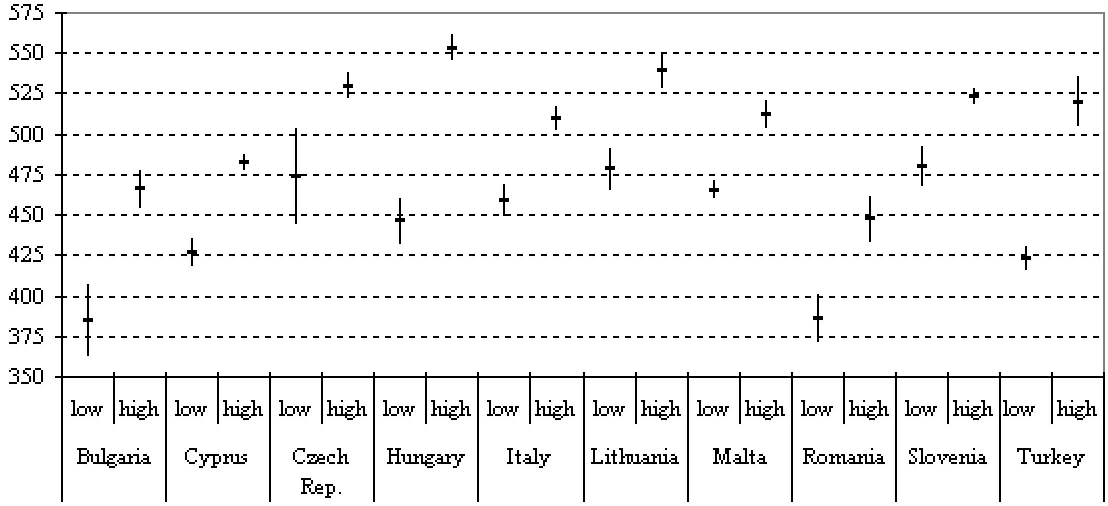

Figure D.4. 95% CIs around means for achievement differences between low- and high-SES students in data-and-chance in each sample country.

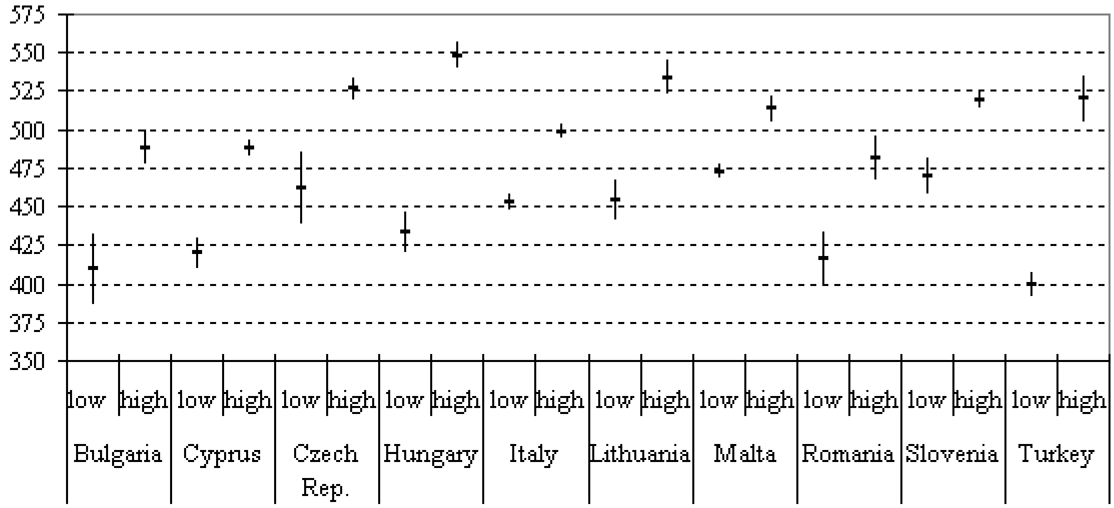

Figure D.5. 95% CIs around means for achievement differences between low- and high-SES students in knowing in each sample country.

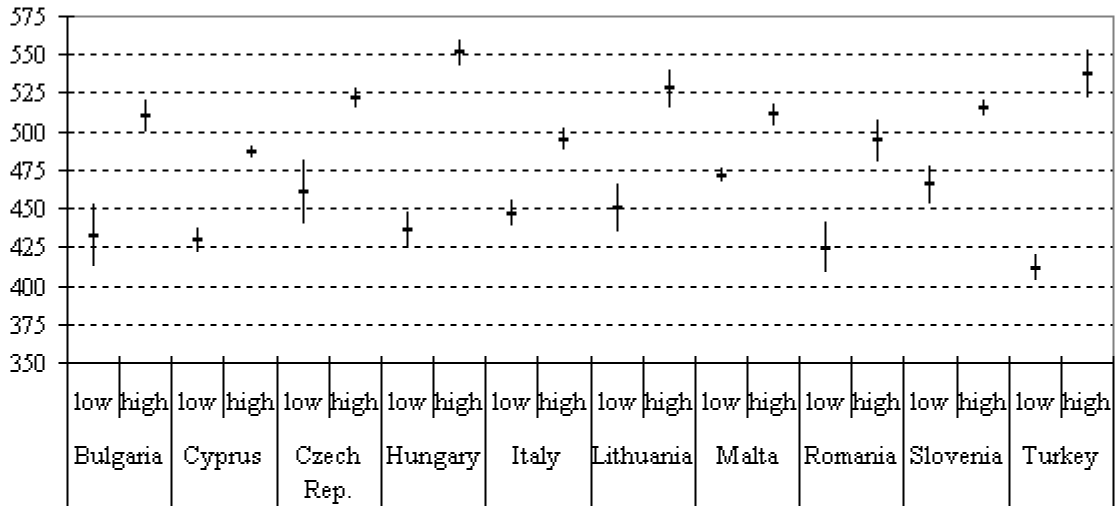

Figure D.6. 95% CIs around means for achievement differences between low- and high-SES students in applying in each sample country.

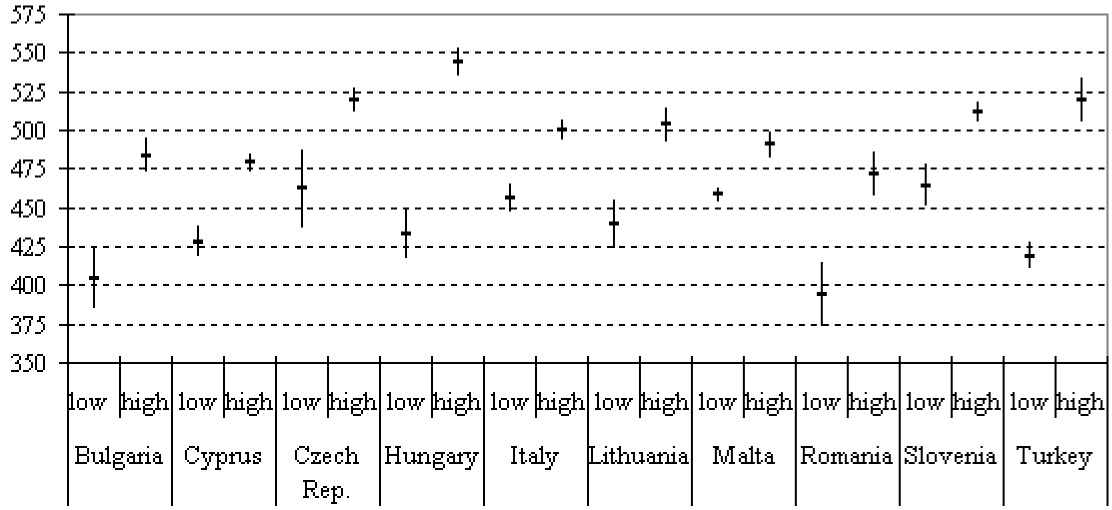

Figure D.7. 95% CIs around means for achievement differences between low- and high-SES students in reasoning in each sample country.

Table D.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]	

Table D.1

Continued

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
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]	

Table D.2

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

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Low	348	439.8	107.3	[419.3, 460.3]	0.68
	High	2066	507.9	98.9	[497.3, 518.4]	
Cyprus	Low	624	432.4	90.8	[421.9, 443.0]	0.62
	High	1973	484.4	80.8	[478.6, 490.1]	
Czech	Low	106	446.7	75.8	[424.1, 469.4]	0.73
	High	1425	503.7	78.7	[496.0, 511.3]	
Hungary	Low	269	423.1	73.9	[407.5, 438.6]	1.39
	High	1543	535.9	82.4	[526.4, 545.3]	
Italy	Low	1241	432.6	81.1	[421.7, 443.4]	0.56
	High	1362	476.9	76.4	[469.9, 483.9]	
Lithuania	Low	255	420.0	87.2	[402.8, 437.3]	0.95
	High	1604	503.5	88.1	[491.5, 515.4]	
Malta	Low	2241	456.3	80.7	[451.6, 460.9]	0.44
	High	1227	491.4	80.9	[482.5, 500.3]	

Table D.2

Continued

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Romania	Low	352	434.2	97.4	[416.0, 452.4]	0.64
	High	1308	501.8	107.3	[488.1, 515.5]	
Slovenia	Low	413	457.4	71.6	[444.5, 470.4]	0.63
	High	1987	504.7	75.2	[498.5, 510.8]	
Turkey	Low	2936	412.9	102.8	[404.0, 421.8]	1.21
	High	583	542.1	125.8	[523.4, 560.8]	

Table D.3

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

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Low	348	408.1	97.9	[388.7, 427.4]	0.90
	High	2066	489.4	89.0	[479.4, 499.4]	
Cyprus	Low	624	422.7	89.7	[413.1, 432.3]	0.73
	High	1973	485.8	85.2	[481.5, 490.1]	
Czech	Low	106	465.2	73.7	[438.7, 491.7]	0.83
	High	1425	533.1	82.7	[525.1, 541.0]	
Hungary	Low	269	433.1	76.6	[414.4, 451.7]	1.36
	High	1543	550.1	87.7	[541.3, 558.9]	
Italy	Low	1241	449.7	75.1	[440.8, 458.7]	0.59
	High	1362	493.8	73.8	[487.6, 500.1]	
Lithuania	Low	255	447.3	76.8	[432.8, 461.8]	1.01
	High	1604	527.9	80.1	[515.7, 540.1]	
Malta	Low	2241	477.0	96.2	[472.1, 481.9]	0.39
	High	1227	514.7	94.4	[507.0, 522.5]	

Table D.3

Continued

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Romania	Low	352	415.4	83.8	[398.6, 432.2]	0.64
	High	1308	476.0	97.5	[463.4, 488.7]	
Slovenia	Low	413	464.8	73.9	[451.4, 478.2]	0.72
	High	1987	519.9	76.9	[514.6, 525.3]	
Turkey	Low	2936	405.7	92.8	[398.4, 412.9]	1.12
	High	583	512.2	107.8	[499.3, 525.1]	

Table D.4

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

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Low	348	431.4	103.5	[407.5, 455.3]	0.68
	High	2066	494.6	91.4	[483.6, 505.6]	
Cyprus	Low	624	412.1	99.8	[401.1, 423.1]	0.72
	High	1973	480.1	92.7	[473.2, 487.1]	
Czech	Low	106	458.0	68.5	[435.9, 480.0]	0.76
	High	1425	518.0	80.2	[510.5, 525.5]	
Hungary	Low	269	430.0	75.2	[412.4, 447.6]	1.31
	High	1543	542.8	87.7	[532.6, 552.9]	
Italy	Low	1241	460.0	78.1	[451.0, 469.0]	0.57
	High	1362	504.3	76.4	[496.7, 511.9]	
Lithuania	Low	255	446.4	74.0	[429.0, 463.8]	1.06
	High	1604	530.4	79.7	[518.6, 542.1]	
Malta	Low	2241	476.5	86.8	[472.5, 480.5]	0.44
	High	1227	514.2	86.2	[505.4, 523.0]	

Table D.4

Continued

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Romania	Low	352	423.8	88.6	[406.1, 441.5]	0.62
	High	1308	485.2	102.3	[471.7, 498.8]	
Slovenia	Low	413	470.7	67.2	[457.8, 483.6]	0.60
	High	1987	513.1	71.4	[507.0, 519.3]	
Turkey	Low	2936	385.9	101.6	[376.8, 394.9]	1.16
	High	583	508.1	123.9	[489.8, 526.4]	

Table D.5

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

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Low	348	384.7	116.7	[362.4, 407.0]	0.78
	High	2066	466.0	102.6	[454.4, 477.6]	
Cyprus	Low	624	426.8	95.4	[418.0, 435.6]	0.62
	High	1973	482.5	87.3	[477.6, 487.5]	
Czech	Low	106	473.5	79.9	[443.4, 503.7]	0.68
	High	1425	529.8	82.6	[522.1, 537.5]	
Hungary	Low	269	446.3	77.2	[432.2, 460.3]	1.34
	High	1543	552.9	79.7	[545.0, 560.9]	
Italy	Low	1241	458.8	82.9	[448.9, 468.6]	0.62
	High	1362	509.5	81.4	[501.7, 517.2]	
Lithuania	Low	255	478.2	77.6	[465.2, 491.3]	0.76
	High	1604	539.4	80.7	[528.2, 550.6]	
Malta	Low	2241	465.4	101.7	[460.2, 470.6]	0.46
	High	1227	512.1	100.9	[503.1, 521.2]	

Table D.5

Continued

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Romania	Low	352	385.7	91.9	[371.0, 400.5]	0.62
	High	1308	447.5	101.6	[433.4, 461.7]	
Slovenia	Low	413	479.5	72.4	[467.1, 492.0]	0.57
	High	1987	522.8	76.0	[517.7, 527.9]	
Turkey	Low	2936	422.9	91.6	[415.1, 430.7]	1.03
	High	583	519.6	103.5	[504.3, 535.0]	

Table D.6

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

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Low	348	409.4	105.9	[386.5, 432.4]	0.81
	High	2066	488.4	95.6	[477.8, 499.1]	
Cyprus	Low	624	420.1	93.3	[410.3, 429.9]	0.76
	High	1973	488.3	88.7	[483.3, 493.2]	
Czech	Low	106	461.5	70.1	[438.1, 484.8]	0.82
	High	1425	526.4	79.3	[518.9, 533.9]	
Hungary	Low	269	432.8	70.5	[419.6, 446.0]	1.42
	High	1543	548.2	82.8	[539.7, 556.7]	
Italy	Low	1241	452.7	74.7	[447.6, 457.8]	0.63
	High	1362	498.8	71.8	[494.0, 503.6]	
Lithuania	Low	255	454.1	72.0	[440.7, 467.6]	1.04
	High	1604	533.9	77.7	[522.6, 545.1]	
Malta	Low	2241	472.5	92.2	[468.0, 477.1]	0.45
	High	1227	513.4	90.9	[504.9, 521.9]	

Table D.6

Continued

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Romania	Low	352	415.7	89.7	[398.0, 433.5]	0.67
	High	1308	481.7	101.0	[467.7, 495.7]	
Slovenia	Low	413	469.4	67.7	[458.0, 480.8]	0.70
	High	1987	518.6	70.8	[513.5, 523.7]	
Turkey	Low	2936	399.2	96.3	[391.1, 407.3]	1.22
	High	583	520.2	114.4	[505.4, 535.1]	

Table D.7

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

Country	SES	N	Mean	SD	CI	Cohen's *d*
Bulgaria	Low	348	432.4	97.7	[412.7, 452.2]	0.85
	High	2066	509.9	89.6	[500.0, 519.8]	
Cyprus	Low	624	429.5	81.8	[421.4, 437.6]	0.75
	High	1973	486.4	74.4	[482.4, 490.4]	
Czech	Low	106	460.7	63.0	[439.4, 482.0]	0.87
	High	1425	521.8	71.1	[514.8, 528.8]	
Hungary	Low	269	435.8	68.7	[423.6, 448.0]	1.50
	High	1543	551.0	78.0	[542.3, 559.6]	
Italy	Low	1241	446.8	71.7	[438.2, 455.5]	0.68
	High	1362	494.5	69.1	[487.4, 501.6]	
Lithuania	Low	255	449.7	76.4	[433.9, 465.4]	0.98
	High	1604	528.1	81.0	[515.7, 540.5]	
Malta	Low	2241	471.5	86.2	[466.6, 476.4]	0.46
	High	1227	510.8	83.2	[503.2, 518.3]	

Table D.7

Continued

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Romania	Low	352	424.7	95.7	[408.3, 441.2]	0.68
	High	1308	494.0	102.7	[480.6, 507.5]	
Slovenia	Low	413	465.5	67.8	[453.1, 477.9]	0.73
	High	1987	515.5	68.8	[510.0, 521.0]	
Turkey	Low	2936	411.5	97.3	[403.1, 419.9]	1.25
	High	583	537.2	115.6	[521.2, 553.3]	

Table D.8

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

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Low	348	404.6	117.0	[384.6, 424.6]	0.76
	High	2066	483.8	101.9	[473.0, 494.5]	
Cyprus	Low	624	427.9	101.1	[418.3, 437.4]	0.52
	High	1973	478.9	96.6	[473.4, 484.4]	
Czech	Low	106	461.9	82.2	[436.5, 487.4]	0.72
	High	1425	519.4	80.2	[511.4, 527.4]	
Hungary	Low	269	433.4	82.0	[417.4, 449.4]	1.29
	High	1543	544.2	86.9	[535.5, 552.9]	
Italy	Low	1241	455.9	80.8	[447.0, 464.8]	0.55
	High	1362	499.9	78.0	[493.0, 506.7]	
Lithuania	Low	255	438.7	80.0	[423.1, 454.3]	0.75
	High	1604	503.3	86.6	[492.2, 514.4]	
Malta	Low	2241	458.0	87.7	[453.7, 462.3]	0.37
	High	1227	490.5	87.4	[482.4, 498.6]	

Table D.8

Continued

Country	SES	*n*	Mean	*SD*	CI	Cohen's *d*
Romania	Low	352	394.0	106.5	[373.3, 414.7]	0.68
	High	1308	471.1	115.8	[456.7, 485.5]	
Slovenia	Low	413	464.4	77.2	[450.3, 478.4]	0.59
	High	1987	511.4	80.5	[505.0, 517.7]	
Turkey	Low	2936	419.1	99.6	[411.0, 427.2]	0.98
	High	583	519.5	114.8	[505.4, 533.5]	

APPENDIX E

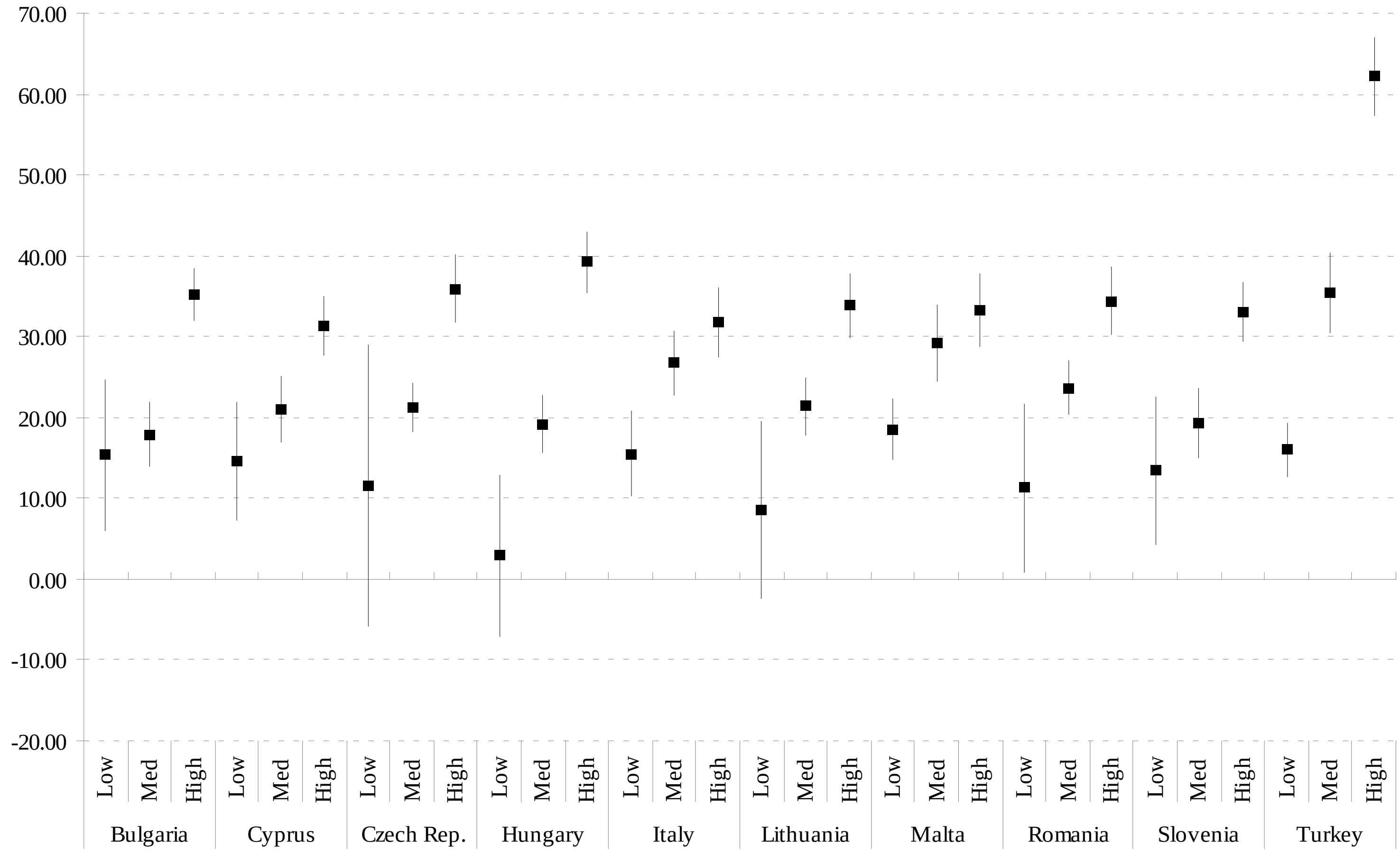

Figure E.1. 95% CIs around percentages of low-, medium, and high-SES students performing in the upper quartile and above in algebra.

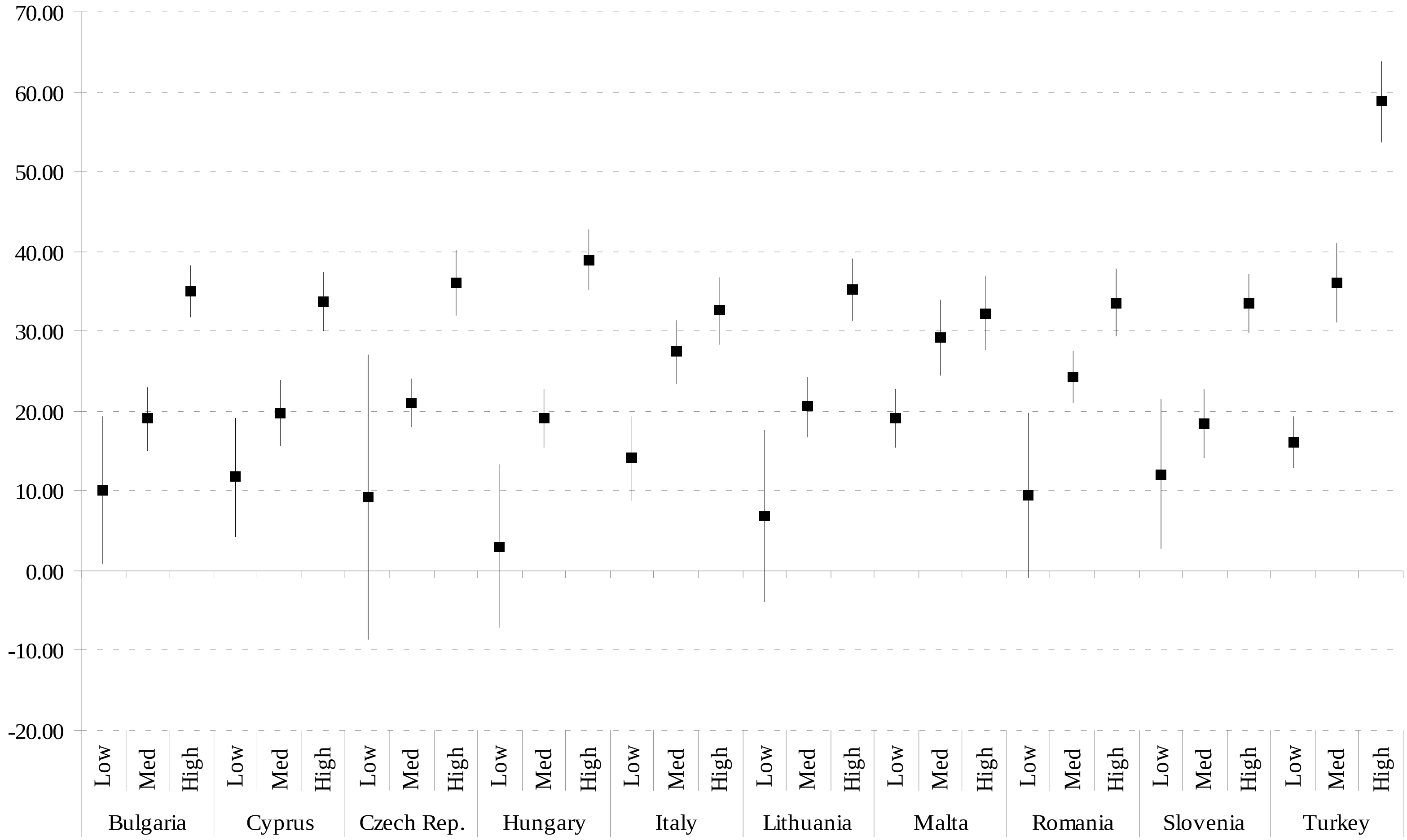

Figure E.2. 95% CIs around percentages of low-, medium, and high-SES students performing in the upper quartile and above in number.

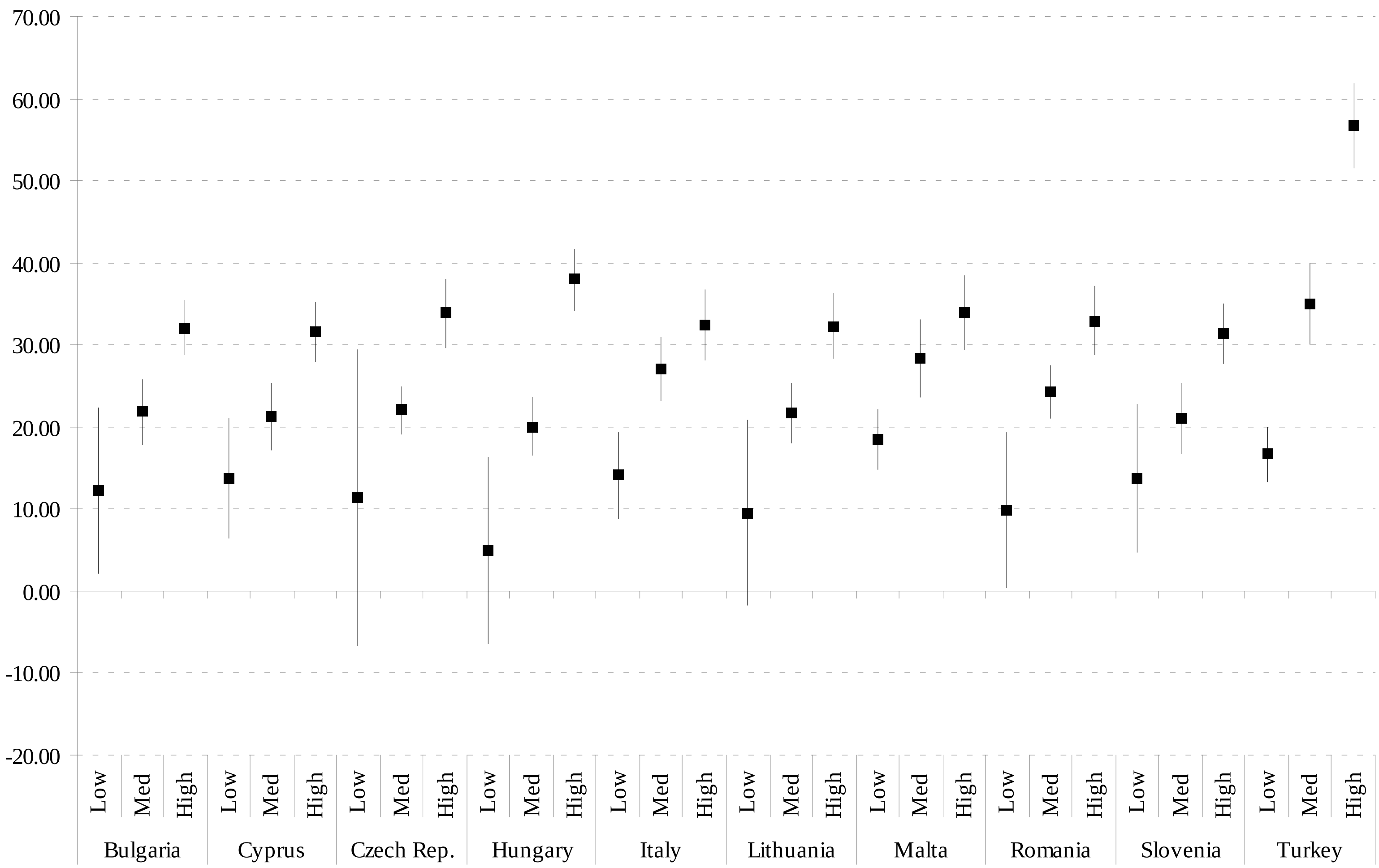

Figure E.3. 95% CIs around percentages of low-, medium, and high-SES students performing in the upper quartile and above in data-and-chance.

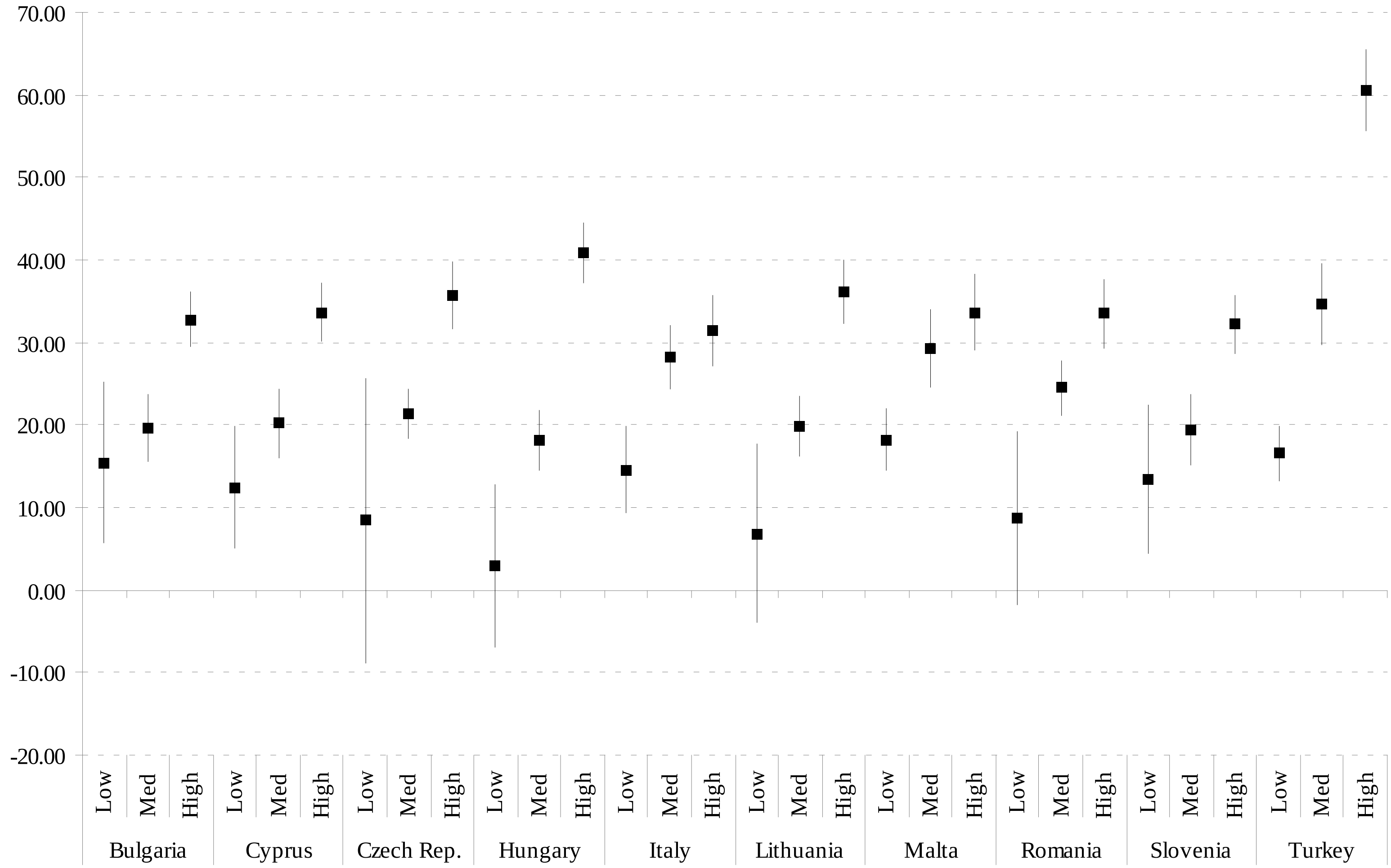

Figure E.4. 95% CIs around percentages of low-, medium, and high-SES students performing in the upper quartile and above in geometry.

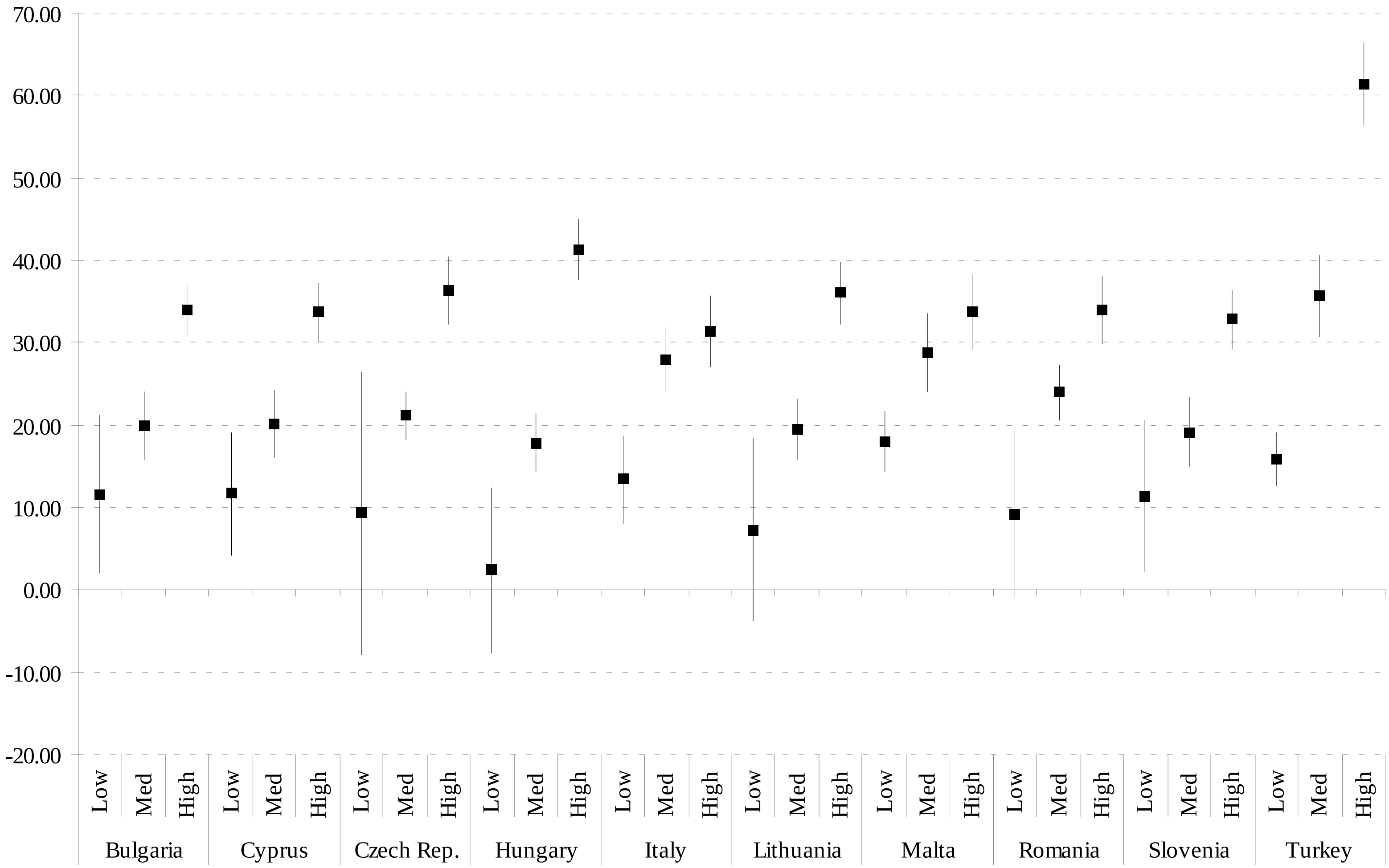

Figure E.5. 95% CIs around percentages of low-, medium, and high-SES students performing in the upper quartile and above in knowing.

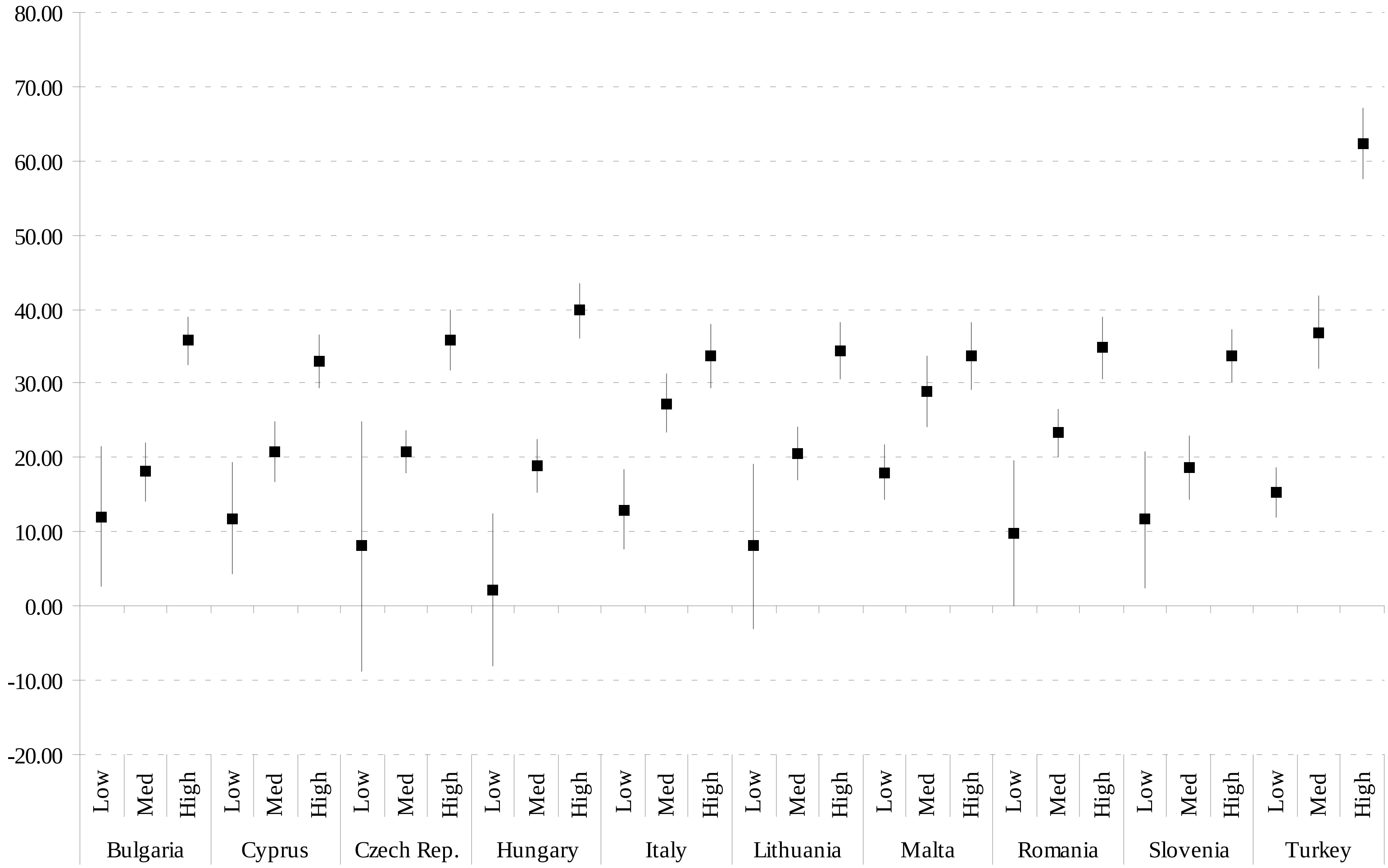

Figure E.6. 95% CIs around percentages of low-, medium, and high-SES students performing in the upper quartile and above in applying.

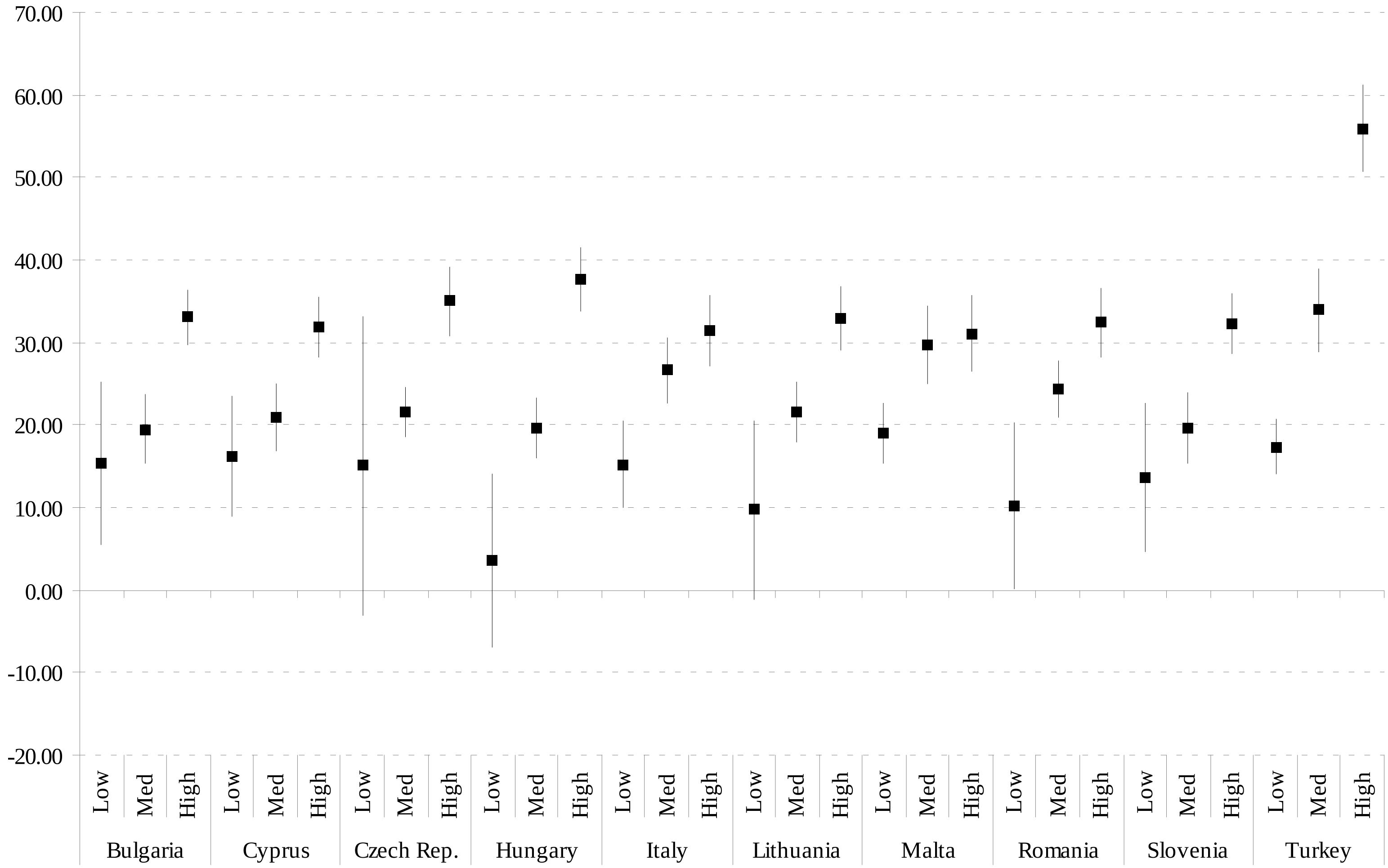

Figure E.7. 95% CIs around percentages of low-, medium, and high-SES students performing in the upper quartile and above in reasoning.

Table E.1

Percentages of Low-, Medium, and High-SES Students Performing in the Upper Quartile and Above in Mathematics

Country	SES level	*n*	Percent	*SE*	CI
Bulgaria	Low	45	12.1	2.9	[2.6, 21.6]
	Med	368	18.9	1.6	[14.9, 22.9]
	High	851	35.4	2.5	[32.2, 38.6]
Cyprus	Low	75	12.3	1.7	[4.8, 19.7]
	Med	361	20.2	1.2	[16.1, 24.4]
	High	661	33.1	1.4	[29.5, 36.7]
Czech Rep.	Low	10	8.8	4.1	[-8.8, 26.4]
	Med	717	20.6	1.3	[17.6, 23.6]
	High	536	36.6	1.8	[32.5, 40.7]
Hungary	Low	9	2.6	1.1	[-7.8, 13.1]
	Med	440	18.1	1.3	[14.5, 21.7]
	High	677	40.6	2.6	[36.9, 44.3]
Italy	Low	156	13.3	1.7	[7.9, 18.6]
	Med	488	27.1	1.5	[23.2, 31.1]
	High	465	33.0	2.0	[28.7, 37.3]

Table E.1

Continued

Country	SES level	*n*	Percent	*SE*	CI
	Low	24	7.9	2.2	[-2.9, 18.7]
Lithuania	Med	461	20.3	1.3	[16.6, 24.0]
	High	594	35.4	1.7	[31.6, 39.2]
	Low	409	17.8	1.0	[14.1, 21.5]
Malta	Med	356	29.2	1.5	[24.5, 33.9]
	High	417	33.6	1.7	[29.1, 38.2]
	Low	30	8.9	2.3	[-1.3, 19.1]
Romania	Med	645	24.1	1.8	[20.8, 27.4]
	High	512	34.4	2.5	[30.3, 38.6]
	Low	49	12.3	2.1	[3.1, 21.4]
Slovenia	Med	322	18.6	1.1	[14.3, 22.8]
	High	666	33.1	1.4	[29.5, 36.7]
	Low	471	15.6	1.4	[12.3, 18.9]
Turkey	Med	366	36.3	2.7	[31.4, 41.2]
	High	387	62.3	3.1	[57.5, 67.1]

Table E.2

Percentages of Low-, Medium, and High-SES Students Performing in the Upper Quartile and Above in Algebra

Country	SES level	*n*	Percent	*SE*	CI
	Low	57	15.4	3.9	[6.0, 24.8]
Bulgaria	Med	357	17.9	1.7	[13.9, 21.9]
	High	844	35.2	2.6	[32.0, 38.4]
	Low	88	14.6	2.1	[7.2, 21.9]
Cyprus	Med	374	21.0	1.3	[16.9, 25.1]
	High	625	31.3	1.3	[27.7, 35.0]
	Low	13	11.6	4.8	[-5.8, 29.1]
Czech Rep.	Med	731	21.3	1.1	[18.3, 24.2]
	High	529	36.0	2.0	[31.9, 40.0]
	Low	11	2.9	1.2	[-7.0, 12.8]
Hungary	Med	468	19.2	1.6	[15.6, 22.7]
	High	651	39.3	2.7	[35.5, 43.0]
	Low	179	15.5	1.9	[10.2, 20.8]
Italy	Med	487	26.8	1.9	[22.8, 30.7]
	High	450	31.7	2.3	[27.4, 36.0]

Table E.2

Continued

Country	SES level	*n*	Percent	*SE*	CI
	Low	25	8.6	2.5	[-2.4, 19.6]
Lithuania	Med	494	21.4	1.5	[17.8, 25.0]
	High	571	33.8	1.7	[29.9, 37.7]
	Low	426	18.6	1.1	[14.9, 22.2]
Malta	Med	356	29.1	1.6	[24.4, 33.9]
	High	412	33.2	2.0	[28.7, 37.8]
	Low	35	11.3	3.2	[0.8, 21.7]
Romania	Med	629	23.6	1.8	[20.3, 26.9]
	High	498	34.4	2.3	[30.2, 38.6]
	Low	54	13.5	2.4	[4.4, 22.6]
Slovenia	Med	327	19.2	1.3	[15.0, 23.5]
	High	655	33.0	1.6	[29.4, 36.6]
	Low	485	16.0	1.3	[12.8, 19.3]
Turkey	Med	359	35.4	2.7	[30.5, 40.3]
	High	387	62.2	3.3	[57.4, 67.0]

Table E.3

Percentages of Low-, Medium, and High-SES Students Performing in the Upper Quartile and Above in Number

Country	SES level	*n*	Percent	*SE*	CI
	Low	41	10.1	2.5	[0.9, 19.3]
Bulgaria	Med	370	19.0	1.8	[15.0, 23.0]
	High	834	35.0	2.5	[31.8, 38.3]
	Low	72	11.7	1.6	[4.3, 19.1]
Cyprus	Med	356	19.7	1.2	[15.6, 23.8]
	High	668	33.7	1.2	[30.1, 37.2]
	Low	10	9.2	4.9	[-8.7, 27.1]
Czech Rep.	Med	723	21.0	1.3	[18.1, 24.0]
	High	523	36.0	2.5	[31.9, 40.1]
	Low	11	3.1	1.2	[-7.1, 13.2]
Hungary	Med	452	19.1	1.8	[15.4, 22.7]
	High	647	38.9	2.1	[35.2, 42.7]
	Low	171	14.1	1.8	[8.9, 19.3]
Italy	Med	499	27.4	1.6	[23.5, 31.3]
	High	465	32.5	2.1	[28.3, 36.8]

Table E.3

Continued

Country	SES level	*n*	Percent	*SE*	CI
	Low	21	6.8	1.7	[-4.0, 17.5]
Lithuania	Med	468	20.5	1.4	[16.8, 24.1]
	High	584	35.2	1.8	[31.3, 39.0]
	Low	438	19.1	1.0	[15.4, 22.8]
Malta	Med	357	29.3	1.5	[24.5, 34.0]
	High	399	32.3	2.1	[27.7, 36.9]
	Low	31	9.4	2.7	[-0.9, 19.7]
Romania	Med	654	24.3	1.7	[21.0, 27.6]
	High	495	33.6	2.3	[29.4, 37.7]
	Low	47	12.0	2.6	[2.7, 21.4]
Slovenia	Med	316	18.4	1.4	[14.1, 22.7]
	High	669	33.5	1.5	[29.9, 37.1]
	Low	486	16.1	1.3	[12.9, 19.4]
Turkey	Med	356	36.0	2.3	[31.0, 41.0]
	High	367	58.8	2.9	[53.7, 63.8]

Table E.4

Percentages of Low-, Medium, and High-SES Students Performing in the Upper Quartile and Above in Data-and-Chance

Country	SES level	*n*	Percent	*SE*	CI
Bulgaria	Low	41	12.2	3.2	[2.2, 22.2]
	Med	402	21.8	1.5	[17.8, 25.8]
	High	759	32.0	2.2	[28.7, 35.3]
Cyprus	Low	84	13.7	1.7	[6.3, 21.0]
	Med	383	21.2	1.0	[17.1, 25.3]
	High	627	31.5	1.2	[27.9, 35.2]
Czech Rep.	Low	12	11.4	4.8	[-6.6, 29.4]
	Med	750	22.0	1.1	[19.0, 25.0]
	High	488	33.8	2.2	[29.6, 38.0]
Hungary	Low	14	5.0	1.9	[-6.4, 16.3]
	Med	476	20.0	1.5	[16.4, 23.6]
	High	624	37.9	2.4	[34.1, 41.7]
Italy	Low	169	14.1	1.8	[8.9, 19.4]
	Med	487	27.0	1.5	[23.1, 31.0]
	High	455	32.4	2.2	[28.1, 36.7]

Table E.4

Continued

Country	SES level	*n*	Percent	*SE*	CI
	Low	26	9.5	2.6	[-1.8, 20.7]
Lithuania	Med	492	21.6	1.3	[18.0, 25.2]
	High	531	32.3	2.0	[28.3, 36.2]
	Low	423	18.4	0.9	[14.7, 22.1]
Malta	Med	346	28.4	1.6	[23.6, 33.1]
	High	421	33.9	1.6	[29.3, 38.4]
	Low	38	9.9	2.1	[0.4, 19.3]
Romania	Med	655	24.3	1.8	[21.0, 27.5]
	High	480	32.9	2.8	[28.7, 37.1]
	Low	56	13.7	2.8	[4.7, 22.8]
Slovenia	Med	357	21.0	1.5	[16.8, 25.2]
	High	625	31.3	1.5	[27.6, 34.9]
	Low	496	16.6	1.4	[13.4, 19.9]
Turkey	Med	351	35.0	2.8	[30.0, 39.9]
	High	356	56.7	3.9	[51.5, 61.8]

Table E.5

Percentages of Low-, Medium, and High-SES Students Performing in the Upper Quartile and Above in Geometry

Country	SES level	*n*	Percent	*SE*	CI
Bulgaria	Low	53	15.4	3.5	[5.7, 25.1]
	Med	365	19.7	1.7	[15.6, 23.8]
	High	785	32.8	2.5	[29.5, 36.1]
Cyprus	Low	77	12.4	1.8	[5.0, 19.8]
	Med	366	20.2	1.4	[16.1, 24.3]
	High	669	33.7	1.7	[30.1, 37.2]
Czech Rep.	Low	10	8.5	3.8	[-8.8, 25.7]
	Med	730	21.4	1.3	[18.4, 24.3]
	High	518	35.7	2.0	[31.6, 39.8]
Hungary	Low	11	2.9	1.2	[-7.0, 12.8]
	Med	435	18.2	1.2	[14.6, 21.8]
	High	671	40.8	2.7	[37.1, 44.5]
Italy	Low	172	14.5	2.0	[9.3, 19.8]
	Med	517	28.3	1.7	[24.4, 32.2]
	High	448	31.5	2.0	[27.2, 35.8]

Table E.5

Continued

Country	SES level	*n*	Percent	*SE*	CI
	Low	21	6.8	1.9	[-4.0, 17.6]
Lithuania	Med	450	19.8	1.5	[16.1, 23.5]
	High	606	36.1	2.2	[32.3, 39.9]
	Low	417	18.2	0.9	[14.5, 21.9]
Malta	Med	355	29.2	1.4	[24.5, 33.9]
	High	417	33.7	1.7	[29.1, 38.2]
	Low	28	8.8	2.0	[-1.7, 19.2]
Romania	Med	652	24.6	1.8	[21.2, 27.9]
	High	496	33.5	2.4	[29.4, 37.7]
	Low	55	13.5	3.0	[4.5, 22.5]
Slovenia	Med	333	19.4	1.7	[15.2, 23.7]
	High	654	32.2	2.0	[28.6, 35.8]
	Low	501	16.5	1.5	[13.3, 19.8]
Turkey	Med	353	34.6	2.9	[29.6, 39.5]
	High	377	60.6	3.5	[55.7, 65.6]

Table E.6

Percentages of Low-, Medium, and High-SES Students Performing in the Upper Quartile and Above in Knowing

Country	SES level	*n*	Percent	*SE*	CI
	Low	43	11.6	3.1	[2.0, 21.2]
Bulgaria	Med	372	19.9	1.6	[15.8, 24.0]
	High	823	34.0	2.5	[30.7, 37.2]
	Low	72	11.7	1.9	[4.3, 19.1]
Cyprus	Med	364	20.1	1.3	[16.0, 24.2]
	High	666	33.6	1.8	[30.1, 37.2]
	Low	11	9.3	3.9	[-7.9, 26.4]
Czech Rep.	Med	728	21.1	1.4	[18.2, 24.1]
	High	531	36.3	2.2	[32.2, 40.4]
	Low	9	2.4	1.1	[-7.6, 12.5]
Hungary	Med	439	17.8	1.3	[14.3, 21.4]
	High	688	41.3	2.4	[37.7, 45.0]
	Low	155	13.4	1.8	[8.0, 18.7]
Italy	Med	504	28.0	1.6	[24.0, 31.9]
	High	447	31.4	2.0	[27.1, 35.7]

Table E.6

Continued

Country	SES level	*n*	Percent	*SE*	CI
	Low	21	7.2	1.9	[-3.8, 18.3]
Lithuania	Med	449	19.5	1.2	[15.9, 23.2]
	High	601	36.0	1.9	[32.2, 39.8]
	Low	415	18.0	0.9	[14.3, 21.7]
Malta	Med	350	28.8	1.5	[24.0, 33.5]
	High	418	33.7	1.5	[29.1, 38.2]
	Low	31	9.2	2.1	[-1.0, 19.3]
Romania	Med	650	23.9	1.6	[20.7, 27.2]
	High	505	34.0	2.6	[29.9, 38.2]
	Low	46	11.4	2.2	[2.2, 20.5]
Slovenia	Med	327	19.2	1.3	[14.9, 23.4]
	High	658	32.8	1.4	[29.2, 36.4]
	Low	479	15.8	1.3	[12.6, 19.1]
Turkey	Med	361	35.8	2.5	[30.8, 40.7]
	High	384	61.4	3.0	[56.5, 66.2]

Table E.7

Percentages of Low-, Medium, and High-SES Students Performing in the Upper Quartile and Above in Applying

Country	SES level	*n*	Percent	*SE*	CI
Bulgaria	Low	46	12.0	3.8	[2.6, 21.5]
	Med	363	18.1	1.6	[14.2, 22.1]
	High	870	35.7	2.5	[32.5, 38.9]
Cyprus	Low	73	11.9	1.5	[4.4, 19.3]
	Med	371	20.8	1.6	[16.7, 24.9]
	High	657	33.0	1.6	[29.4, 36.6]
Czech Rep.	Low	10	8.1	3.2	[-8.8, 25.0]
	Med	724	20.8	1.3	[17.9, 23.8]
	High	527	35.8	2.1	[31.7, 39.9]
Hungary	Low	8	2.2	1.3	[-8.0, 12.5]
	Med	456	18.9	1.2	[15.3, 22.5]
	High	665	39.8	2.6	[36.1, 43.6]
Italy	Low	152	13.0	1.8	[7.7, 18.4]
	Med	493	27.3	1.7	[23.3, 31.2]
	High	477	33.7	2.2	[29.5, 38.0]

Table E.7

Continued

Country	SES level	*n*	Percent	*SE*	CI
	Low	23	8.1	2.2	[-3.1, 19.2]
Lithuania	Med	469	20.5	1.4	[16.9, 24.2]
	High	577	34.5	1.9	[30.6, 38.4]
	Low	413	18.0	1.1	[14.3, 21.7]
Malta	Med	352	28.9	1.4	[24.2, 33.6]
	High	419	33.7	1.7	[29.2, 38.2]
	Low	35	9.8	2.4	[0.0, 19.7]
Romania	Med	631	23.3	1.7	[20.0, 26.6]
	High	512	34.8	2.4	[30.7, 38.9]
	Low	47	11.7	2.2	[2.5, 20.9]
Slovenia	Med	322	18.7	1.8	[14.4, 22.9]
	High	676	33.7	1.7	[30.1, 37.2]
	Low	461	15.3	1.3	[12.0, 18.6]
Turkey	Med	372	36.8	2.9	[31.9, 41.7]
	High	388	62.3	2.8	[57.5, 67.1]

Table E.8

Percentages of Low-, Medium, and High-SES Students Performing in the Upper Quartile and Above in Reasoning

Country	SES level	*n*	Percent	*SE*	CI
Bulgaria	Low	52	15.4	3.3	[5.6, 25.2]
	Med	362	19.5	1.8	[15.4, 23.6]
	High	767	33.1	2.2	[29.8, 36.5]
Cyprus	Low	99	16.2	1.8	[8.9, 23.4]
	Med	376	20.9	1.1	[16.8, 25.0]
	High	635	31.9	1.7	[28.2, 35.5]
Czech Rep.	Low	15	15.1	4.5	[-3.0, 33.2]
	Med	734	21.6	1.4	[18.6, 24.5]
	High	504	35.1	1.9	[30.9, 39.2]
Hungary	Low	12	3.5	1.8	[-6.9, 14.0]
	Med	472	19.7	1.2	[16.1, 23.3]
	High	622	37.7	2.3	[33.9, 41.5]
Italy	Low	181	15.2	1.7	[10.0, 20.4]
	Med	482	26.6	1.5	[22.7, 30.6]
	High	444	31.4	2.2	[27.1, 35.8]

Table E.8

Continued

Country	SES level	*n*	Percent	*SE*	CI
	Low	29	9.7	2.2	[-1.1, 20.5]
Lithuania	Med	493	21.5	1.5	[17.9, 25.2]
	High	563	32.9	1.7	[29.0, 36.8]
	Low	436	19.0	1.0	[15.3, 22.7]
Malta	Med	362	29.8	1.4	[25.1, 34.5]
	High	385	31.1	1.9	[26.5, 35.7]
	Low	35	10.2	2.4	[0.2, 20.2]
Romania	Med	637	24.4	1.8	[21.0, 27.7]
	High	465	32.4	2.2	[28.2, 36.7]
	Low	55	13.6	2.4	[4.5, 22.7]
Slovenia	Med	335	19.7	1.3	[15.4, 23.9]
	High	639	32.3	1.7	[28.7, 35.9]
	Low	521	17.4	1.4	[14.1, 20.6]
Turkey	Med	344	33.9	2.9	[28.9, 39.0]
	High	351	55.9	3.2	[50.7, 61.1]

APPENDIX F

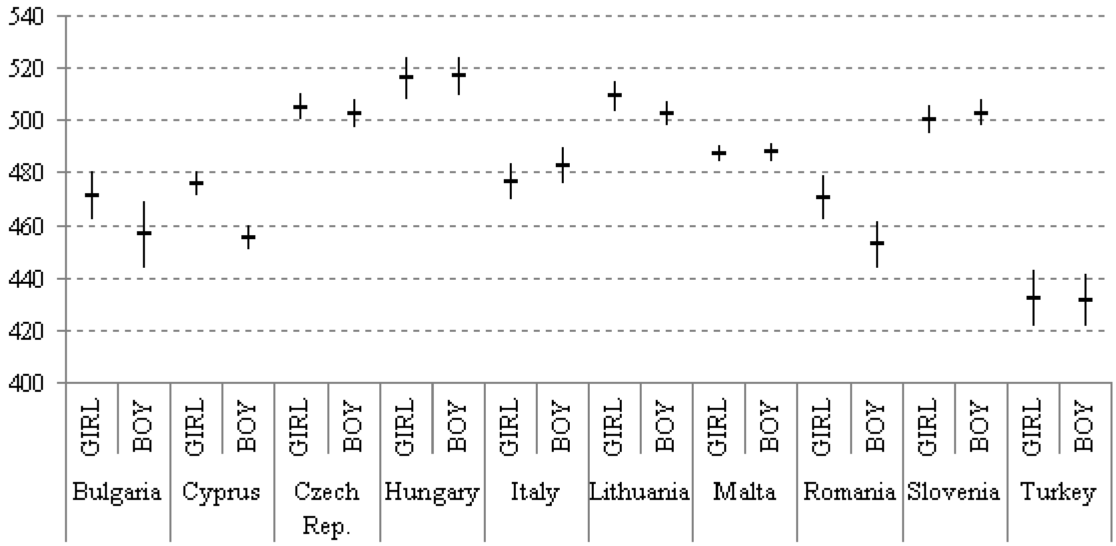

Figure F.1. 95% CIs around means for achievement differences between boys and girls in mathematics in each sample country.

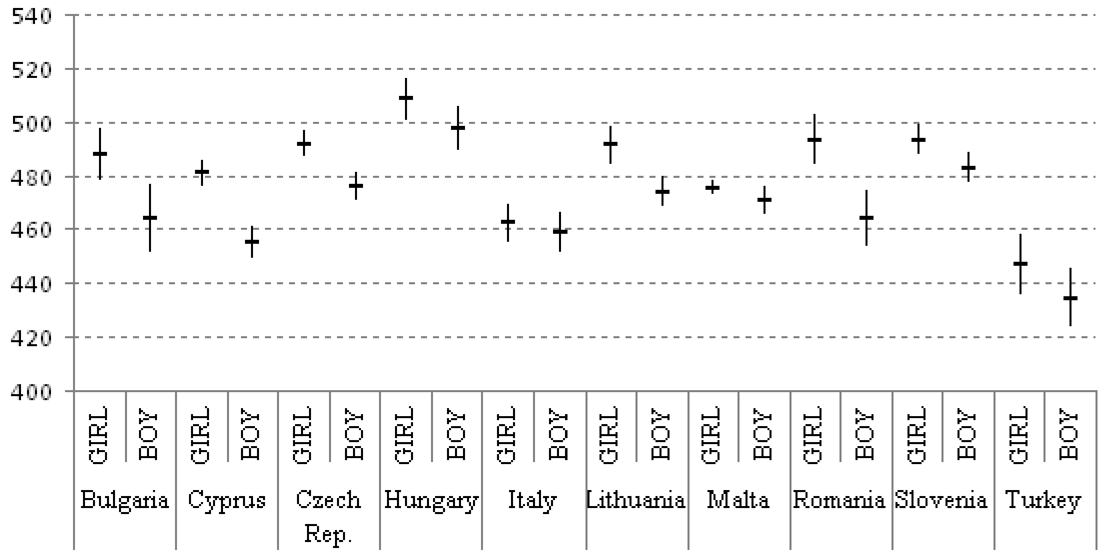

Figure F.2. 95% CIs around means for achievement differences between boys and girls in algebra in each sample country.

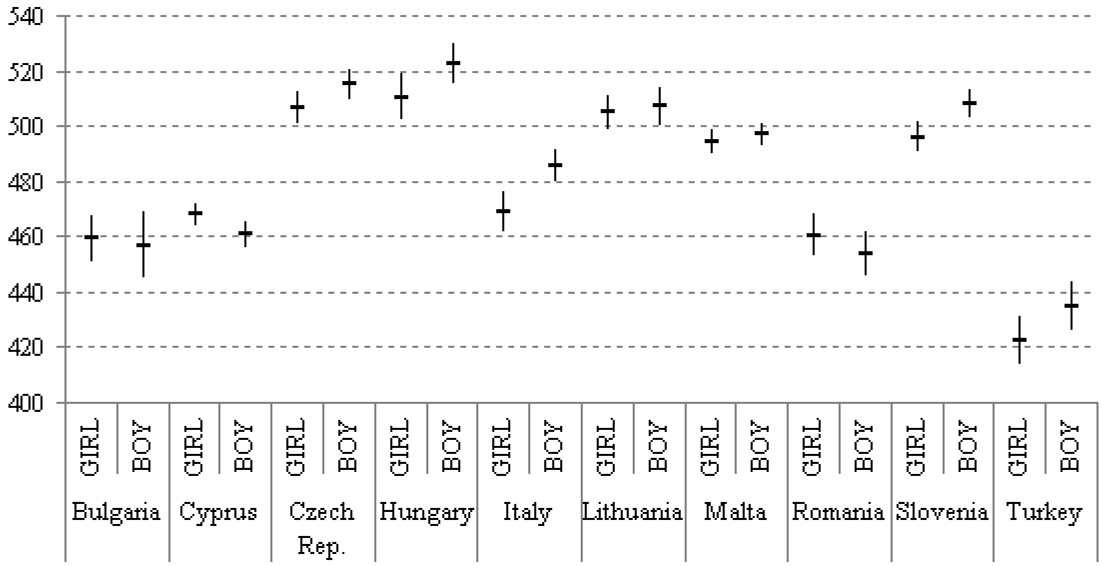

Figure F.3. 95% CIs around means for achievement differences between boys and girls in number in each sample country.

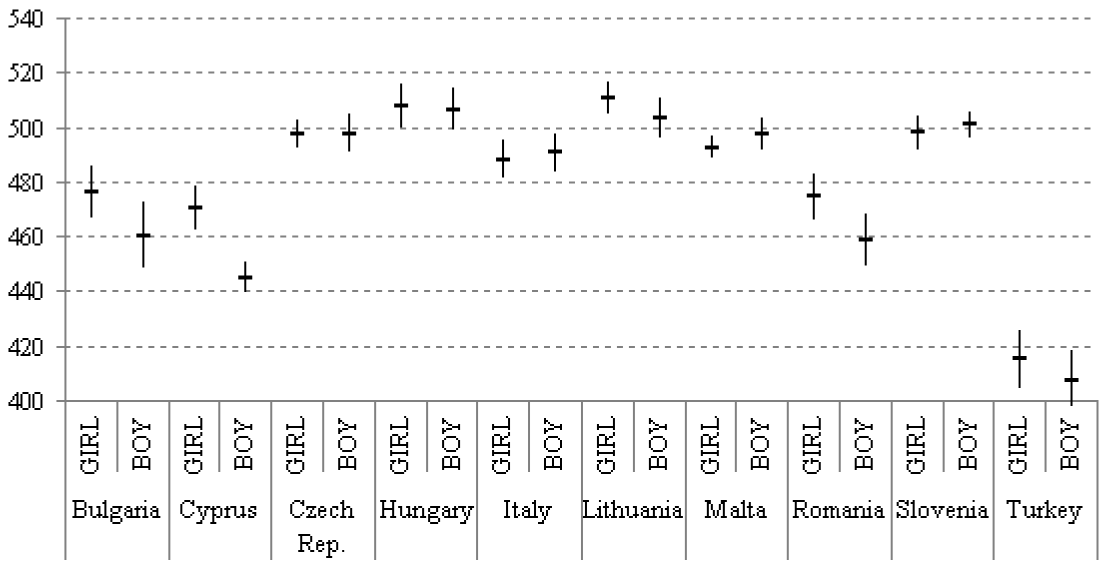

Figure F.4. 95% CIs around means for achievement differences between boys and girls in geometry in each sample country.

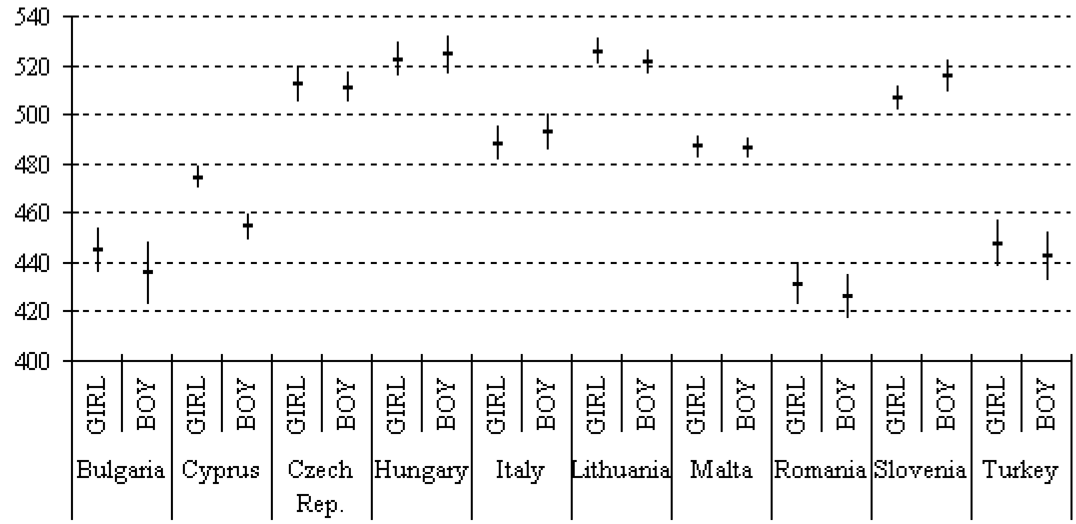

Figure F.5. 95% CIs around means for achievement differences between boys and girls in data-and-chance in each sample country.

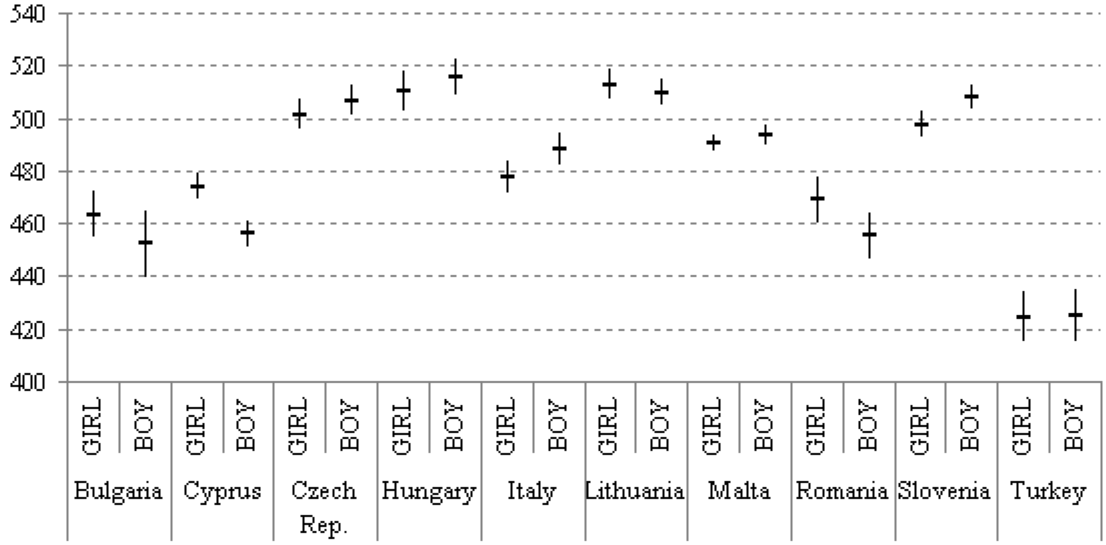

Figure F.6. 95% CIs around means for achievement differences between boys and girls in knowing in each sample country.

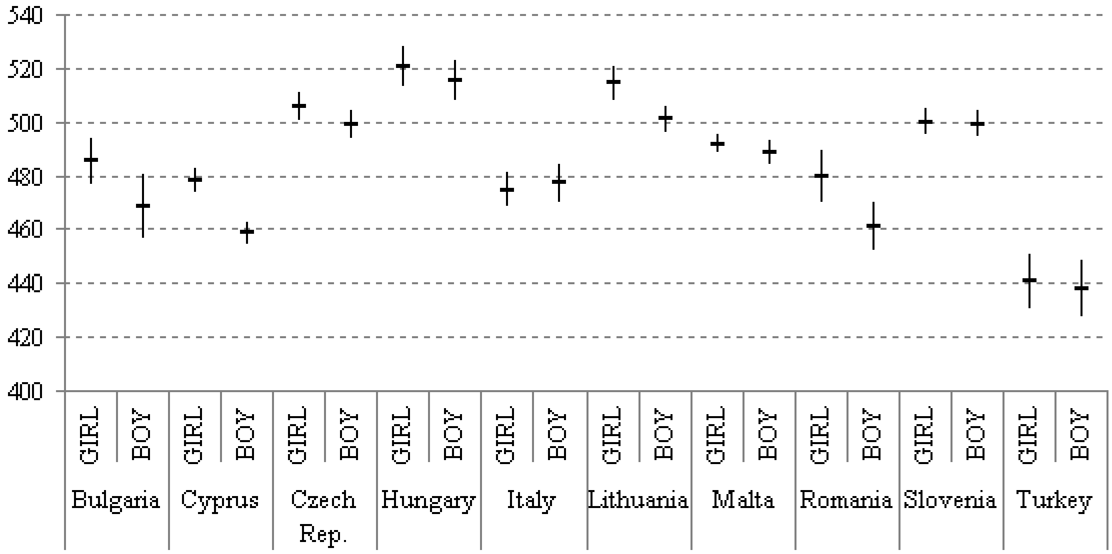

Figure F.7. 95% CIs around means for achievement differences between boys and girls in applying in each sample country.

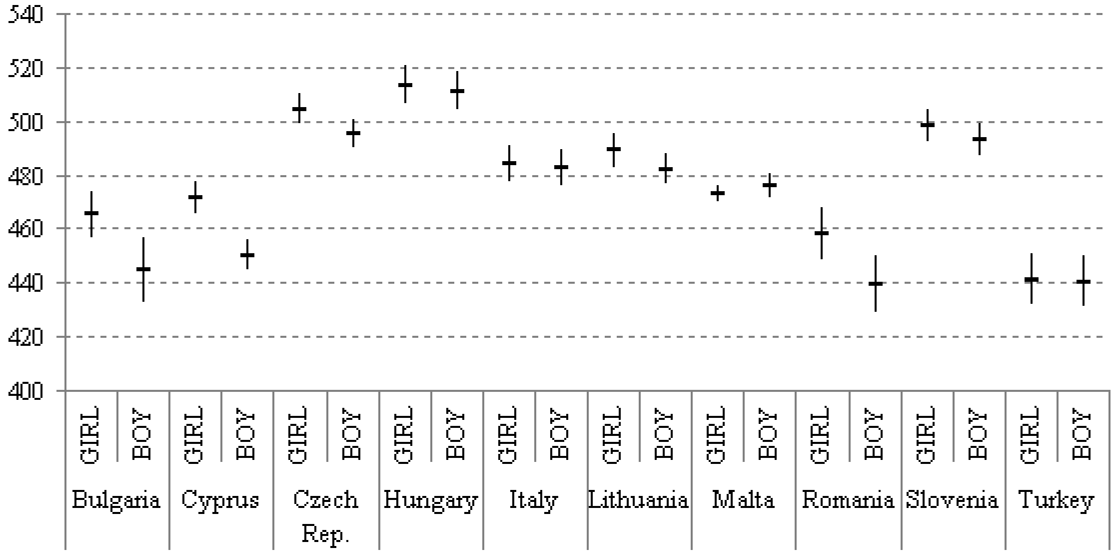

Figure F.8. 95% CIs around means for achievement differences between boys and girls in reasoning in each sample country.

Table F.1

Cohen's d Effect Sizes and 95% CIs Around Means for Achievement Differences Between Boys and Girls in Algebra in Each Sample Country

Country	Gender	*n*	Mean	*SD*	95% CI	Cohen's *d*
Bulgaria	Girl	2045	487.7	102.1	[477.93, 497.57]	-0.23
	Boy	1974	464.1	107.6	[451.72, 476.55]	
Cyprus	Girl	2196	480.8	79.0	[476.02, 485.64]	-0.31
	Boy	2203	455.0	87.5	[449.27, 460.71]	
Czech Republic	Girl	2335	492.0	71.3	[486.95, 496.98]	-0.22
	Boy	2510	475.9	75.2	[470.60, 481.25]	
Hungary	Girl	2051	508.6	81.2	[500.86, 516.28]	-0.13
	Boy	2060	497.3	86.4	[489.10, 505.49]	
Italy	Girl	2114	462.2	78.3	[455.09, 469.35]	-0.04
	Boy	2294	458.8	80.7	[451.71, 465.97]	
Lithuania	Girl	2016	491.4	84.8	[484.41, 498.34]	-0.20
	Boy	1975	473.8	89.6	[468.16, 479.46]	
Malta	Girl	2374	475.5	78.1	[472.61, 478.46]	-0.06
	Boy	2296	470.7	85.4	[465.56, 475.77]	
Romania	Girl	2094	493.4	99.3	[484.18, 502.58]	-0.28
	Boy	2104	463.8	108.3	[453.48, 474.16]	
Slovenia	Girl	2022	493.4	72.3	[487.80, 499.02]	-0.14
	Boy	2021	482.7	77.1	[477.10, 488.27]	
Turkey	Girl	2093	446.8	112.2	[435.42, 458.23]	-0.11
	Boy	2405	434.5	116.9	[423.52, 445.47]	

Table F.2

Cohen's d Effect Sizes and 95% CIs Around Means for Achievement Differences Between Boys and Girls in Number in Each Sample Country

Country	Gender	*n*	Mean	*SD*	95% CI	Cohen's *d*
Bulgaria	Girl	2045	459.1	94.7	[450.46, 467.79]	-0.02
	Boy	1974	456.7	100.9	[444.89, 468.58]	
Cyprus	Girl	2196	467.9	84.6	[463.63, 472.09]	-0.08
	Boy	2203	460.7	92.9	[455.92, 465.46]	
Czech Republic	Girl	2335	506.7	78.8	[501.15, 512.31]	0.11
	Boy	2510	515.1	78.3	[509.80, 520.37]	
Hungary	Girl	2051	510.4	86.8	[501.96, 518.93]	0.14
	Boy	2060	522.5	88.4	[515.23, 529.76]	
Italy	Girl	2114	469.0	73.9	[461.99, 475.91]	0.22
	Boy	2294	485.4	76.5	[479.50, 491.40]	
Lithuania	Girl	2016	504.8	78.9	[498.87, 510.80]	0.03
	Boy	1975	507.2	81.2	[500.33, 514.01]	
Malta	Girl	2374	494.3	91.8	[490.15, 498.48]	0.03
	Boy	2296	497.0	101.0	[493.19, 500.91]	
Romania	Girl	2094	460.6	91.5	[452.63, 468.48]	-0.07
	Boy	2104	453.5	95.7	[445.47, 461.60]	
Slovenia	Girl	2022	496.0	72.6	[490.50, 501.58]	0.16
	Boy	2021	508.1	79.4	[503.03, 513.13]	
Turkey	Girl	2093	422.6	99.2	[414.14, 431.07]	0.12
	Boy	2405	434.9	103.6	[426.04, 443.76]	

Table F.3

Cohen's d Effect Sizes and 95% CIs Around Means for Achievement Differences Between Boys and Girls in Geometry in Each Sample Country

Country	Gender	*n*	Mean	*SD*	95% CI	Cohen's *d*
Bulgaria	Girl	2045	476.2	94.3	[466.38, 486.05]	-0.16
	Boy	1974	460.2	101.8	[448.19, 472.30]	
Cyprus	Girl	2196	470.3	91.6	[462.53, 478.06]	-0.26
	Boy	2203	445.0	99.7	[439.39, 450.65]	
Czech Republic	Girl	2335	497.4	75.5	[492.11, 502.76]	0.00
	Boy	2510	497.8	77.5	[491.12, 504.47]	
Hungary	Girl	2051	508.0	85.3	[499.98, 516.09]	-0.02
	Boy	2060	506.5	89.8	[498.66, 514.32]	
Italy	Girl	2114	488.3	76.7	[481.45, 495.19]	0.03
	Boy	2294	490.8	79.8	[483.72, 497.82]	
Lithuania	Girl	2016	510.5	78.2	[504.66, 516.29]	-0.09
	Boy	1975	503.4	81.0	[496.05, 510.77]	
Malta	Girl	2374	492.6	83.6	[488.55, 496.66]	0.05
	Boy	2296	497.3	91.0	[491.60, 503.01]	
Romania	Girl	2094	474.5	94.8	[465.94, 483.12]	-0.16
	Boy	2104	458.6	100.1	[448.95, 468.24]	
Slovenia	Girl	2022	497.9	68.3	[491.84, 503.91]	0.05
	Boy	2021	501.0	71.9	[496.20, 505.89]	
Turkey	Girl	2093	415.2	111.4	[404.47, 426.01]	-0.07
	Boy	2405	407.5	114.3	[396.97, 418.02]	

Table F.4

Cohen's d Effect Sizes and 95% CIs Around Means for Achievement Differences Between Boys and Girls in Data-and-Chance in Each Sample Country

Country	Gender	*n*	Mean	*SD*	95% CI	Cohen's *d*
Bulgaria	Girl	2045	444.8	106.7	[435.77, 453.84]	-0.08
	Boy	1974	435.6	114.3	[423.07, 448.14]	
Cyprus	Girl	2196	474.5	84.3	[469.79, 479.11]	-0.23
	Boy	2203	454.1	95.7	[449.19, 459.07]	
Czech Republic	Girl	2335	512.3	80.5	[505.18, 519.38]	-0.01
	Boy	2510	511.1	81.9	[505.12, 517.06]	
Hungary	Girl	2051	522.3	79.1	[515.34, 529.20]	0.03
	Boy	2060	524.4	86.1	[516.77, 532.06]	
Italy	Girl	2114	488.2	82.2	[481.51, 494.96]	0.05
	Boy	2294	492.8	84.9	[485.55, 500.04]	
Lithuania	Girl	2016	525.5	77.6	[520.27, 530.64]	-0.05
	Boy	1975	521.3	82.3	[516.29, 526.39]	
Malta	Girl	2374	487.0	96.5	[482.47, 491.48]	-0.01
	Boy	2296	486.2	108.1	[482.44, 490.04]	
Romania	Girl	2094	431.3	97.2	[422.94, 439.65]	-0.05
	Boy	2104	426.3	101.5	[417.45, 435.19]	
Slovenia	Girl	2022	506.5	71.0	[501.61, 511.41]	0.12
	Boy	2021	515.4	76.8	[508.83, 522.05]	
Turkey	Girl	2093	447.6	95.7	[438.30, 456.81]	-0.05
	Boy	2405	442.4	100.9	[432.89, 452.01]	

Table F.5

Cohen's d Effect Sizes and 95% CIs Around Means for Achievement Differences Between Boys and Girls in Knowing in Each Sample Country

Country	Gender	*n*	Mean	*SD*	95% CI	Cohen's *d*
Bulgaria	Girl	2045	463.5	98.9	[454.77, 472.18]	-0.11
	Boy	1974	452.3	108.2	[439.91, 464.63]	
Cyprus	Girl	2196	474.2	88.1	[469.01, 479.32]	-0.20
	Boy	2203	456.0	96.4	[451.09, 460.82]	
Czech Republic	Girl	2335	501.5	74.4	[496.04, 507.04]	0.07
	Boy	2510	506.9	76.6	[500.97, 512.81]	
Hungary	Girl	2051	510.1	83.2	[502.41, 517.75]	0.07
	Boy	2060	515.8	84.6	[509.13, 522.54]	
Italy	Girl	2114	477.3	72.6	[471.14, 483.42]	0.15
	Boy	2294	488.3	75.4	[481.92, 494.64]	
Lithuania	Girl	2016	513.0	76.4	[507.22, 518.74]	-0.04
	Boy	1975	509.8	78.8	[504.75, 514.87]	
Malta	Girl	2374	490.5	88.4	[487.58, 493.42]	0.03
	Boy	2296	493.4	96.9	[489.69, 497.13]	
Romania	Girl	2094	469.1	94.0	[460.37, 477.85]	-0.14
	Boy	2104	455.2	98.9	[446.47, 463.95]	
Slovenia	Girl	2022	497.7	67.1	[493.13, 502.34]	0.15
	Boy	2021	508.3	72.6	[503.58, 512.97]	
Turkey	Girl	2093	424.7	105.9	[415.16, 434.21]	0.00
	Boy	2405	425.1	108.1	[415.47, 434.79]	

Table F.6

Cohen's d Effect Sizes and 95% CIs Around Means for Achievement Differences Between Boys and Girls in Applying in Each Sample Country

Country	Gender	*n*	Mean	*SD*	95% CI	Cohen's *d*
Bulgaria	Girl	2045	485.5	93.8	[476.99, 494.00]	-0.17
	Boy	1974	468.4	101.7	[456.75, 480.15]	
Cyprus	Girl	2196	478.4	72.5	[474.03, 482.82]	-0.26
	Boy	2203	458.5	81.9	[454.11, 462.82]	
Czech Republic	Girl	2335	505.9	67.5	[500.49, 511.23]	-0.10
	Boy	2510	499.2	68.8	[493.83, 504.55]	
Hungary	Girl	2051	520.4	79.2	[512.92, 527.83]	-0.06
	Boy	2060	515.6	81.1	[508.32, 522.82]	
Italy	Girl	2114	474.8	70.3	[468.20, 481.41]	0.03
	Boy	2294	477.2	72.5	[470.34, 484.04]	
Lithuania	Girl	2016	514.3	78.4	[508.02, 520.66]	-0.17
	Boy	1975	500.9	81.7	[496.22, 505.65]	
Malta	Girl	2374	491.7	82.2	[488.25, 495.13]	-0.04
	Boy	2296	488.6	90.1	[484.23, 492.89]	
Romania	Girl	2094	479.7	97.1	[470.21, 489.21]	-0.19
	Boy	2104	460.7	102.2	[451.80, 469.64]	
Slovenia	Girl	2022	500.1	66.1	[495.16, 505.03]	-0.01
	Boy	2021	499.4	70.8	[494.22, 504.50]	
Turkey	Girl	2093	440.7	107.6	[430.58, 450.73]	-0.02
	Boy	2405	438.0	109.7	[427.63, 448.38]	

Table F.7

Cohen's d Effect Sizes and 95% CIs Around Means for Achievement Differences Between Boys and Girls in Reasoning in Each Sample Country

Country	Gender	*n*	Mean	*SD*	95% CI	Cohen's *d*
Bulgaria	Girl	2045	465.4	103.7	[456.77, 474.07]	-0.19
	Boy	1974	444.6	112.8	[432.68, 456.50]	
Cyprus	Girl	2196	471.6	93.0	[465.43, 477.72]	-0.22
	Boy	2203	450.1	101.3	[444.40, 455.80]	
Czech Republic	Girl	2335	504.6	75.6	[498.90, 510.31]	-0.12
	Boy	2510	495.3	78.6	[489.80, 500.85]	
Hungary	Girl	2051	513.5	86.2	[506.19, 520.78]	-0.03
	Boy	2060	511.2	90.5	[503.95, 518.40]	
Italy	Girl	2114	484.3	78.9	[477.63, 490.88]	-0.02
	Boy	2294	482.7	81.2	[476.06, 489.38]	
Lithuania	Girl	2016	489.3	83.5	[482.92, 495.62]	-0.08
	Boy	1975	482.3	85.7	[476.92, 487.66]	
Malta	Girl	2374	473.1	85.5	[470.07, 476.13]	0.03
	Boy	2296	476.0	90.9	[471.69, 480.27]	
Romania	Girl	2094	457.8	109.6	[448.10, 467.48]	-0.16
	Boy	2104	439.7	117.5	[429.10, 450.24]	
Slovenia	Girl	2022	498.5	77.7	[492.44, 504.57]	-0.07
	Boy	2021	493.1	80.6	[487.44, 498.70]	
Turkey	Girl	2093	441.2	105.9	[431.98, 450.43]	-0.01
	Boy	2405	440.3	108.2	[431.01, 449.58]	

APPENDIX G

Table G.1

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

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	150	416.6	103.4	[388.8, 444.3]	-0.02
	Boy	197	414.4	104.1	[390.9, 437.9]	
Cyprus	Girl	313	438.9	88.7	[429.5, 448.2]	-0.38
	Boy	311	403.8	94.6	[391.8, 415.7]	
Czech Rep.	Girl	48	456.0	70.5	[426.6, 485.3]	0.12
	Boy	58	464.3	65.8	[439.4, 489.2]	
Hungary	Girl	162	424.8	71.1	[409.6, 439.9]	0.28
	Boy	107	444.9	73.2	[424.2, 465.6]	
Italy	Girl	607	446.3	78.0	[435.4, 457.2]	0.06
	Boy	634	450.7	76.3	[440.9, 460.5]	
Lithuania	Girl	116	450.9	74.4	[436.4, 465.5]	-0.12
	Boy	139	441.5	76.8	[423.1, 460.0]	
Malta	Girl	1180	468.8	89.8	[463.4, 474.2]	-0.03
	Boy	1061	466.4	93.9	[459.3, 473.4]	
Romania	Girl	169	422.1	86.5	[400.6, 443.6]	-0.24
	Boy	182	400.0	97.7	[380.9, 419.2]	
Slovenia	Girl	203	461.1	66.2	[447.5, 474.8]	0.15
	Boy	210	471.8	72.0	[457.9, 485.6]	
Turkey	Girl	1333	405.2	95.8	[394.1, 416.3]	0.01
	Boy	1603	405.7	99.2	[397.2, 414.2]	

Table G.2

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Medium-SES Students in Mathematics in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	863	455.3	95.8	[443.7, 466.9]	-0.21
	Boy	742	434.9	101.5	[419.3, 450.5]	
Cyprus	Girl	908	465.6	80.4	[459.2, 472.1]	-0.21
	Boy	895	447.6	88.7	[440.1, 455.0]	
Czech Rep.	Girl	1624	497.6	68.1	[492.7, 502.5]	-0.05
	Boy	1691	494.4	71.6	[488.6, 500.2]	
Hungary	Girl	1160	510.3	73.8	[502.9, 517.6]	-0.10
	Boy	1139	502.8	77.6	[495.6, 510.1]	
Italy	Girl	912	485.8	68.6	[479.1, 492.6]	0.08
	Boy	893	491.2	73.8	[484.2, 498.2]	
Lithuania	Girl	1130	501.6	72.6	[494.3, 508.9]	-0.09
	Boy	1002	495.1	75.6	[488.3, 501.9]	
Malta	Girl	583	503.0	78.2	[495.2, 510.8]	0.02
	Boy	619	504.7	92.5	[496.7, 512.6]	
Romania	Girl	1301	472.5	91.7	[463.5, 481.4]	-0.24
	Boy	1238	449.9	98.9	[439.1, 460.7]	
Slovenia	Girl	866	491.1	63.1	[485.5, 496.8]	0.02
	Boy	778	492.7	68.2	[484.9, 500.5]	
Turkey	Girl	487	465.0	99.8	[452.8, 477.1]	0.03
	Boy	492	468.3	99.2	[455.2, 481.3]	

Table G.3

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

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	1032	501.6	86.0	[490.7, 512.5]	-0.13
	Boy	1034	489.3	100.0	[475.8, 502.9]	
Cyprus	Girl	975	496.3	79.1	[490.3, 502.3]	-0.22
	Boy	997	477.8	90.0	[471.8, 483.8]	
Czech Rep.	Girl	663	528.3	78.5	[519.5, 537.0]	-0.05
	Boy	761	524.8	76.2	[516.6, 532.9]	
Hungary	Girl	730	553.2	79.0	[543.1, 563.3]	-0.03
	Boy	813	550.9	87.1	[539.3, 562.5]	
Italy	Girl	595	493.6	70.5	[486.8, 500.4]	0.09
	Boy	767	500.1	74.7	[490.6, 509.5]	
Lithuania	Girl	770	531.8	78.7	[518.1, 545.4]	-0.09
	Boy	834	524.2	81.3	[512.3, 536.2]	
Malta	Girl	611	509.1	84.7	[500.6, 517.6]	-0.01
	Boy	616	507.8	94.7	[496.4, 519.3]	
Romania	Girl	624	487.4	100.1	[470.6, 504.2]	-0.07
	Boy	684	480.4	104.4	[465.8, 495.1]	
Slovenia	Girl	954	518.3	70.2	[511.0, 525.6]	-0.01
	Boy	1033	517.3	74.9	[510.5, 524.1]	
Turkey	Girl	273	527.5	109.2	[509.2, 545.7]	0.02
	Boy	310	529.5	122.7	[509.7, 549.2]	

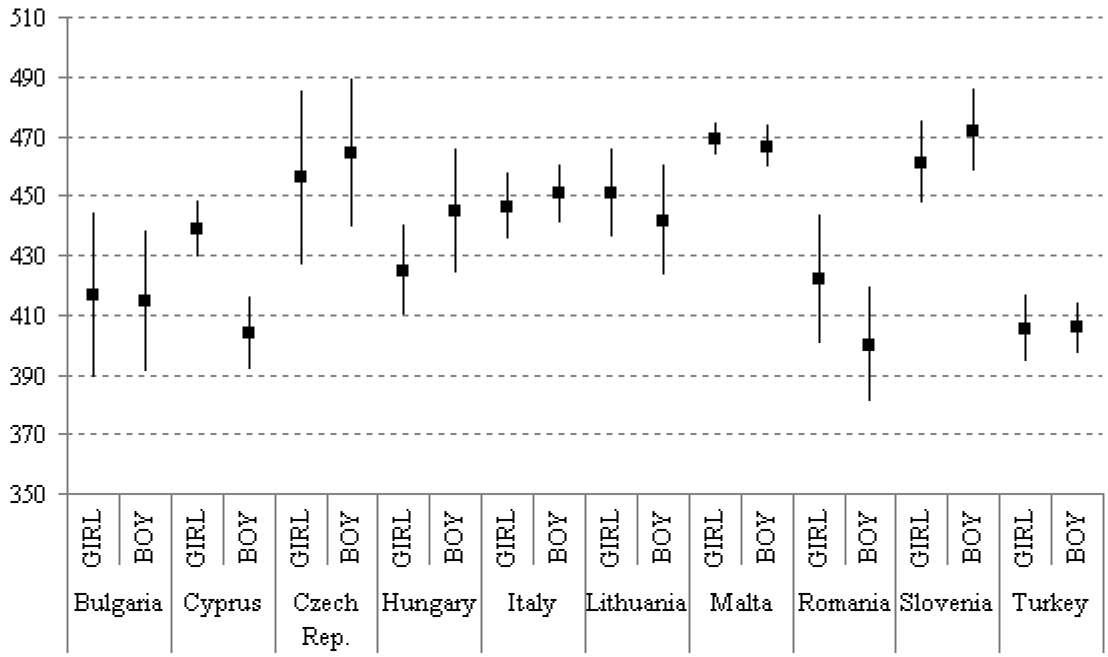

Figure G.1. 95% CIs around means for gender-based achievement differences among low-SES students in mathematics in each sample country.

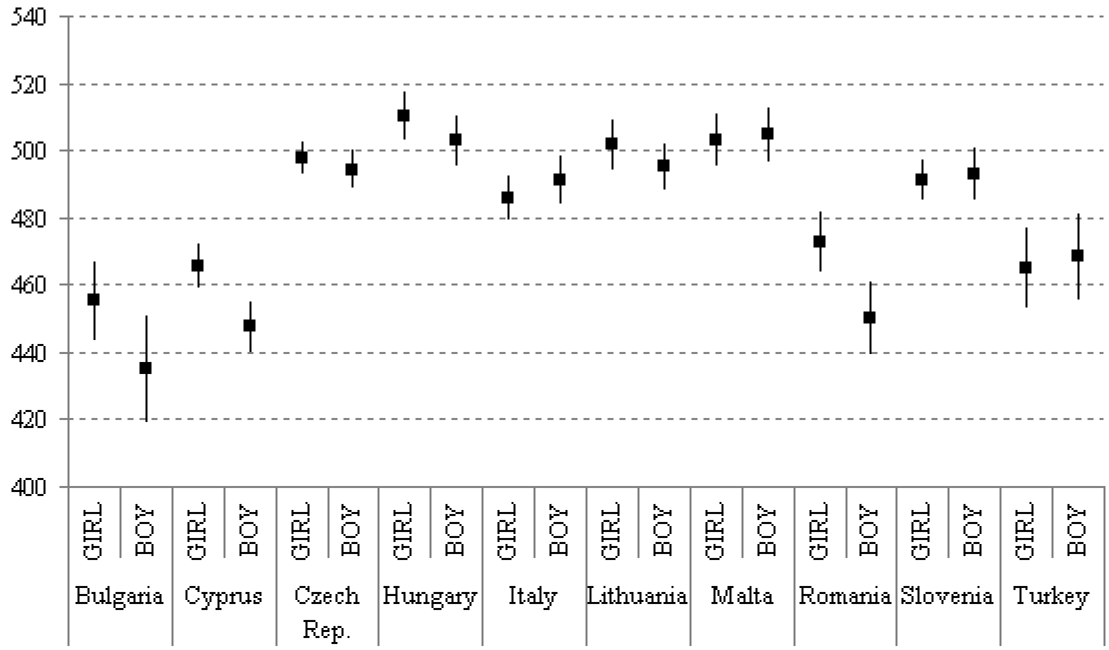

Figure G.2. 95% CIs around means for gender-based achievement differences among medium-SES students in mathematics in each sample country.

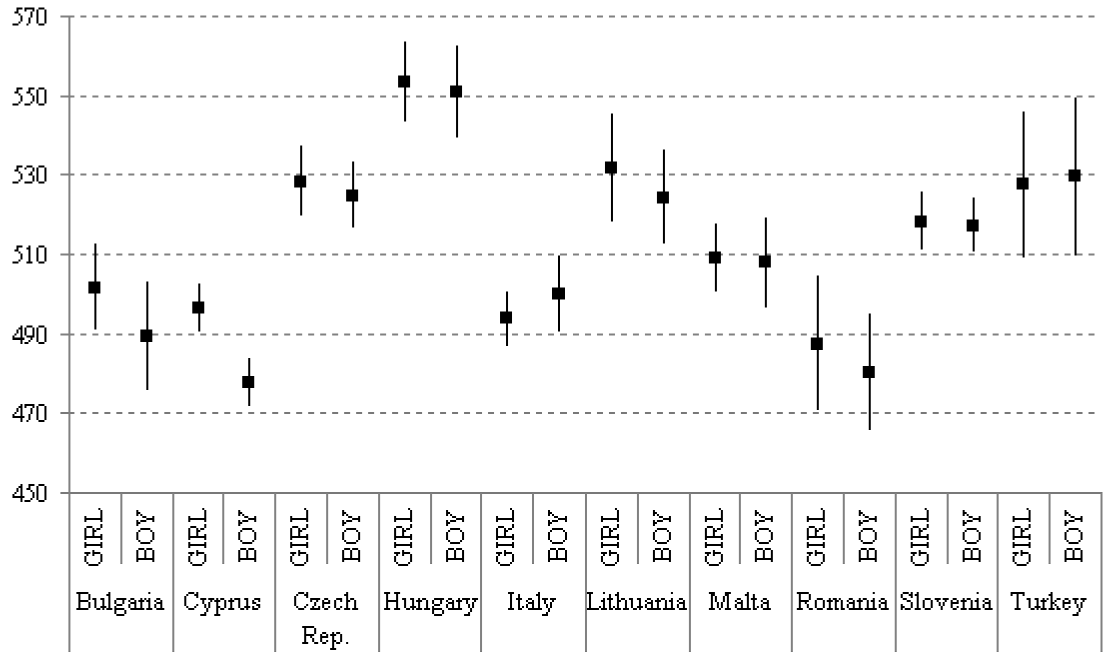

Figure G.3. 95% CIs around means for gender-based achievement differences among high-SES students in mathematics in each sample country.

Table G.4

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Low-SES Students in Algebra in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	150	442.3	112.2	[409.6, 474.9]	-0.04
	Boy	197	437.7	102.8	[415.4, 460.1]	
Cyprus	Girl	313	451.6	85.8	[440.3, 463.0]	-0.43
	Boy	311	413.7	91.4	[398.5, 428.9]	
Czech Rep.	Girl	48	453.4	70.3	[418.2, 488.6]	-0.16
	Boy	58	441.2	79.4	[417.9, 464.4]	
Hungary	Girl	162	421.2	68.4	[404.7, 437.7]	0.06
	Boy	107	425.7	81.1	[399.8, 451.7]	
Italy	Girl	607	435.8	82.5	[422.7, 449.0]	-0.08
	Boy	634	429.5	79.6	[417.4, 441.5]	
Lithuania	Girl	116	430.9	81.7	[411.2, 450.5]	-0.23
	Boy	139	411.3	90.1	[386.1, 436.5]	
Malta	Girl	1180	459.4	78.8	[454.8, 464.0]	-0.08
	Boy	1061	452.7	82.7	[444.9, 460.5]	
Romania	Girl	169	450.1	94.3	[423.7, 476.6]	-0.32
	Boy	182	419.1	97.8	[400.2, 438.0]	
Slovenia	Girl	203	459.3	66.6	[444.7, 474.0]	-0.05
	Boy	210	455.6	76.1	[439.6, 471.6]	
Turkey	Girl	1333	418.8	101.4	[406.8, 430.8]	-0.11
	Boy	1603	407.9	103.6	[398.6, 417.3]	

Table G.5

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Medium-SES Students in Algebra in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	863	469.3	99.7	[457.2, 481.5]	-0.30
	Boy	742	438.8	103.9	[422.8, 454.8]	
Cyprus	Girl	908	473.9	76.7	[466.9, 480.9]	-0.31
	Boy	895	449.2	83.9	[441.7, 456.7]	
Czech Rep.	Girl	1624	485.3	66.9	[480.4, 490.2]	-0.24
	Boy	1691	468.4	71.5	[462.5, 474.3]	
Hungary	Girl	1160	503.4	73.7	[495.8, 511.0]	-0.25
	Boy	1139	484.2	78.4	[476.4, 492.0]	
Italy	Girl	912	469.5	73.3	[462.0, 477.0]	-0.04
	Boy	893	466.3	78.0	[459.3, 473.4]	
Lithuania	Girl	1130	484.7	79.7	[475.9, 493.5]	-0.22
	Boy	1002	467.0	83.9	[458.9, 475.2]	
Malta	Girl	583	489.8	70.8	[482.8, 496.7]	-0.08
	Boy	619	483.9	84.1	[475.5, 492.2]	
Romania	Girl	1301	493.7	95.1	[482.9, 504.5]	-0.34
	Boy	1238	459.4	106.3	[447.0, 471.8]	
Slovenia	Girl	866	482.3	68.0	[475.6, 488.9]	-0.16
	Boy	778	471.0	73.2	[463.5, 478.5]	
Turkey	Girl	487	479.7	102.1	[467.1, 492.2]	-0.08
	Boy	492	471.5	109.2	[455.1, 487.9]	

Table G.6

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among High-SES Students in Algebra in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	1032	519.4	92.4	[507.6, 531.3]	-0.23
	Boy	1034	496.7	103.5	[483.4, 510.1]	
Cyprus	Girl	975	496.2	75.3	[489.0, 503.4]	-0.29
	Boy	997	472.8	84.2	[465.4, 480.2]	
Czech Rep.	Girl	663	512.4	77.6	[503.4, 521.3]	-0.21
	Boy	761	496.2	78.8	[487.0, 505.4]	
Hungary	Girl	730	543.3	76.5	[533.5, 553.0]	-0.17
	Boy	813	529.6	86.6	[517.7, 541.5]	
Italy	Girl	595	478.4	74.4	[470.4, 486.4]	-0.04
	Boy	767	475.7	78.0	[466.2, 485.2]	
Lithuania	Girl	770	512.9	85.8	[498.6, 527.2]	-0.20
	Boy	834	495.0	89.3	[483.5, 506.6]	
Malta	Girl	611	493.9	76.5	[485.2, 502.7]	-0.06
	Boy	616	488.9	84.8	[476.9, 500.9]	
Romania	Girl	624	512.1	105.0	[496.0, 528.1]	-0.18
	Boy	684	492.5	108.5	[476.1, 508.9]	
Slovenia	Girl	954	512.2	72.5	[504.9, 519.4]	-0.19
	Boy	1033	497.8	77.0	[490.3, 505.3]	
Turkey	Girl	273	548.6	115.8	[526.5, 570.7]	-0.10
	Boy	310	536.3	133.7	[512.0, 560.6]	

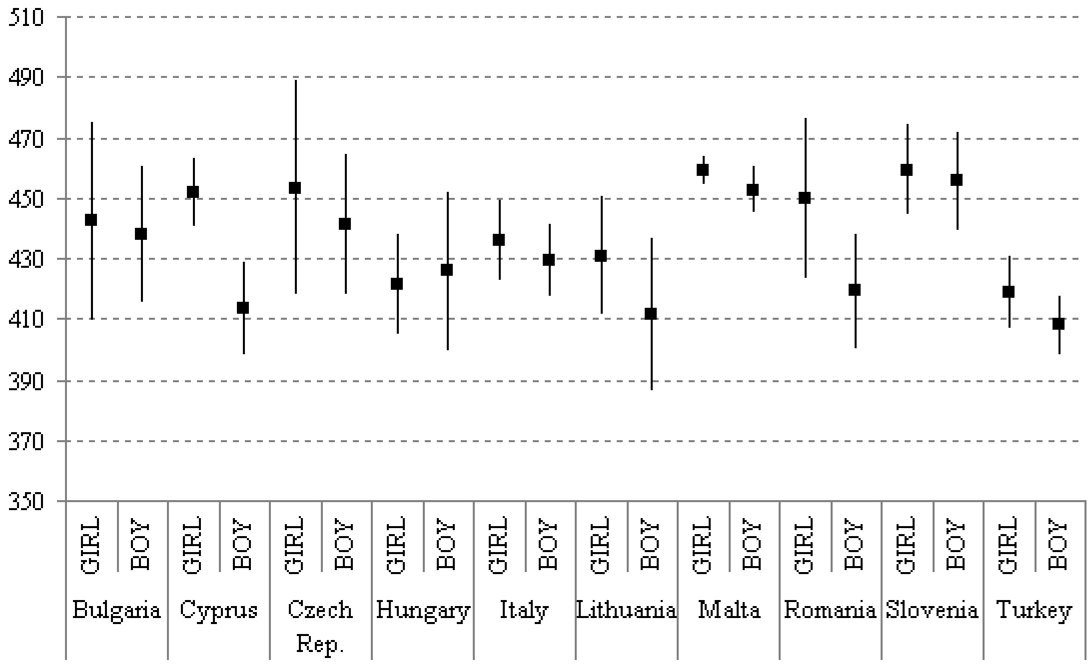

Figure G.4. 95% CIs around means for gender-based achievement differences among low-SES students in algebra in each sample country.

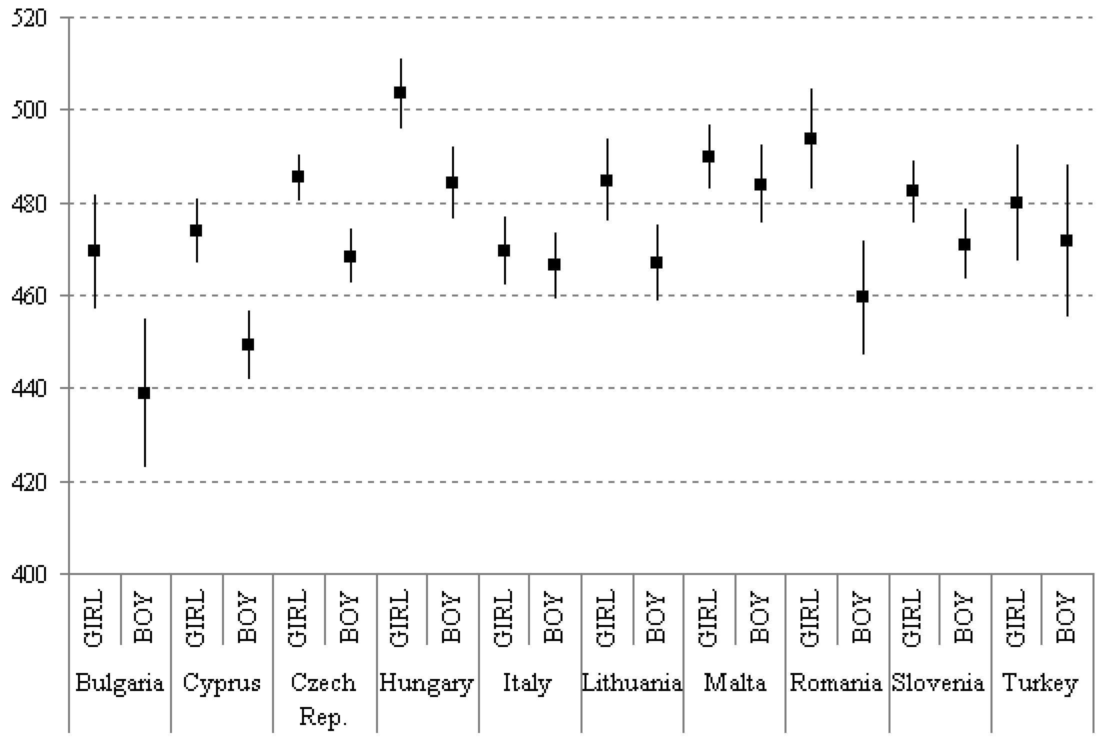

Figure G.5. 95% CIs around means for gender-based achievement differences among medium-SES students in algebra in each sample country.

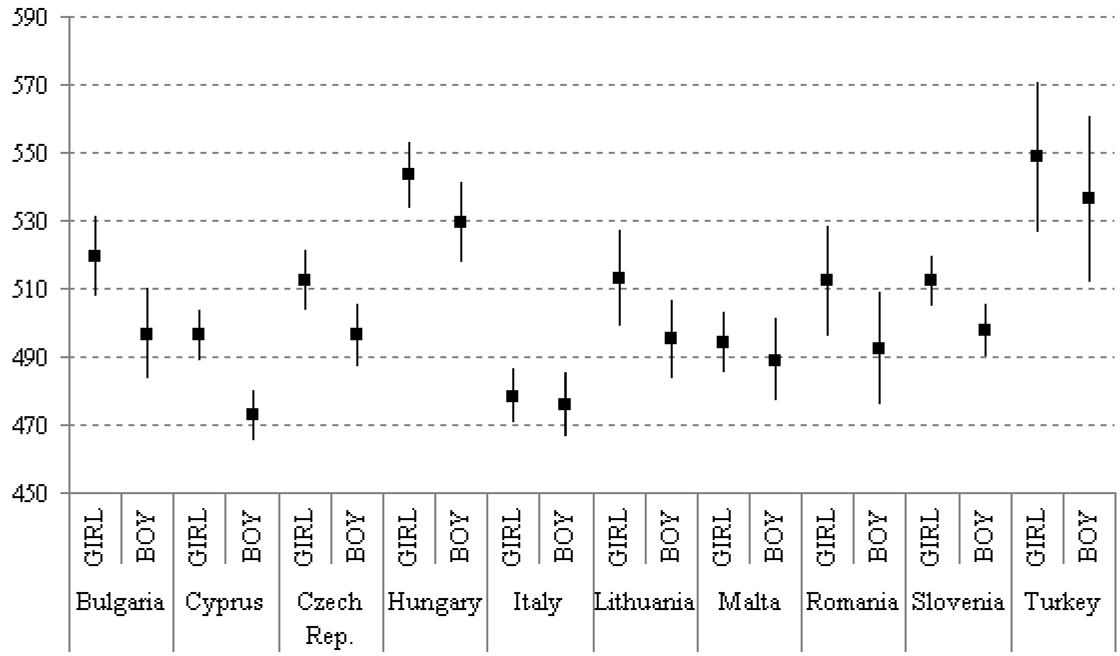

Figure G.6. 95% CIs around means for gender-based achievement differences among high-SES students in algebra in each sample country.

Table G.7

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Low-SES Students in Number in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	150	398.6	98.1	[371.9, 425.4]	0.18
	Boy	197	416.0	96.9	[394.0, 438.1]	
Cyprus	Girl	313	431.7	85.6	[421.0, 442.3]	-0.20
	Boy	311	414.0	92.6	[399.5, 428.4]	
Czech Rep.	Girl	48	454.1	76.8	[417.9, 490.2]	0.28
	Boy	58	474.4	69.2	[446.3, 502.6]	
Hungary	Girl	162	421.1	73.3	[402.2, 440.1]	0.39
	Boy	107	450.6	77.8	[426.9, 474.3]	
Italy	Girl	607	442.1	75.5	[429.6, 454.6]	0.20
	Boy	634	456.9	74.0	[447.7, 466.2]	
Lithuania	Girl	116	446.3	74.0	[429.1, 463.5]	0.02
	Boy	139	448.1	78.9	[427.8, 468.4]	
Malta	Girl	1180	477.6	93.6	[471.1, 484.0]	-0.01
	Boy	1061	476.4	99.1	[468.8, 483.9]	
Romania	Girl	169	416.8	83.1	[395.6, 438.0]	-0.03
	Boy	182	414.0	84.3	[393.8, 434.3]	
Slovenia	Girl	203	456.3	71.7	[440.4, 472.2]	0.23
	Boy	210	473.3	75.0	[457.0, 489.5]	
Turkey	Girl	1333	398.6	90.8	[389.2, 408.0]	0.14
	Boy	1603	411.6	94.1	[403.5, 419.7]	

Table G.8

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Medium-SES Students in Number in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	863	444.8	93.4	[433.5, 456.1]	-0.09
	Boy	742	435.7	99.1	[420.7, 450.7]	
Cyprus	Girl	908	456.6	81.9	[450.4, 462.8]	-0.05
	Boy	895	452.4	89.6	[444.6, 460.3]	
Czech Rep.	Girl	1624	499.6	74.3	[493.9, 505.3]	0.11
	Boy	1691	507.5	75.3	[501.2, 513.8]	
Hungary	Girl	1160	505.6	78.5	[496.0, 515.3]	0.05
	Boy	1139	509.6	80.0	[500.6, 518.7]	
Italy	Girl	912	477.0	68.9	[469.2, 484.8]	0.22
	Boy	893	493.1	74.4	[486.8, 499.5]	
Lithuania	Girl	1130	497.9	73.5	[491.5, 504.3]	0.02
	Boy	1002	499.3	76.4	[489.2, 509.3]	
Malta	Girl	583	509.7	84.2	[501.1, 518.4]	0.04
	Boy	619	513.7	98.5	[504.3, 523.0]	
Romania	Girl	1301	463.0	88.0	[453.2, 472.7]	-0.14
	Boy	1238	450.3	93.6	[440.3, 460.3]	
Slovenia	Girl	866	485.7	65.9	[478.5, 493.0]	0.16
	Boy	778	497.3	74.5	[490.4, 504.2]	
Turkey	Girl	487	454.0	92.2	[441.5, 466.5]	0.17
	Boy	492	469.7	95.1	[457.4, 482.0]	

Table G.9

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among High-SES Students in Number in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	1032	489.9	83.6	[479.4, 500.3]	-0.01
	Boy	1034	489.0	93.9	[476.3, 501.6]	
Cyprus	Girl	975	489.4	80.7	[483.9, 494.9]	-0.08
	Boy	997	482.3	89.2	[475.6, 489.0]	
Czech Rep.	Girl	663	529.6	84.1	[519.6, 539.7]	0.08
	Boy	761	536.0	81.3	[526.9, 545.2]	
Hungary	Girl	730	545.1	84.5	[534.0, 556.1]	0.11
	Boy	813	554.4	90.2	[543.4, 565.5]	
Italy	Girl	595	484.5	72.3	[476.9, 492.0]	0.23
	Boy	767	501.3	74.2	[492.8, 509.8]	
Lithuania	Girl	770	526.4	80.4	[512.4, 540.3]	0.04
	Boy	834	529.3	79.7	[516.8, 541.7]	
Malta	Girl	611	512.8	88.8	[503.9, 521.8]	0.04
	Boy	616	516.6	99.6	[505.4, 527.8]	
Romania	Girl	624	474.4	97.1	[458.5, 490.2]	0.03
	Boy	684	477.5	97.8	[462.9, 492.1]	
Slovenia	Girl	954	515.3	73.0	[508.4, 522.2]	0.12
	Boy	1033	524.2	80.0	[516.8, 531.6]	
Turkey	Girl	273	503.7	100.2	[488.4, 519.0]	0.15
	Boy	310	519.7	113.5	[501.2, 538.3]	

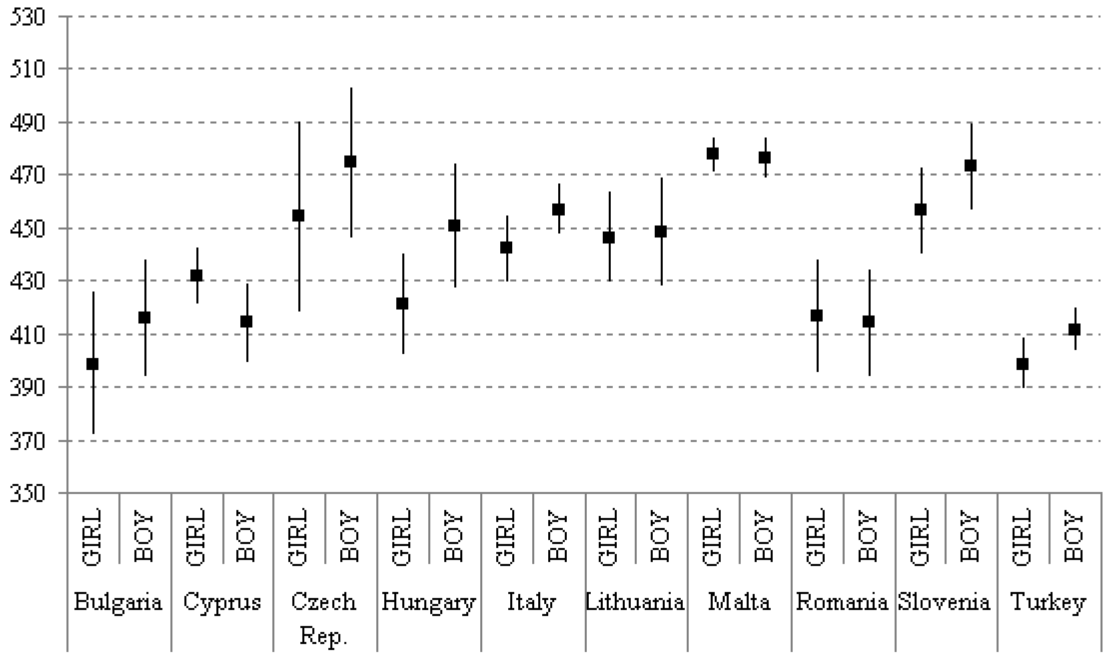

Figure G.7. 95% CIs around means for gender-based achievement differences among low-SES students in number in each sample country.

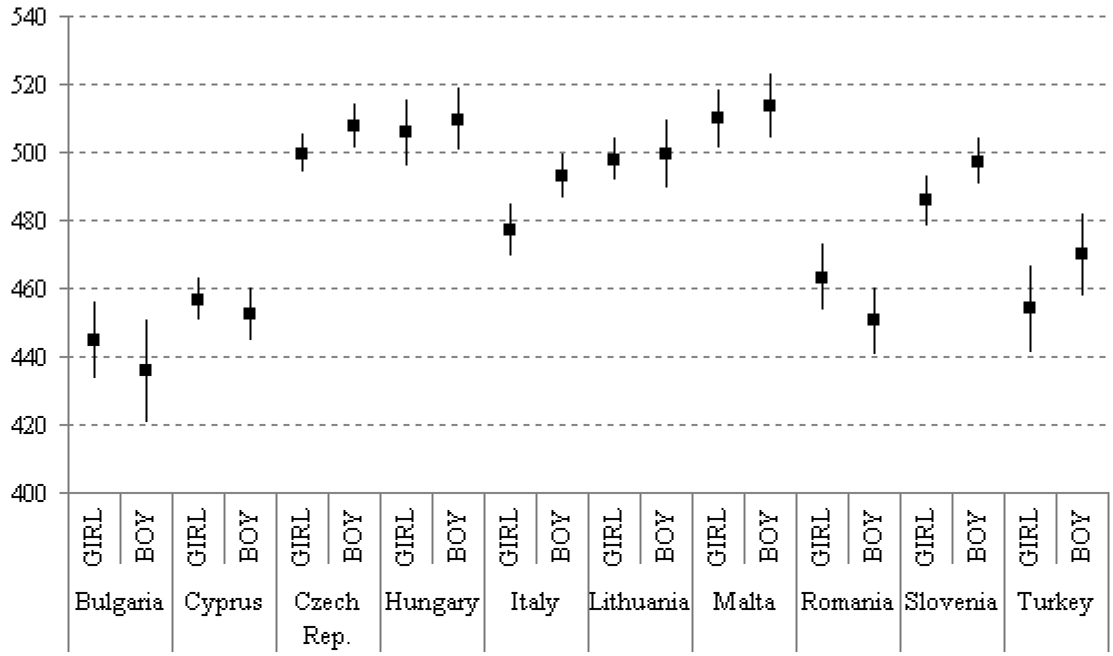

Figure G.8. 95% CIs around means for gender-based achievement differences among medium-SES students in number in each sample country.

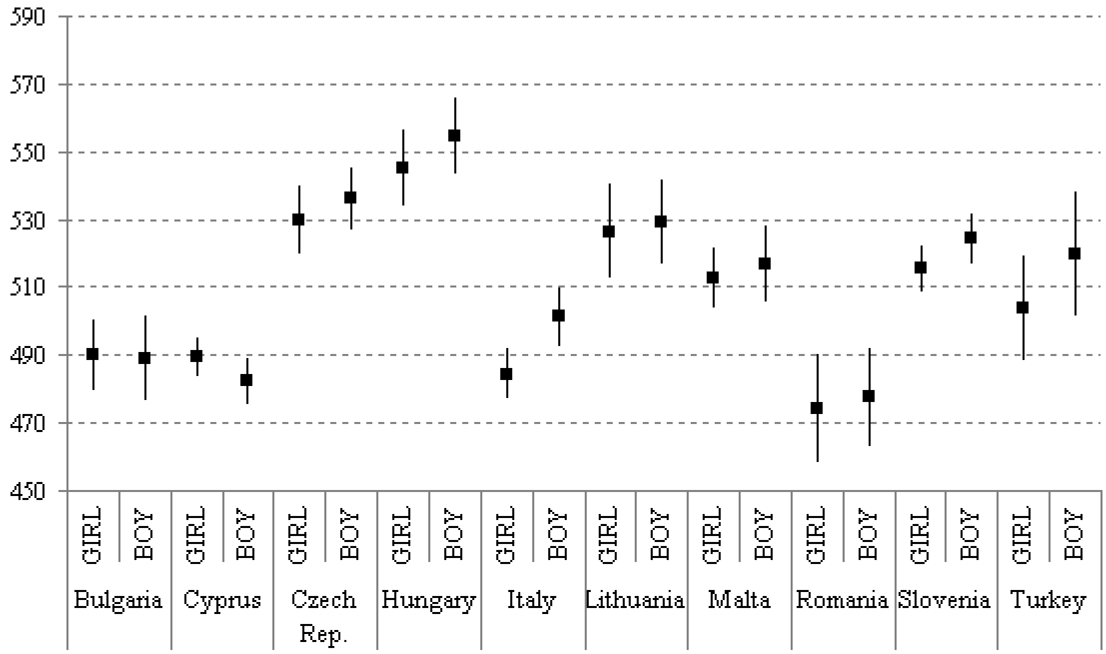

Figure G.9. 95% CIs around means for gender-based achievement differences among high-SES students in number in each sample country.

Table G.10

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Low-SES Students in Data-and-Chance in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	150	380.5	114.9	[350.8, 410.2]	0.07
	Boy	197	388.2	117.8	[358.5, 418.0]	
Cyprus	Girl	313	443.7	90.3	[430.8, 456.5]	-0.36
	Boy	311	410.3	97.2	[396.5, 424.1]	
Czech Rep.	Girl	48	462.1	80.0	[420.0, 504.1]	0.27
	Boy	58	483.2	78.0	[451.7, 514.7]	
Hungary	Girl	162	438.0	75.6	[421.6, 454.3]	0.27
	Boy	107	458.4	77.5	[437.1, 479.8]	
Italy	Girl	607	456.1	82.6	[443.7, 468.4]	0.06
	Boy	634	461.3	83.0	[450.1, 472.5]	
Lithuania	Girl	116	485.4	76.9	[468.2, 502.6]	-0.17
	Boy	139	472.5	77.5	[455.0, 490.1]	
Malta	Girl	1180	467.9	98.0	[461.2, 474.7]	-0.05
	Boy	1061	462.5	105.7	[454.4, 470.6]	
Romania	Girl	169	392.1	89.1	[373.0, 411.2]	-0.13
	Boy	182	379.8	93.9	[360.1, 399.5]	
Slovenia	Girl	203	471.1	68.3	[456.2, 486.0]	0.23
	Boy	210	487.9	75.3	[472.3, 503.4]	
Turkey	Girl	1333	425.8	89.6	[416.0, 435.7]	-0.06
	Boy	1603	420.5	93.2	[411.4, 429.6]	

Table G.11

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Medium-SES Students in Data-and-Chance in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	863	437.0	106.0	[426.1, 447.9]	-0.14
	Boy	742	421.4	113.0	[405.8, 436.9]	
Cyprus	Girl	908	466.0	81.2	[460.1, 471.9]	-0.21
	Boy	895	447.3	93.3	[439.3, 455.4]	
Czech Rep.	Girl	1624	506.7	77.7	[499.4, 513.9]	-0.03
	Boy	1691	504.4	80.7	[497.2, 511.6]	
Hungary	Girl	1160	518.2	71.5	[510.9, 525.6]	-0.06
	Boy	1139	513.7	81.4	[504.5, 522.8]	
Italy	Girl	912	496.7	77.2	[489.0, 504.5]	0.06
	Boy	893	501.4	81.4	[494.0, 508.8]	
Lithuania	Girl	1130	519.4	74.7	[512.8, 526.0]	-0.03
	Boy	1002	516.9	78.7	[509.2, 524.6]	
Malta	Girl	583	499.8	87.5	[490.7, 509.0]	0.02
	Boy	619	502.2	103.7	[492.9, 511.4]	
Romania	Girl	1301	432.6	94.7	[423.0, 442.2]	-0.08
	Boy	1238	425.0	99.4	[414.7, 435.4]	
Slovenia	Girl	866	501.4	66.1	[494.7, 508.2]	0.13
	Boy	778	510.2	72.2	[500.5, 519.8]	
Turkey	Girl	487	475.4	86.6	[460.4, 490.5]	0.03
	Boy	492	477.9	91.4	[465.2, 490.6]	

Table G.12

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among High-SES Students in Data-and-Chance in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	1032	469.2	97.0	[456.0, 482.3]	-0.06
	Boy	1034	462.9	107.5	[448.9, 477.0]	
Cyprus	Girl	975	491.7	81.2	[484.7, 498.8]	-0.21
	Boy	997	473.5	91.9	[466.2, 480.9]	
Czech Rep.	Girl	663	530.9	83.5	[520.2, 541.5]	-0.02
	Boy	761	528.8	81.8	[520.0, 537.6]	
Hungary	Girl	730	554.0	73.6	[544.3, 563.6]	-0.02
	Boy	813	552.1	84.6	[541.0, 563.2]	
Italy	Girl	595	508.7	79.3	[500.5, 516.8]	0.02
	Boy	767	510.1	83.0	[499.7, 520.5]	
Lithuania	Girl	770	542.3	77.9	[530.4, 554.2]	-0.07
	Boy	834	536.8	83.1	[524.7, 548.9]	
Malta	Girl	611	512.4	93.7	[502.9, 522.0]	-0.01
	Boy	616	511.8	107.5	[498.8, 524.9]	
Romania	Girl	624	445.9	101.5	[428.5, 463.3]	0.03
	Boy	684	449.0	101.5	[433.4, 464.6]	
Slovenia	Girl	954	519.7	72.7	[513.0, 526.4]	0.08
	Boy	1033	525.7	78.7	[517.3, 534.0]	
Turkey	Girl	273	521.8	95.8	[502.8, 540.7]	-0.04
	Boy	310	517.8	109.8	[498.2, 537.3]	

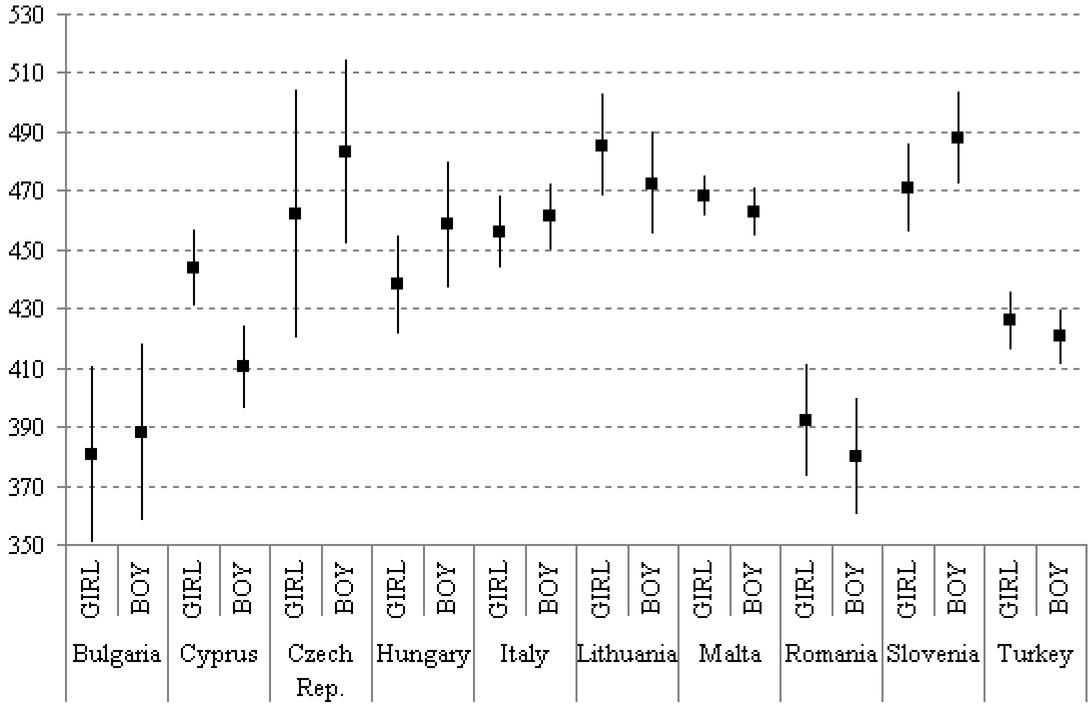

Figure G.10. 95% CIs around means for gender-based achievement differences among low-SES students in data-and-chance in each sample country.

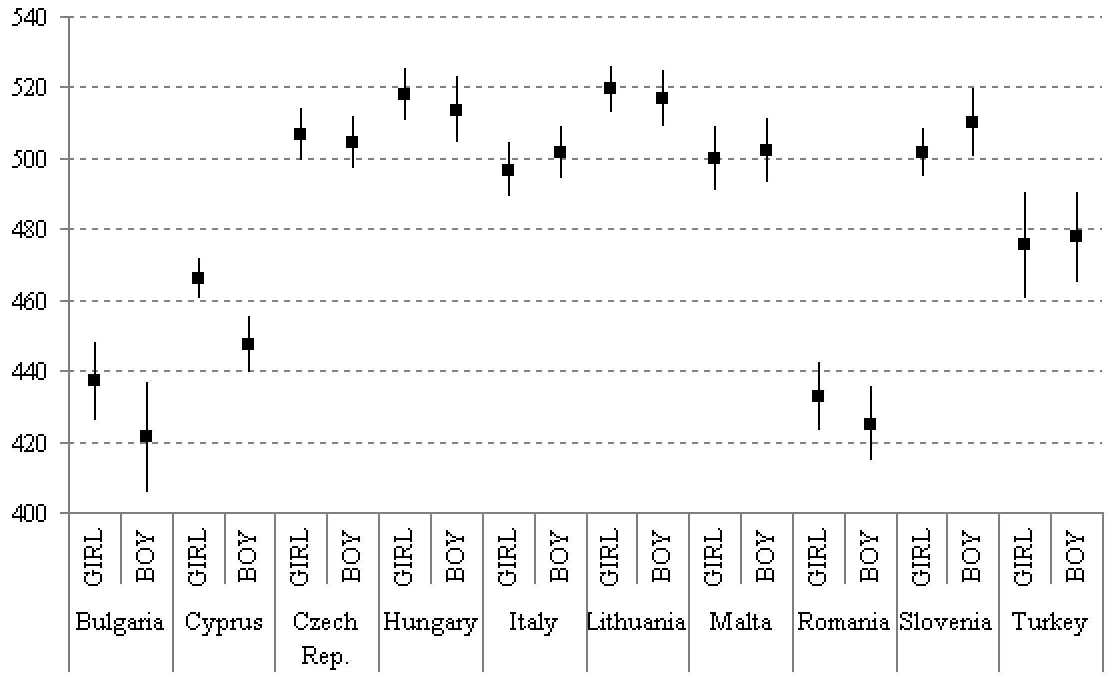

Figure G.11. 95% CIs around means for gender-based achievement differences among medium-SES students in data-and-chance in each sample country.

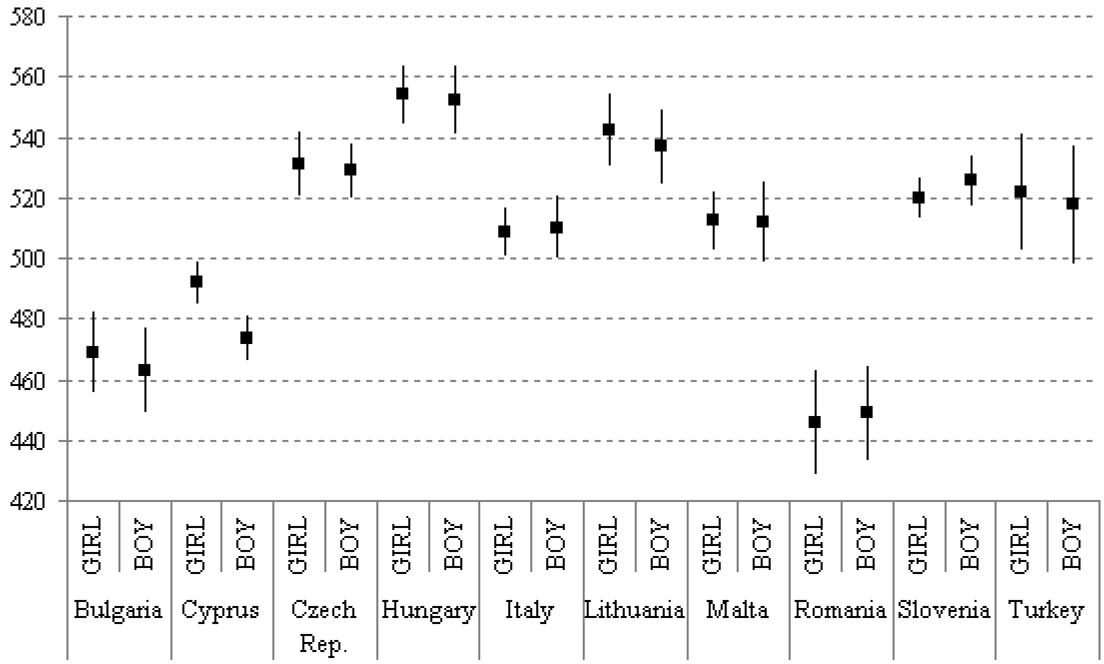

Figure G.12. 95% CIs around means for gender-based achievement differences among high-SES students in data-and-chance in each sample country.

Table G.13

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Low-SES Students in Geometry in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	150	429.5	105.6	[399.5, 459.6]	0.03
	Boy	197	432.9	101.5	[406.1, 459.7]	
Cyprus	Girl	313	429.5	98.3	[416.6, 442.3]	-0.35
	Boy	311	395.1	98.2	[380.8, 409.4]	
Czech Rep.	Girl	48	451.3	68.6	[421.2, 481.4]	0.18
	Boy	58	463.5	67.6	[437.1, 489.9]	
Hungary	Girl	162	422.9	71.0	[406.0, 439.9]	0.23
	Boy	107	440.3	79.4	[413.7, 466.8]	
Italy	Girl	607	459.1	78.1	[447.1, 471.1]	0.02
	Boy	634	460.9	78.0	[450.6, 471.2]	
Lithuania	Girl	116	451.5	70.0	[434.5, 468.5]	-0.12
	Boy	139	442.4	76.6	[419.7, 465.0]	
Malta	Girl	1180	476.0	84.7	[469.7, 482.2]	0.01
	Boy	1061	477.1	88.9	[470.1, 484.1]	
Romania	Girl	169	428.8	86.3	[408.3, 449.4]	-0.11
	Boy	182	419.0	90.4	[398.2, 439.9]	
Slovenia	Girl	203	464.4	62.7	[449.9, 478.9]	0.19
	Boy	210	476.9	70.7	[460.8, 493.1]	
Turkey	Girl	1333	389.3	101.1	[377.8, 400.8]	-0.06
	Boy	1603	382.9	101.9	[373.7, 392.2]	

Table G.14

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Medium-SES Students in Geometry in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	863	463.7	93.0	[452.8, 474.6]	-0.24
	Boy	742	440.1	100.3	[425.1, 455.1]	
Cyprus	Girl	908	459.3	87.9	[450.8, 467.8]	-0.24
	Boy	895	436.9	95.8	[428.5, 445.2]	
Czech Rep.	Girl	1624	491.1	71.2	[485.2, 496.9]	-0.01
	Boy	1691	490.2	75.4	[482.8, 497.6]	
Hungary	Girl	1160	501.2	76.7	[493.3, 509.1]	-0.12
	Boy	1139	491.5	81.3	[483.6, 499.5]	
Italy	Girl	912	498.2	71.4	[491.5, 504.9]	0.04
	Boy	893	500.9	77.1	[493.4, 508.3]	
Lithuania	Girl	1130	501.6	72.8	[494.5, 508.6]	-0.08
	Boy	1002	495.3	75.9	[487.1, 503.5]	
Malta	Girl	583	506.3	75.6	[498.4, 514.3]	0.09
	Boy	619	513.9	87.5	[504.2, 523.7]	
Romania	Girl	1301	476.8	90.1	[467.3, 486.3]	-0.22
	Boy	1238	456.0	98.2	[444.0, 468.0]	
Slovenia	Girl	866	489.6	63.2	[483.1, 496.0]	0.05
	Boy	778	493.1	68.2	[486.3, 499.9]	
Turkey	Girl	487	444.6	104.5	[429.6, 459.6]	-0.05
	Boy	492	439.7	108.5	[423.4, 455.9]	

Table G.15

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among High-SES Students in Geometry in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	1032	501.6	85.3	[489.0, 514.2]	-0.15
	Boy	1034	487.9	96.4	[474.9, 500.9]	
Cyprus	Girl	975	493.1	86.4	[482.9, 503.2]	-0.28
	Boy	997	467.5	96.7	[459.3, 475.7]	
Czech Rep.	Girl	663	517.8	81.8	[508.8, 526.8]	0.00
	Boy	761	518.1	78.9	[509.5, 526.8]	
Hungary	Girl	730	545.1	83.3	[533.9, 556.3]	-0.05
	Boy	813	540.8	91.3	[528.1, 553.4]	
Italy	Girl	595	503.6	74.8	[493.9, 513.3]	0.02
	Boy	767	504.9	77.6	[495.6, 514.3]	
Lithuania	Girl	770	535.2	79.1	[522.1, 548.3]	-0.12
	Boy	834	526.0	80.0	[513.1, 539.0]	
Malta	Girl	611	512.5	81.5	[503.3, 521.7]	0.04
	Boy	616	516.0	90.4	[502.2, 529.7]	
Romania	Girl	624	489.6	102.5	[472.6, 506.7]	-0.08
	Boy	684	481.2	101.9	[467.0, 495.5]	
Slovenia	Girl	954	513.8	69.9	[506.1, 521.4]	-0.02
	Boy	1033	512.6	72.7	[505.2, 520.0]	
Turkey	Girl	273	511.5	115.8	[492.3, 530.7]	-0.05
	Boy	310	505.1	130.6	[481.9, 528.3]	

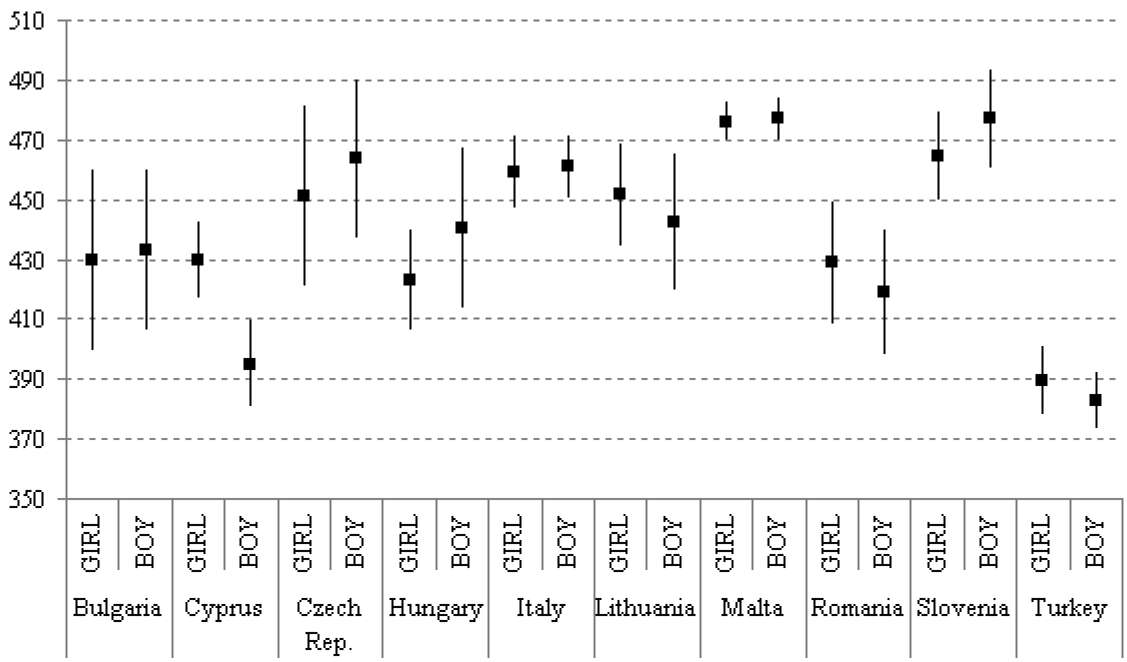

Figure G.13. 95% CIs around means for gender-based achievement differences among low-SES students in geometry in each sample country.

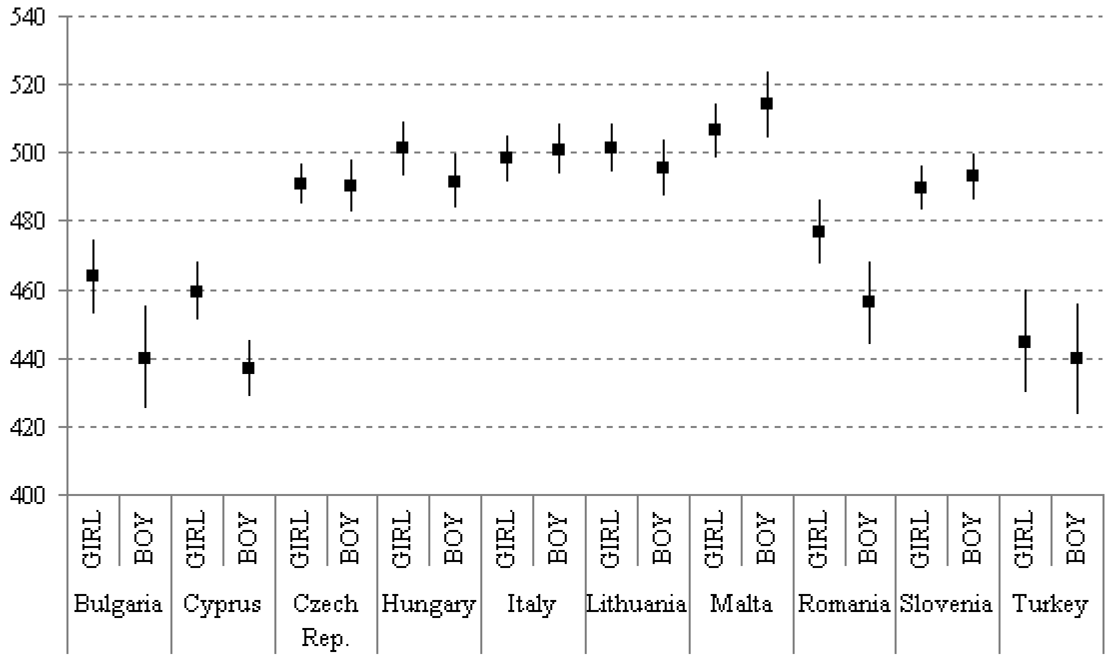

Figure G.14. 95% CIs around means for gender-based achievement differences among medium-SES students in geometry in each sample country.

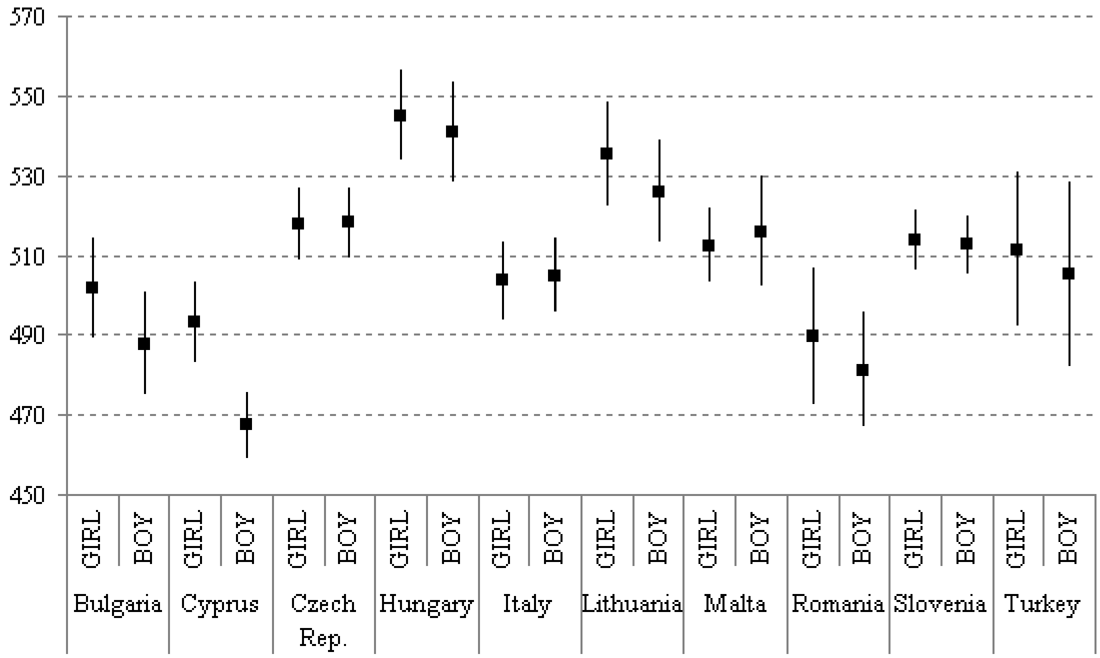

Figure G.15. 95% CIs around means for gender-based achievement differences among high-SES students in geometry in each sample country.

Table G.16

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Low-SES Students in Knowing in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	150	407.0	106.7	[378.3, 435.7]	0.04
	Boy	197	411.5	105.0	[383.9, 439.0]	
Cyprus	Girl	313	436.8	89.3	[423.2, 450.5]	-0.36
	Boy	311	403.8	94.1	[391.6, 415.9]	
Czech Rep.	Girl	48	450.3	69.0	[419.4, 481.1]	0.30
	Boy	58	470.8	69.1	[440.9, 500.6]	
Hungary	Girl	162	422.7	69.7	[407.2, 438.2]	0.36
	Boy	107	447.6	68.7	[427.4, 467.8]	
Italy	Girl	607	447.0	75.5	[436.7, 457.3]	0.15
	Boy	634	458.1	73.6	[449.1, 467.1]	
Lithuania	Girl	116	457.9	73.5	[441.8, 474.0]	-0.09
	Boy	139	451.2	70.6	[433.8, 468.5]	
Malta	Girl	1180	472.8	90.1	[467.7, 477.9]	-0.01
	Boy	1061	472.2	94.5	[464.6, 479.8]	
Romania	Girl	169	423.3	87.2	[399.5, 447.1]	-0.16
	Boy	182	408.6	91.3	[388.9, 428.4]	
Slovenia	Girl	203	460.0	63.5	[445.8, 474.1]	0.28
	Boy	210	478.7	70.3	[464.8, 492.7]	
Turkey	Girl	1333	398.2	95.8	[388.2, 408.2]	0.02
	Boy	1603	400.1	96.8	[391.3, 408.8]	

Table G.17

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Medium-SES Students in Knowing in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	863	450.6	97.7	[439.5, 461.7]	-0.20
	Boy	742	430.4	105.9	[415.1, 445.6]	
Cyprus	Girl	908	462.2	86.0	[455.1, 469.3]	-0.17
	Boy	895	446.8	92.3	[439.1, 454.5]	
Czech Rep.	Girl	1624	494.4	70.0	[489.0, 499.8]	0.06
	Boy	1691	498.9	73.7	[492.3, 505.6]	
Hungary	Girl	1160	503.8	74.5	[496.7, 511.0]	-0.03
	Boy	1139	501.5	76.8	[495.1, 508.0]	
Italy	Girl	912	487.3	66.1	[481.1, 493.6]	0.15
	Boy	893	498.0	72.1	[491.0, 505.1]	
Lithuania	Girl	1130	505.1	71.1	[498.0, 512.2]	-0.05
	Boy	1002	501.4	73.9	[494.0, 508.8]	
Malta	Girl	583	504.6	79.9	[496.8, 512.3]	0.05
	Boy	619	509.3	94.2	[501.7, 516.9]	
Romania	Girl	1301	471.2	89.8	[461.8, 480.6]	-0.19
	Boy	1238	453.5	95.2	[442.8, 464.2]	
Slovenia	Girl	866	489.0	61.4	[483.5, 494.6]	0.16
	Boy	778	499.2	68.3	[492.4, 505.9]	
Turkey	Girl	487	456.8	97.8	[444.2, 469.5]	0.03
	Boy	492	459.8	98.7	[446.8, 472.9]	

Table G.18

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among High-SES Students in Knowing in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	1032	491.6	88.9	[480.8, 502.3]	-0.06
	Boy	1034	485.4	101.6	[471.7, 499.2]	
Cyprus	Girl	975	496.7	83.3	[490.3, 503.2]	-0.19
	Boy	997	480.0	92.8	[472.5, 487.4]	
Czech Rep.	Girl	663	524.3	79.7	[514.3, 534.2]	0.05
	Boy	761	528.2	79.0	[520.1, 536.4]	
Hungary	Girl	730	546.7	79.9	[537.0, 556.5]	0.03
	Boy	813	549.4	85.2	[538.6, 560.2]	
Italy	Girl	595	493.4	69.6	[486.7, 500.0]	0.14
	Boy	767	503.1	73.2	[494.3, 512.0]	
Lithuania	Girl	770	535.4	77.4	[523.4, 547.4]	-0.04
	Boy	834	532.5	78.0	[520.6, 544.3]	
Malta	Girl	611	512.2	85.4	[503.6, 520.8]	0.03
	Boy	616	514.7	95.9	[501.3, 528.1]	
Romania	Girl	624	484.7	100.1	[468.0, 501.4]	-0.06
	Boy	684	479.0	101.7	[463.8, 494.1]	
Slovenia	Girl	954	515.0	68.0	[509.0, 521.0]	0.10
	Boy	1033	521.9	73.1	[515.1, 528.7]	
Turkey	Girl	273	518.7	107.5	[501.6, 535.9]	0.02
	Boy	310	521.6	120.2	[502.7, 540.5]	

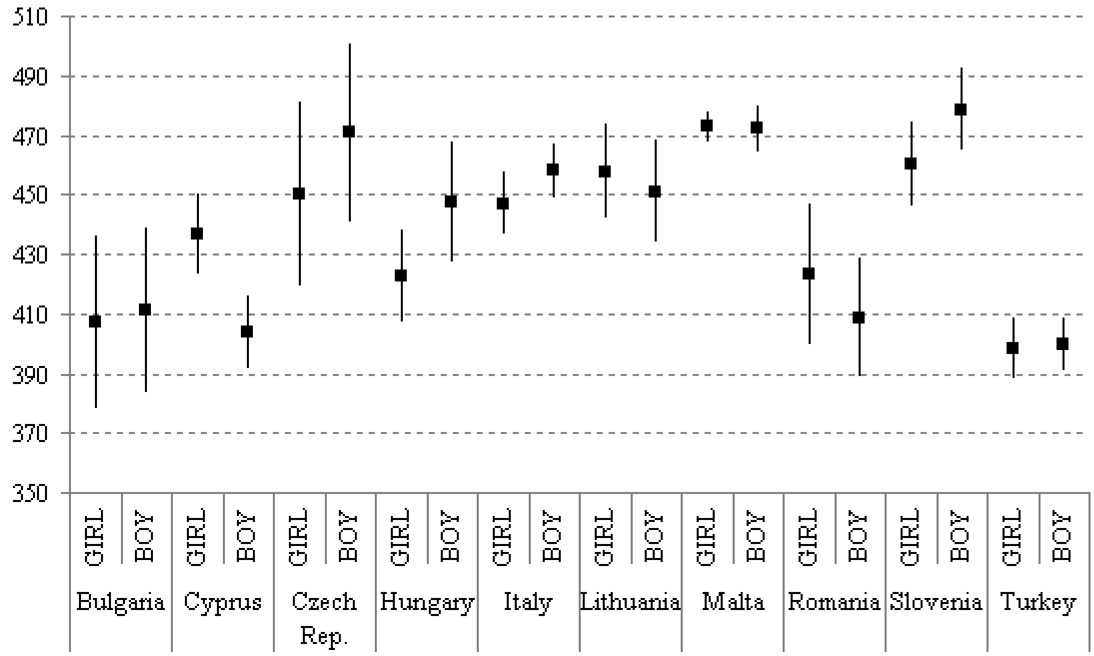

Figure G.16. 95% CIs around means for gender-based achievement differences among low-SES students in knowing in each sample country.

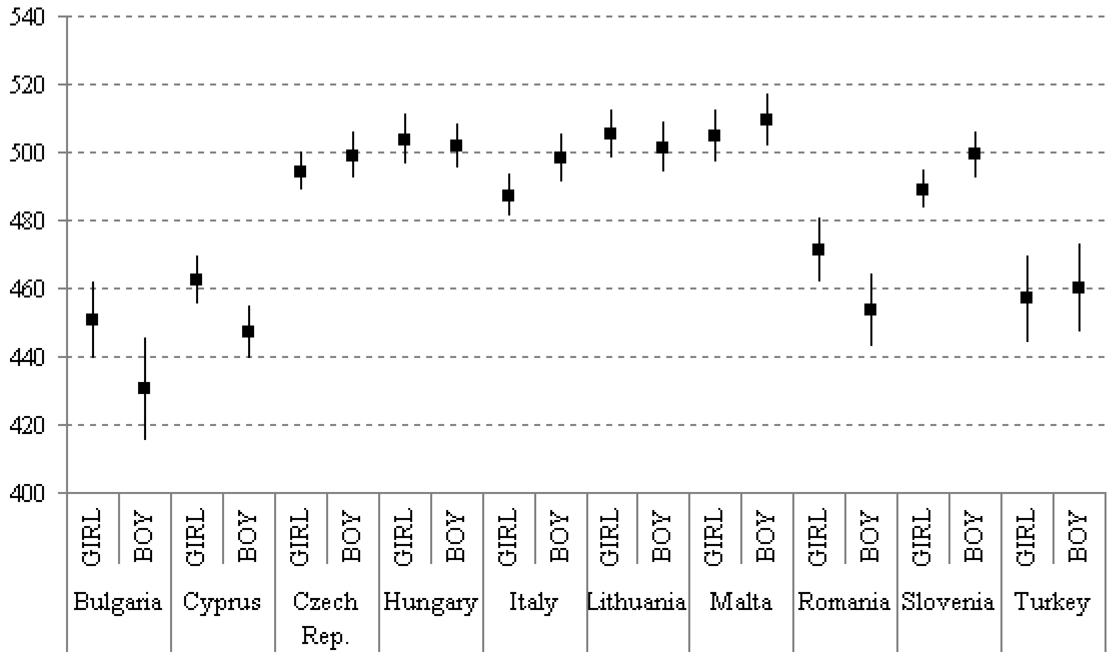

Figure G.17. 95% CIs around means for gender-based achievement differences among medium-SES students in knowing in each sample country.

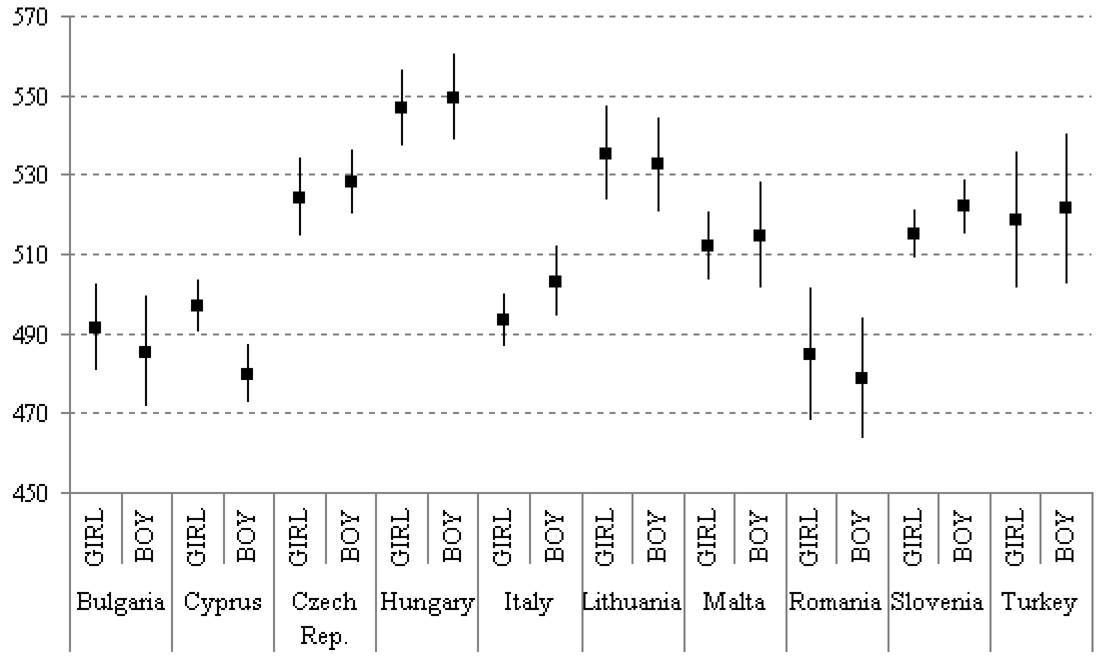

Figure G.18. 95% CIs around means for gender-based achievement differences among high-SES students in knowing in each sample country.

Table G.19

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Low-SES Students in Applying in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	150	432.6	100.1	[403.7, 461.5]	0.00
	Boy	197	432.3	95.4	[411.2, 453.4]	
Cyprus	Girl	313	446.8	75.7	[437.5, 456.1]	-0.43
	Boy	311	412.6	84.0	[400.8, 424.5]	
Czech Rep.	Girl	48	459.9	63.8	[429.6, 490.1]	0.02
	Boy	58	461.4	62.1	[436.3, 486.6]	
Hungary	Girl	162	432.5	68.3	[419.0, 446.0]	0.12
	Boy	107	440.6	68.9	[422.3, 459.0]	
Italy	Girl	607	446.1	72.5	[435.3, 456.8]	0.02
	Boy	634	447.5	70.9	[438.1, 457.0]	
Lithuania	Girl	116	456.6	74.7	[439.9, 473.3]	-0.16
	Boy	139	444.1	77.3	[423.4, 464.9]	
Malta	Girl	1180	474.1	83.8	[468.8, 479.4]	-0.06
	Boy	1061	468.6	88.7	[460.9, 476.2]	
Romania	Girl	169	434.8	92.5	[411.5, 458.2]	-0.21
	Boy	182	415.2	97.4	[393.1, 437.3]	
Slovenia	Girl	203	462.7	64.2	[448.3, 477.1]	0.08
	Boy	210	468.3	71.1	[452.6, 484.0]	
Turkey	Girl	1333	412.2	97.0	[401.9, 422.5]	-0.01
	Boy	1603	410.9	97.5	[401.8, 419.9]	

Table G.20

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Medium-SES Students in Applying in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	863	468.7	91.1	[458.4, 479.0]	-0.26
	Boy	742	444.0	99.9	[428.8, 459.2]	
Cyprus	Girl	908	470.6	69.0	[464.8, 476.5]	-0.24
	Boy	895	452.7	78.6	[445.3, 460.1]	
Czech Rep.	Girl	1624	499.7	64.0	[494.1, 505.4]	-0.12
	Boy	1691	492.1	66.2	[486.0, 498.2]	
Hungary	Girl	1160	515.8	70.3	[509.0, 522.6]	-0.18
	Boy	1139	502.5	73.9	[495.8, 509.3]	
Italy	Girl	912	482.1	64.3	[475.3, 488.9]	0.03
	Boy	893	483.8	68.6	[477.3, 490.3]	
Lithuania	Girl	1130	507.9	73.8	[499.8, 516.0]	-0.19
	Boy	1002	493.6	76.2	[487.0, 500.2]	
Malta	Girl	583	506.6	74.2	[498.8, 514.5]	-0.05
	Boy	619	502.9	87.7	[495.0, 510.7]	
Romania	Girl	1301	480.7	92.6	[470.6, 490.8]	-0.26
	Boy	1238	455.8	98.8	[445.1, 466.5]	
Slovenia	Girl	866	491.1	60.8	[485.1, 497.0]	-0.02
	Boy	778	490.0	65.5	[481.9, 498.1]	
Turkey	Girl	487	477.0	97.1	[464.6, 489.5]	0.02
	Boy	492	478.8	99.0	[464.2, 493.4]	

Table G.21

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among High-SES Students in Applying in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	1032	517.2	83.8	[507.1, 527.3]	-0.16
	Boy	1034	502.9	94.3	[490.1, 515.7]	
Cyprus	Girl	975	495.4	70.0	[488.8, 502.0]	-0.24
	Boy	997	477.6	77.4	[471.7, 483.5]	
Czech Rep.	Girl	663	525.5	71.3	[516.5, 534.5]	-0.10
	Boy	761	518.6	70.7	[511.0, 526.3]	
Hungary	Girl	730	554.2	75.9	[544.5, 563.8]	-0.08
	Boy	813	548.2	79.7	[537.2, 559.3]	
Italy	Girl	595	493.4	67.7	[486.2, 500.7]	0.03
	Boy	767	495.4	70.2	[485.5, 505.2]	
Lithuania	Girl	770	535.0	79.1	[521.3, 548.6]	-0.16
	Boy	834	521.9	82.1	[509.3, 534.5]	
Malta	Girl	611	512.3	78.6	[504.5, 520.1]	-0.04
	Boy	616	509.3	87.4	[498.5, 520.1]	
Romania	Girl	624	497.6	103.0	[480.2, 514.9]	-0.07
	Boy	684	490.8	102.2	[476.4, 505.3]	
Slovenia	Girl	954	517.6	66.0	[510.9, 524.2]	-0.06
	Boy	1033	513.5	71.2	[506.8, 520.2]	
Turkey	Girl	273	538.2	108.4	[519.6, 556.8]	-0.02
	Boy	310	536.4	121.5	[516.8, 556.0]	

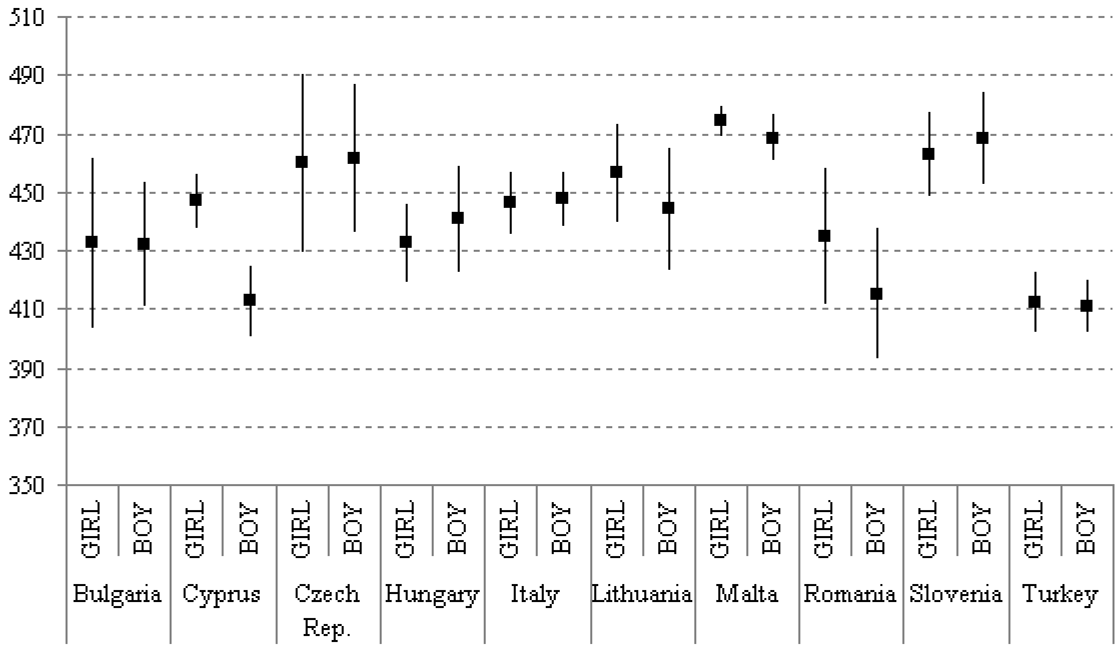

Figure G.19. 95% CIs around means for gender-based achievement differences among low-SES students in applying in each sample country.

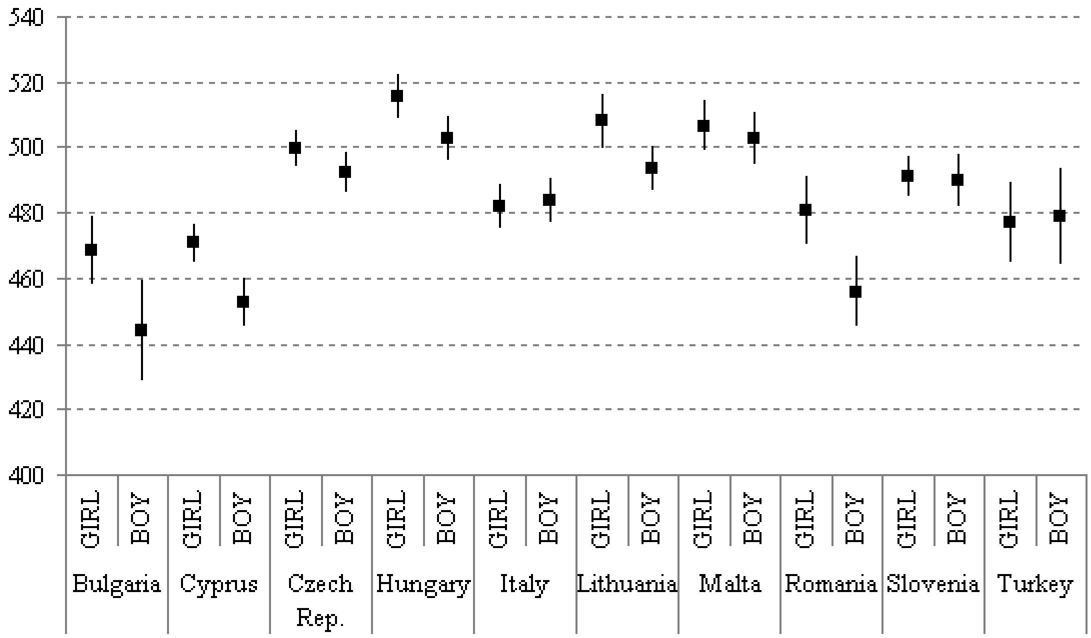

Figure G.20. 95% CIs around means for gender-based achievement differences among medium-SES students in applying in each sample country.

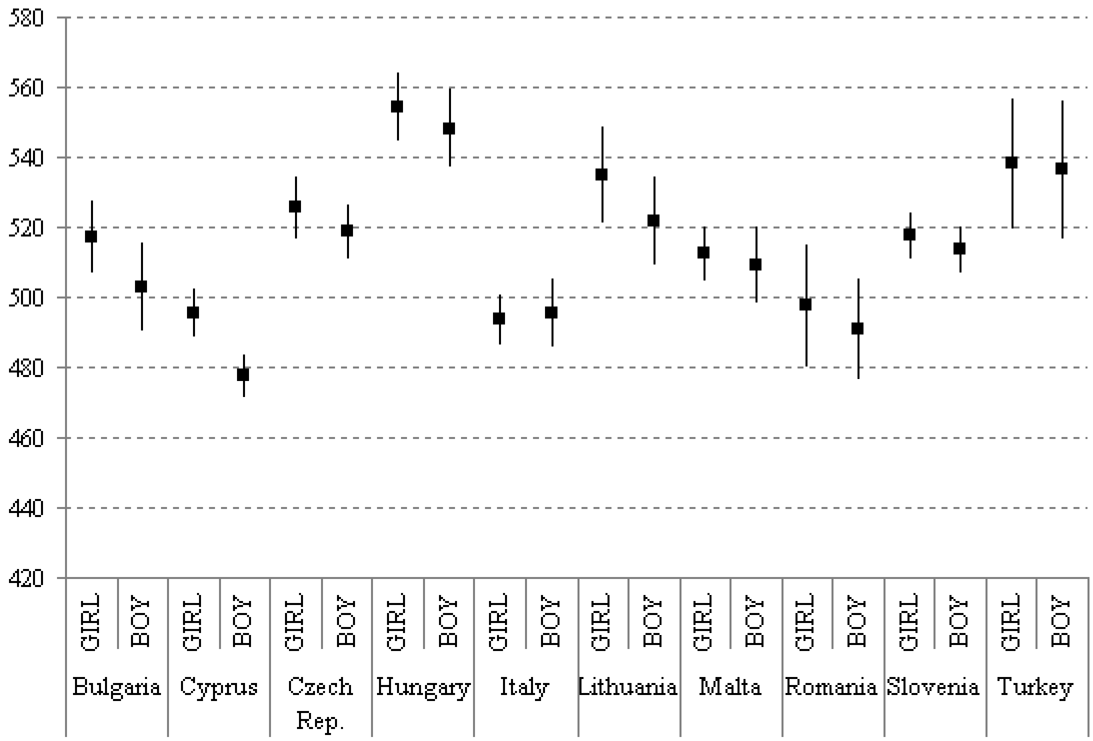

Figure G.21. 95% CIs around means for gender-based achievement differences among high-SES students in applying in each sample country.

Table G.22

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Low-SES Students in Reasoning in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	150	409.0	120.9	[377.0, 441.0]	-0.07
	Boy	197	400.9	113.2	[376.2, 425.6]	
Cyprus	Girl	313	447.4	96.4	[436.9, 458.0]	-0.39
	Boy	311	408.7	101.8	[394.6, 422.9]	
Czech Rep.	Girl	48	463.2	76.7	[430.8, 495.6]	-0.03
	Boy	58	460.8	85.9	[426.4, 495.3]	
Hungary	Girl	162	427.9	81.1	[412.2, 443.7]	0.16
	Boy	107	441.4	82.4	[415.7, 467.0]	
Italy	Girl	607	457.3	82.4	[445.5, 469.2]	-0.03
	Boy	634	454.5	79.2	[443.9, 465.1]	
Lithuania	Girl	116	446.9	75.9	[426.4, 467.4]	-0.19
	Boy	139	432.1	82.5	[409.4, 454.8]	
Malta	Girl	1180	457.2	86.2	[452.1, 462.3]	0.02
	Boy	1061	458.9	89.4	[452.7, 465.1]	
Romania	Girl	169	402.2	100.3	[372.2, 432.2]	-0.15
	Boy	182	386.2	111.2	[364.9, 407.5]	
Slovenia	Girl	203	462.1	75.1	[444.7, 479.6]	0.06
	Boy	210	466.6	79.2	[449.7, 483.5]	
Turkey	Girl	1333	419.2	98.7	[409.3, 429.0]	0.00
	Boy	1603	419.1	100.4	[409.5, 428.6]	

Table G.23

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among Medium-SES Students in Reasoning in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	863	454.2	100.6	[442.2, 466.3]	-0.28
	Boy	742	425.1	108.8	[410.4, 439.7]	
Cyprus	Girl	908	461.5	88.7	[453.5, 469.5]	-0.21
	Boy	895	442.3	97.9	[434.3, 450.2]	
Czech Rep.	Girl	1624	498.2	72.1	[492.9, 503.4]	-0.14
	Boy	1691	488.1	75.8	[482.0, 494.2]	
Hungary	Girl	1160	509.2	79.2	[501.5, 516.8]	-0.13
	Boy	1139	498.4	83.0	[490.4, 506.3]	
Italy	Girl	912	491.2	73.2	[484.5, 497.9]	-0.01
	Boy	893	490.2	78.9	[483.3, 497.2]	
Lithuania	Girl	1130	482.0	79.9	[473.3, 490.7]	-0.06
	Boy	1002	477.5	80.9	[469.8, 485.2]	
Malta	Girl	583	488.2	79.2	[480.3, 496.1]	0.04
	Boy	619	491.2	88.5	[481.9, 500.6]	
Romania	Girl	1301	460.4	105.4	[449.1, 471.8]	-0.20
	Boy	1238	438.0	115.3	[425.0, 450.9]	
Slovenia	Girl	866	488.2	72.2	[480.8, 495.5]	-0.06
	Boy	778	483.8	75.5	[475.3, 492.3]	
Turkey	Girl	487	467.6	99.7	[452.9, 482.3]	0.04
	Boy	492	471.5	99.5	[458.1, 485.0]	

Table G.24

Cohen's d Effect Sizes and 95% CIs Around Means for Gender-Based Achievement Differences Among High-SES Students in Reasoning in Each Sample Country

Country	Sex	*n*	Mean	*SD*	CI	Cohen's *d*
Bulgaria	Girl	1032	491.6	94.4	[479.6, 503.6]	-0.15
	Boy	1034	476.2	108.0	[462.4, 490.0]	
Cyprus	Girl	975	488.3	92.8	[479.3, 497.3]	-0.19
	Boy	997	469.7	99.2	[460.7, 478.6]	
Czech Rep.	Girl	663	524.7	79.6	[514.0, 535.4]	-0.12
	Boy	761	514.9	80.4	[506.4, 523.5]	
Hungary	Girl	730	546.0	81.2	[537.1, 555.0]	-0.04
	Boy	813	542.7	91.4	[531.3, 554.1]	
Italy	Girl	595	501.6	76.3	[493.1, 510.1]	-0.04
	Boy	767	498.5	79.3	[488.7, 508.3]	
Lithuania	Girl	770	508.6	85.3	[494.6, 522.7]	-0.12
	Boy	834	498.5	87.5	[487.3, 509.7]	
Malta	Girl	611	490.3	84.0	[481.2, 499.5]	0.00
	Boy	616	490.6	90.6	[478.9, 502.4]	
Romania	Girl	624	476.4	115.2	[459.5, 493.3]	-0.09
	Boy	684	466.3	116.1	[449.5, 483.2]	
Slovenia	Girl	954	517.0	78.4	[509.5, 524.5]	-0.14
	Boy	1033	506.2	82.1	[497.7, 514.6]	
Turkey	Girl	273	520.4	108.8	[505.0, 535.8]	-0.02
	Boy	310	518.7	119.9	[499.9, 537.4]	

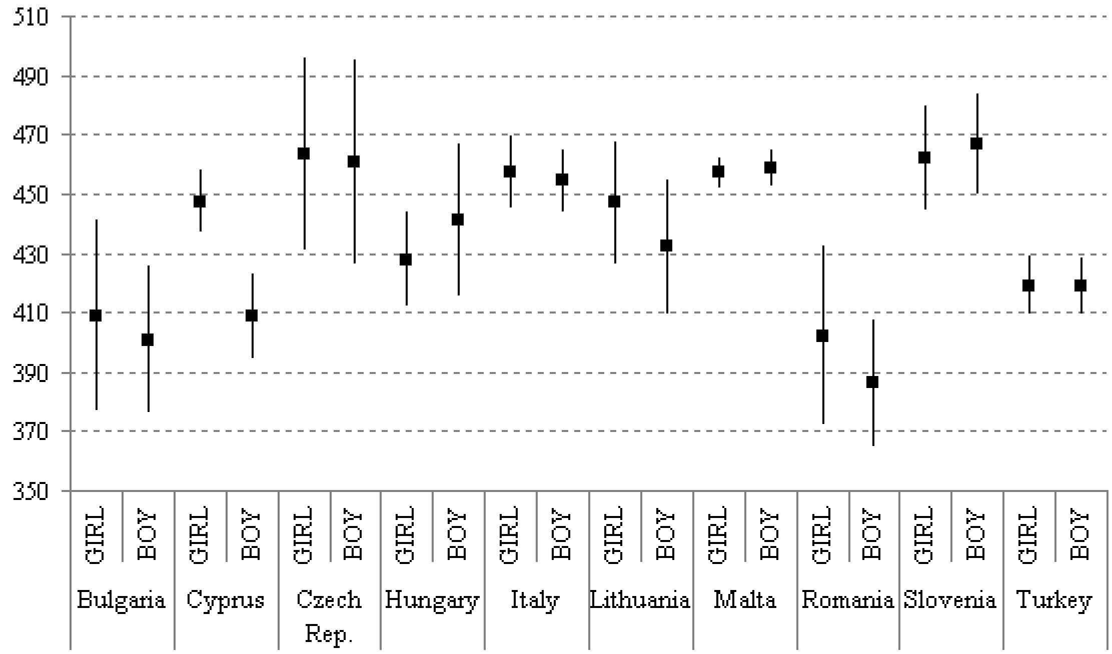

Figure G.22. 95% CIs around means for gender-based achievement differences among low-SES students in reasoning in each sample country.

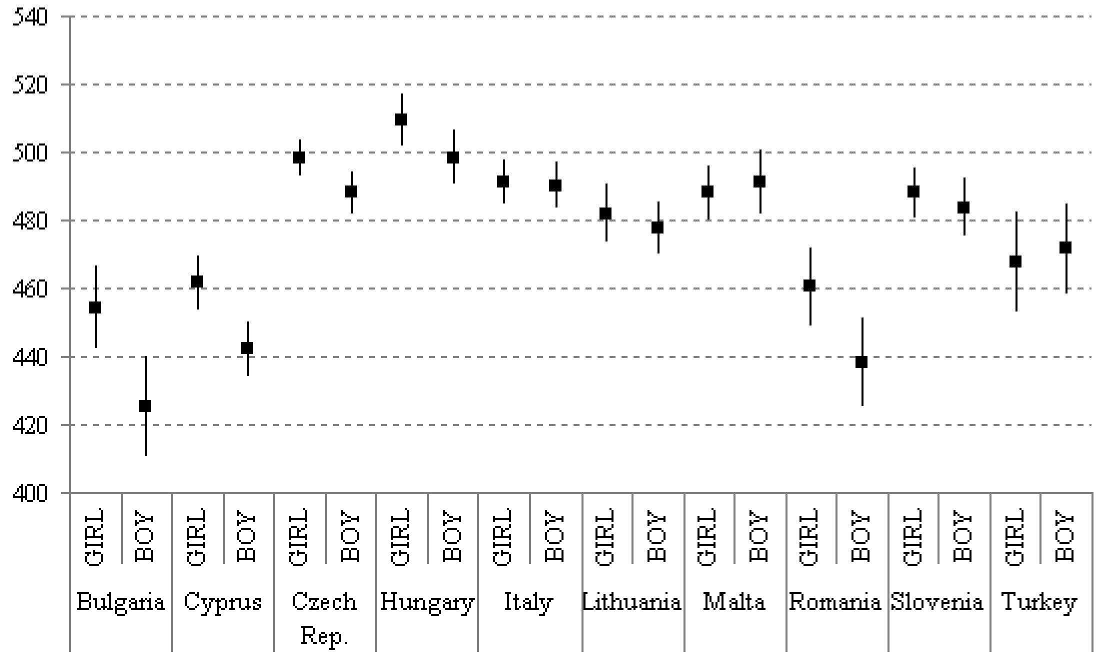

Figure G.23. 95% CIs around means for gender-based achievement differences among medium-SES students in reasoning in each sample country.

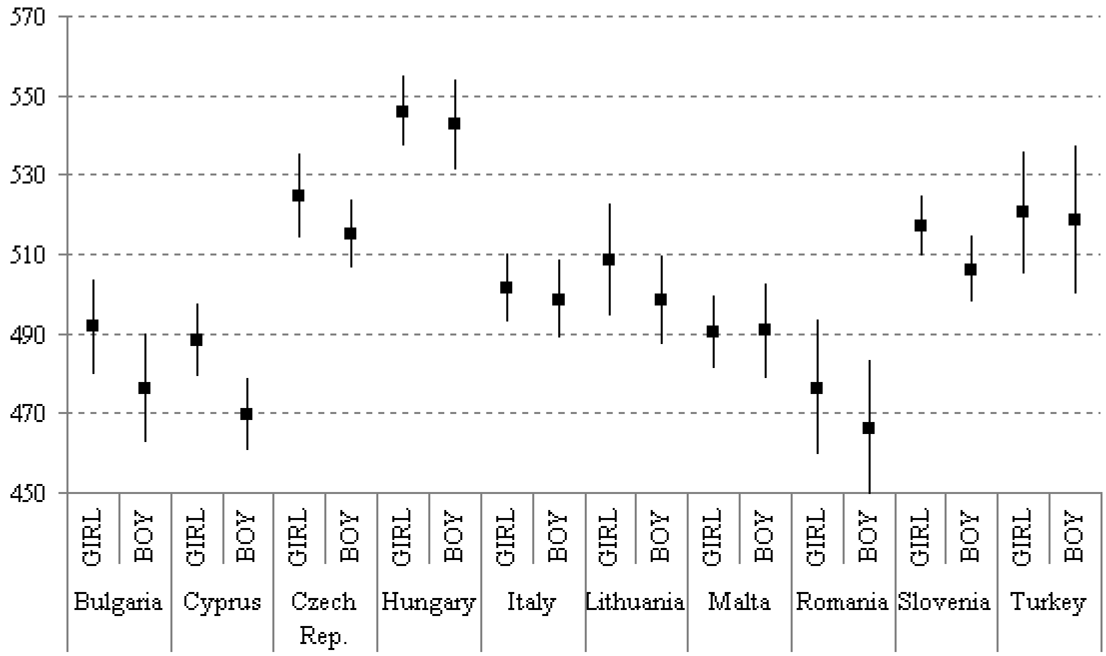

Figure G.24. 95% CIs around means for gender-based achievement differences among high-SES students in reasoning in each sample country.

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Capraro, M. M., Capraro, R. M., Yetkiner, Z. E., Rangel-Chavez, A. F., & Lewis, C. W. (2010). Examining Hispanic student mathematics performance on high-stakes tests: An examination of one urban-school district in Colorado. *The Urban Review, 42*, 193-209.

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Yetkiner, Z. E. (2009). An introduction to regression and canonical commonality analyses: Partitioning predicted variance into constituent parts. *Middle Grades Research Journal, 4*(2), 57-69.

Yetkiner, Z. E., & Capraro, M. M. (2009). Teaching fractions in middle grades mathematics. *Research in Middle Level Education Online*. Retrieved from http://www.nmsa.org/Research/ResearchSummaries/TeachingFractions/tabid/1866/Default.aspx

Özel, S., Yetkiner, Z. E., & Capraro, R. M. (2008). Technology in k-12 mathematics classrooms. *School Science and Mathematics, 108*, 80-85.